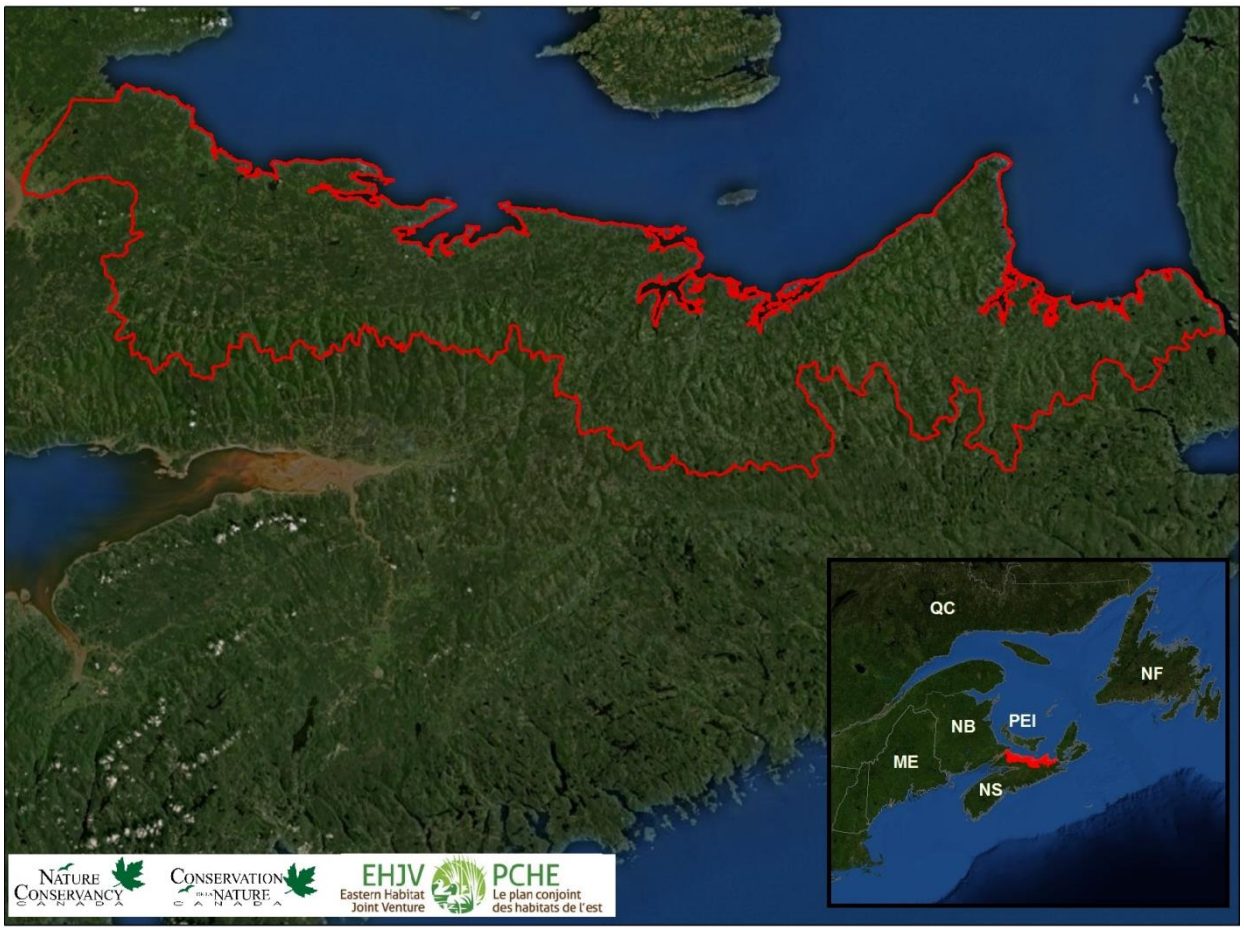
Nova Scotia Northumberland Strait

Habitat Conservation Strategy



Final Report to Environment Canada
by the Nature Conservancy of Canada
July 2014

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 the first 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 Northumberland Shore (NSNS) 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, 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

The 654,032 ha Nova Scotia Northumberland Strait bioregion extends from the Nova Scotia - New Brunswick border, east along the shorelines of the Northumberland Strait and St. Georges Bay, and inland into the Cobequid Hills and the Pictou and Antigonish Highlands to encompass the headwaters of all rivers on mainland Nova Scotia flowing into the Northumberland Strait. The nutrient rich, less acidic soils, and long warm growing season are enduring landscape features that maintain biologically productive ecosystems. The coastline features expansive beaches and dunes, as well as large estuaries and Eelgrass (*Zostra marina)* beds that form at the mouths of river systems and extend far inland due to low topographical gradients. While large salt marshes are uncommon due to low tidal ranges, many smaller ones exist, usually in association with estuarine systems, which are among the most ecologically productive habitat complexes.

Two general forest communities are found in the bioregion, one being the mixed species conifer dominated forests found in the Northumberland and Bras D'Or lowlands, and the other the deciduous dominated forests found in the Acadian Upland subregions. Remaining forest patches found on the narrow Chignecto Isthmus connecting Nova Scotia to New Brunswick are considered critical for ecological connectivity between the two provinces. Eighty-five percent of the bioregion is in natural cover, while 84% is privately owned and only 2.2% is currently managed for conservation (Summary—Figure 1).

The Cobequid Hills and Pictou and Antigonish Highlands help to support populations of endangered mainland Nova Scotia Moose (*Alces alces americana*), and may have once played a larger role as a travel corridor for wide ranging terrestrial mammals, such as the Canada Lynx (*Lynx canadensis)*. The region contains a diverse range of flora and fauna, including 28 species assessed as at risk by the Committee on the Status of Endangered Wildlife in Canada, of which 17 are listed under the Federal Species at Risk Act. Notable among these are Piping Plover (*Charadrius melodus melodus),* Atlantic Salmon *(Salmo salar),* and Wood Turtle (*Glyptemys insculpta)*. Three additional species are listed as at risk within Nova Scotia - Nova Scotia Mainland Moose, Eastern White Cedar (*Thuja occidentalis*, and Ram's Head Lady Slipper (*Cypripedium arietinum*).

The primary river systems are relatively healthy; however the dense and growing number of summer homes and cottages, golf courses and resorts are placing stresses on coastal systems in a province without a coastal development policy. The forestry and agricultural industries have a major presence in the bioregion and continue to play a role in re-shaping the natural landscape here.

Goals

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

1) Identify key conservation areas that are critical for priority conservation species and habitats.
2) Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3) Maintain healthy, intact, and fully functioning ecosystems by building on existing conservation 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.
6) Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7) Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

Vision

The Nova Scotia Northumberland Strait bioregion contains climatic and geologic conditions unique to Nova Scotia. The region contains a diverse array of habitats, including rich and productive coastal estuaries, beach and dune systems that seasonally support significant numbers of migratory waterfowl, water birds, and shorebirds. Habitat connectivity to and through the Chignecto Isthmus is intact allowing for the movement of plant and animal species between Nova Scotia and New Brunswick. These habitats, along with the area's diverse forests and freshwater aquatic ecosystems, are conserved through a coordinated network of public and private initiatives aimed at maintaining their ecological integrity. Sustainable forestry, farming and fishing practices, along with recreational tourism and other resource-based activities continue to provide economic benefits to the region, while utilizing the latest ecosystem-based management approaches in order to minimize impacts on ecological communities. The conservation, restoration, and stewardship of priority habitats and species continues, guided by science and supported by people who are both well-informed and fully engaged in the process.

Conservation priority habitats

Based on habitat affinities of rare species, species at risk, and bird species identified as conservation priorities, the following seven habitat types were determined to be conservation priorities for the NSNS bioregion.

1) Beaches and dunes
2) Salt marshes
3) Tidal flats
4) Acadian forest mosaic
5) Riparian and floodplain systems
6) Freshwater wetlands
7) Grasslands/agro-ecosystems

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 37 (p. 78 to 89) 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 SWNS bioregion that have the highest conservation value in terms of priority habitat attributes and priority species, given the available data. Given that no single map can be expected to provide one 'best' answer, the reader is advised to compare and contrast the priority habitat composite map with the Conservation Value Index (CVI) map when using this document for decision support. To supplement these figures Appendix D presents a summary of the species presented in each map, 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:

1.1 Residential and seasonal cottage development (Status: Medium)
1.3 Recreational development (Status: Medium)
2.1 Blueberry, grain, and crop production (Status: Medium)
2.2 Large scale planting: Pulp and Christmas tree (Status: Medium)
4.1 Road fragmentation (Status: Medium)
5.3 Forest product harvesting (Status: High)
6.1 Recreational Beach Use (Status: Medium)
8.1 Invasive Non-Native Species – European Green Crab (Status: Medium)
8.1 Invasive Non-Native Species – Glossy Buckthorn (Status: Medium)
9.1 Urban/Industrial Effluents (Status: Medium)
9.3 Agricultural and Forestry Effluent (Status: Medium)
11.3 Temperature Extremes (Status: Medium)

The overall threat status for the Nova Scotia Northumberland Shore bioregion is High.

Conservation actions

The following summary presents the conservation actions undertaken by organizations working in the NSNS bioregion 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. 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 15, p. 95.

Government of Nova Scotia

- 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).
- 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.
- Inform and implement the North American Waterfowl Management Plan (NAWMP) and conduct waterfowl surveys as required by the plan (in partnership with the EHJV).
- Conserve habitat and wildlife within Chignecto, John Lusby Marsh, and Wallace Bay National Willdife Areas according to the vision, goals and objectives of their respective managmenet plans.
- 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 SWNS 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.
- 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 ENGO and aboriginal organizations for work specifically on species at risk via the Habitat Stewardship Program and Aboriginal Fund for Species at Risk.
- Continue to support ENGO work on habitat and ecological system conservation/stewardship through direct and in-kind support (Ecological Gifts Program, Environmental Damages Fund, Eco Action, Atlantic Ecosystem Initiative, Wetland Conservation Fund, Habitat Stewardship Program).

Government of Nova Scotia

- Designate an additional 17,764 ha across the bioregion as provincial Wilderness Areas or Nature Reserves, as detailed in the *Parks and Protected Areas Plan*
- Complete a gap analysis for the network of protected areas in the province.
- 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.
- Assess air quality and climate change using lichens within permanent sample plots.
- Conduct biodiversity assessments using stratified, systematic sampling and transects through major landscape features within the bioregion.

- Work is underway to carry out focused inventories for species and ecosystems at risk.
- Carbon modelling on proposed protected areas to compare carbon storage to traditional forestry regime.
- Conduct Moose population surveys.

Eastern Habitat Joint Venture

- 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.

Nature Conservancy of Canada (NCC)

- Continue to pursue high priority conservation lands in key focal areas including on the Chignecto Isthmus and at the Pugwash estuary as well as explore opportunities for the development of land acquisition programs in the Cobequid Highlands and within intact riparian habitats throughout the region. A minimum of 800 ha will be protected during the 5 years of the HCS.
- Jointly explore with the Province of Nova Scotia options for acquisition and protection of a 3,500 ha block of privately owned industrial freehold lands on Chignecto Isthmus.
- Work collaboratively with partners and neighbours to manage conservation lands in the region including conducting baseline inventories and developing management plans for all NCC sites and monitoring key threats. Where possible, direct action will be taken to mitigate threats posing an imminent impact to priority conservation targets. Monitor effectiveness of active management techniques employed on NCC property.
- Update NCC prioritization layer using aerial photo analysis and fieldwork in potential calcareous and floodplain priority areas to determine best site for NCC land assembly efforts.
- Conduct an analysis of landscape connectivity options in the Chignecto Isthmus region.
- Work with MTRI to develop improved mapping of old forest distribution in the bioregion.
- Continue to support research and advance knowledge of unique wetland communities and rare plant occurrences in Mussaguash marshes.
- Work with conservation partners under new and existing frameworks and programs for advancing conservation measures in the region.
- Continue to work to refine knowledge regarding the location of NCC key biodiversity targets to inform property prioritizations.
- Conduct experimental trials to determine best control technique for Glossy Buckthorn and disseminate information to partners.
- Establish a structure to facilitate collaboration and strategic decision making regarding invasive species control techniques (i.e. Invasive Species Alliance).
- Participate in a minimum of six meetings of species at risk recovery teams/advisory committees for Piping Plover and if possible, Wood Turtle by 2018, and where possible, assist with recovery actions.
- 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.

Nova Scotia Nature Trust

- The Nova Scotia Nature Trust does not own or manage any lands within the bioregion.
- Address habitat threats through the education and engagement of stakeholders, landowners, and landusers. The Coastal Conservation and Endangered Species Campaigns may see some activity in bioregion.
- 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.

Bird Studies Canada

- Continue to work together through the coordination of volunteers and partners in plover monitoring, breeding habitat protection, and stewardship on beaches in northern Nova Scotia, including joint monitoring collaborations, outreach, and volunteer celebration events. A Piping Plover recovery strategy has been developed, with a population objective of 60 pairs for NS and 13 for the gulf region, which includes Cape Breton and the Northumberland Strait region.

Ducks Unlimited Canada

- Continue ongoing work in wetland restoration, management and monitoring.
- Administer the Atlantic Wetland Care Program with a goal to target 1800 landowners in the Maritimes and encourage 25 of them to take action to protect essential wetland habitat. The program will secure wetland habitat by encouraging landowners to sign conservation and stewardship agreements.

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.
- Conduct biological surveys in areas of high biodiversity significance to further understanding of rare species' status and distribution.
- Map calcareous ecosystem distribution in the bioregion.

Friends of Pugwash Estuary

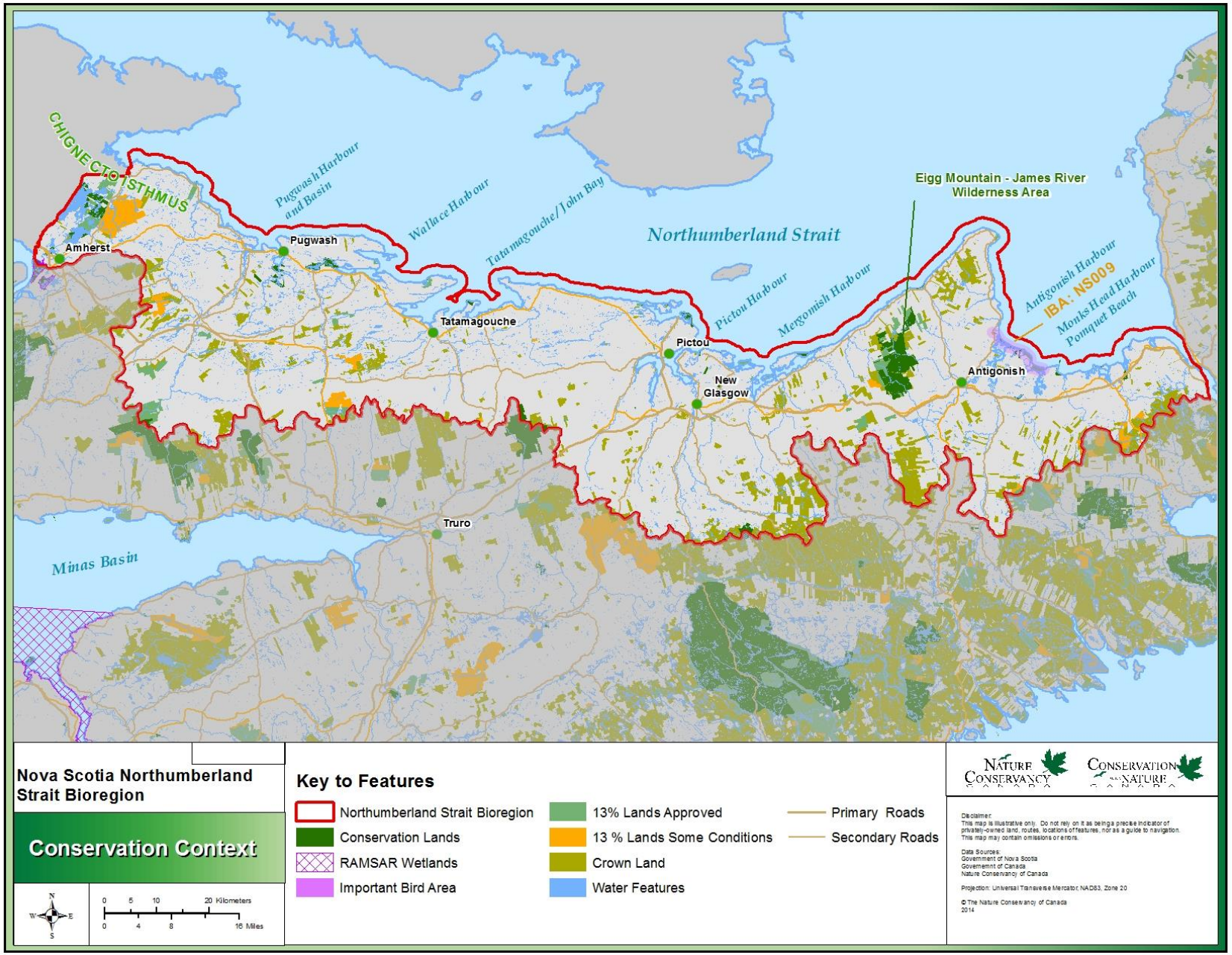
- Continue stewardship of the Pugwash Estuary, including water quality assessments and restoration of tributary streams.

Habitat Unlimited

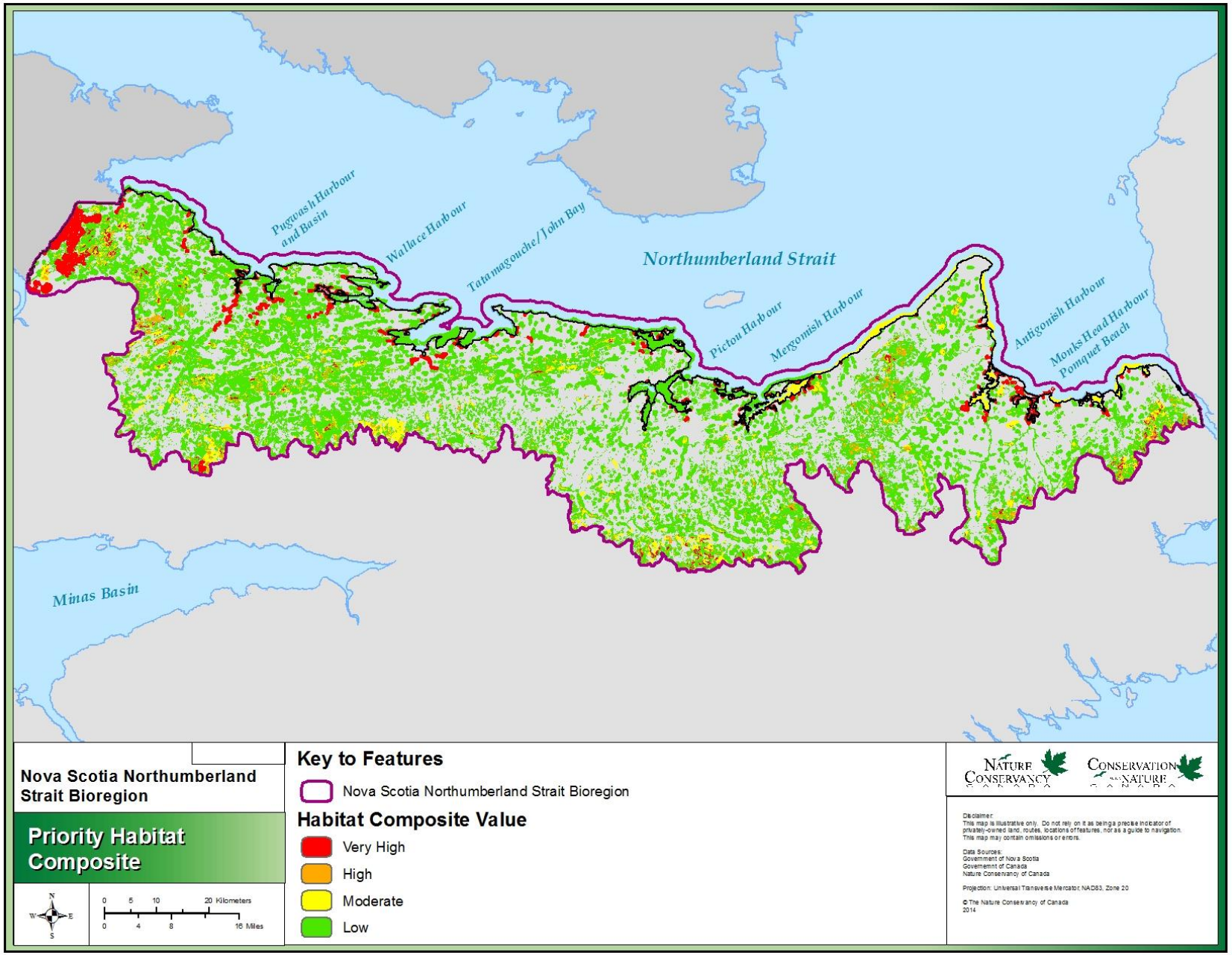
- Conduct annual river restorations in Antigonish County, including clean up and installation of in-stream structures, resulting in the restoration and enhancement of 1 km of stream habitat per year. Develop a remediation strategy for the restoration of Gaspereaux Lake in Antigonish County, as well as the restoration of a wetland within the Town of Antigonish in partnership with St. Francis Xavier. Develop watershed management plans for four watersheds in Antigonish County. Assist a ten-year study on the effects of river restoration on populations of trout.

North Colchester River Restoration Association, Pictou County Rivers Association, Antigonish Rivers Association, Paqtnkek Fisheries

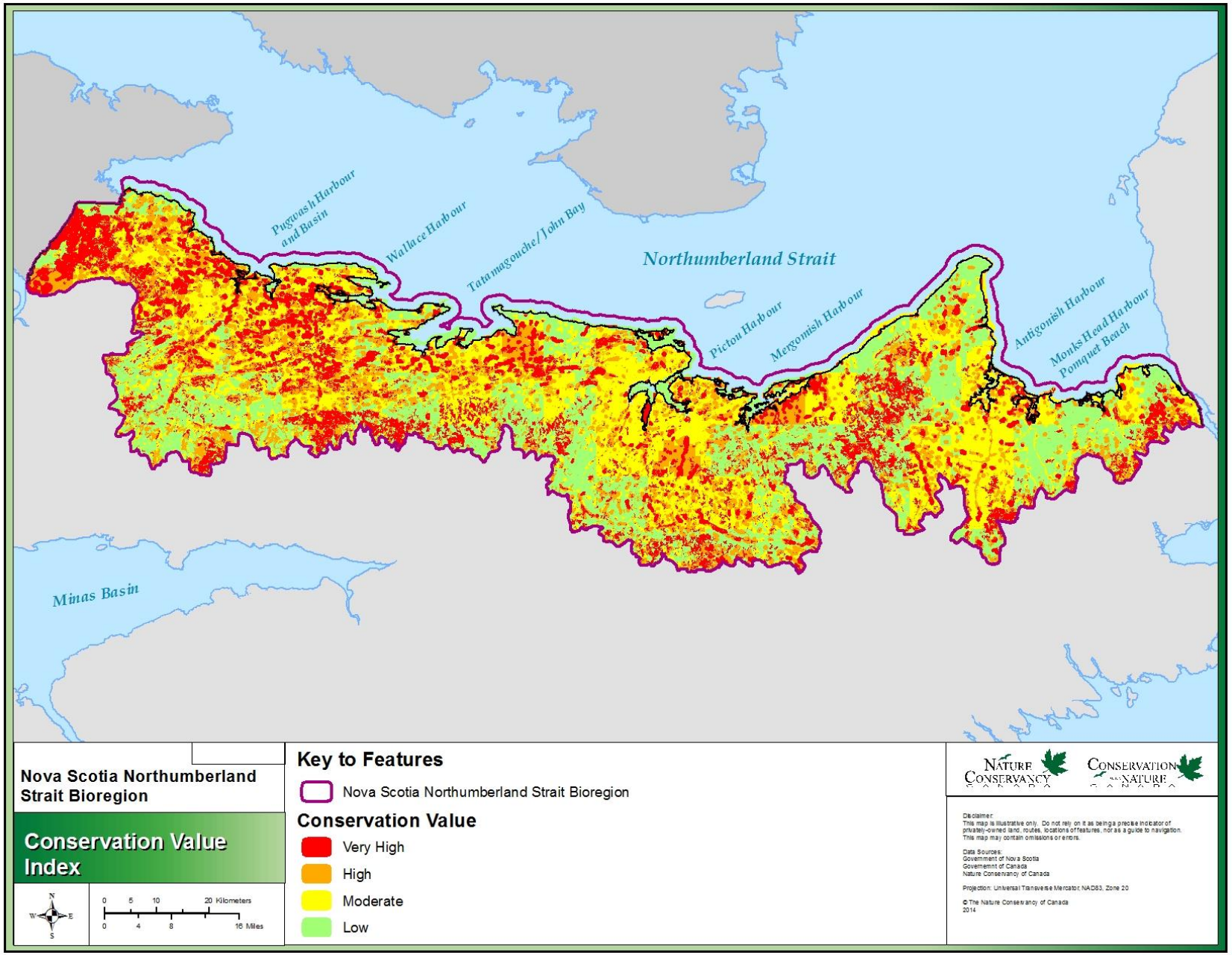
- Continue various river and stream restoration activities in the bioregion.



Summary—Figure 1. Conservation lands in the Nova Scotia Northumberland Strait bioregion.



Summary—Figure 2. Priority habitat composite for the Nova Scotia Northumberland Strait bioregion.



Summary—Figure 3. Conservation value index for the Nova Scotia Northumberland Strait bioregion.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

ACKNOWLEDGEMENTS xvi

1. CONSERVATION CONTEXT 1
   A. Bioregion Scope 1
      i. Location and Size 1
      ii. Boundary Justification 1
      iii. Ecological Significance 3
   B. Ecological Context 5
      i. Climate and geology 5
      ii. Priority species 5
      iii. Protected Areas and Conservation Lands 15
      iv. Social and Economic Considerations 19
2. HABITAT, THREAT, AND SPECIES SPATIAL PRIORITIZATION 21
   A. Conservation Priority Habitat Types 21
      i. Priority Habitat: *Beaches and Dunes* 25
      ii. Priority Habitat: *Salt Marshes* 28
      iii. Priority Habitat: *Tidal Flats* 31
      iv. Priority Habitat: *Riparian and Floodplain Systems* 34
      v. Priority Habitat: *Freshwater Wetlands* 38
      vi. Priority Habitat: *Acadian Forest Mosaic* 42
      vii. Priority Habitat: *Grasslands* 47
      Summary of Habitat Conservation Priority Assessments 50
   B. Threats 51
      i. Current Threats 56
      ii. Emerging Threats 60
   C. Spatial Analyses 72
      i. Habitat spatial prioritization 72
      ii. Species Composites 75
      iii. Conservation Value Index 90
3. CONSERVATION STRATEGY 92
   A. Vision 92
   B. Goals 92
   C. Actions 93
      i. Identified Knowledge and Action Gaps 93
      ii. Conservation Actions 95
      iii. Additional Stewardship, Education, Outreach and Advocacy 107

References 108

Appendices 117

Appendix A. List of Abbreviations 117
Appendix B. Glossary of Biodiversity and Conservation Ranks 118
Appendix C. Priority species—Conservation Ranks and Data Sources 121

Appendix D. Priority species—Habitat Associations 134
Appendix E. Priority habitat composite methodology 152
Appendix F. Priority species composites methodology 158
Appendix G. Conservation value index methodology 163
Appendix H. IUCN Threat Categories 164
Appendix I. IUCN Conservation Actions Classification 167

List of Tables

Table 1. Ecological Land Classifications in the Nova Scotia Northumberland Strait bioregion. 3

Table 2. Nationally assessed and provincially listed species in the Nova Scotia Northumberland Strait bioregion. 7

Table 3. Global priority species (G1-G3G4) within the Nova Scotia Northumberland Strait bioregion. 8

Table 4. Priority bird species in Bird Conservation Region 14, and Marine Biogeographic Unit 12 in Nova Scotia and justification for their priority status (Environment Canada 2013). Species are listed alphabetically by common name within their respective group. Adapted with permission from Environment Canada 11

Table 5. Conservation lands within the Nova Scotia Northumberland Strait bioregion. 16

Table 6. Proposed (approved and pending) conservation lands in the Nova Scotia Northumberland Strait bioregion, including new conservation lands and expansions to existing conservation lands. 17

Table 7. Population of year round residents by County in 2006 and 2011 (Statistics Canada 2012 a,b,c,d). 20

Table 8. Description of the assessment ranks of ecological integrity of the conservation priority habitat types for the Northumberland Strait bioregion 23

Table 9. Priority species associated with each conservation priority habitat type in the Nova Scotia Northumberland Strait bioregion (see Appendix D for the complete list of priority species with fine-filter habitat associations). 24

Table 10. Assessment ranks of ecological integrity for the habitat conservation priorities in the Nova Scotia Northumberland Strait Bioregion. 50

Table 11. Summary of threats to the Nova Scotia Northumberland Strait bioregion. 51

Table 12. Relative magnitude of identified threats to priority species within BCR 14 NB, and MBU 12 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. 53

Table 13. Priority habitat and species composites generated and spatial data sources used. 76

Table 14. Summary results for the conservation value index for the Nova Scotia Northumberland Strait bioregion. 90

Table 15. Conservation actions and associated information for conservation partners in the Nova Scotia Northumberland Strait bioregion. 95

Table 16. Minimum size criteria for each habitat type within the NS Northumberland Strait bioregion. 156

Table 17. Data layers, sources, and types used to describe priority species spatial distribution within the Nova Scotia Northumberland Strait bioregion. 158

Table 18. Precision codes, definitions, spatial context, unit size, and range of values for species occurrence records within the ACCDC dataset. 159

Table 19. List of rasterized layers used in the conservation value index analysis with their respective scoring range. 163

List of Figures

Figure 1. Nova Scotia Northumberland Strait bioregion. 2

Figure 2. Primary watersheds within the Nova Scotia Northumberland Strait bioregion. 4

Figure 3. Nova Scotia Mainland Moose concentration areas (Source: NS DNR Wildlife Division 2012). .. 10

Figure 4. Conservation lands in the Nova Scotia Northumberland Strait bioregion. 18

Figure 5. Beach and dune habitat within the Nova Scotia Northumberland Strait bioregion 27

Figure 6. Salt marsh habitat within the Nova Scotia Northumberland Strait bioregion 30

Figure 7. Tidal flat habitat within the Nova Scotia Northumberland Strait bioregion. 33

Figure 8. Riparian and floodplain systems within the Nova Scotia Northumberland Strait bioregion 37

Figure 9. Composition of freshwater wetlands within the Nova Scotia Northumberland Strait bioregion according to the provincial wetland classification and inventory. 39

Figure 10. Freshwater wetland habitat within the Nova Scotia Northumberland Strait bioregion. 41

Figure 11. Scaling factors for matrix forming forest in the Northern Appalachian/Acadian Ecoregion showing rationale for minimum core protected area (forest block size) (Anderson *et al.* 2006). 43

Figure 12. Composition of late-successional forest types within the Nova Scotia Northumberland Strait bioregion. 44

Figure 13. Late successional Acadian Forest matrix habitat within the Nova Scotia Northumberland Strait Bioregion 46

Figure 14. Potential for grassland habitat within the Nova Scotia Northumberland Strait bioregion. 49

Figure 15. Ranked IUCN sub-categories of threats to priority bird species within BCR 14 NS and corresponding to priority habitats 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; Salaksky 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 2016 by A. R. Benoît. 54

Figure 16. Human Footprint Index in the Nova Scotia Northumberland Strait bioregion. 63

Figure 17. Urban, rural, and coastal development in the Nova Scotia Northumberland Strait bioregion. 64

Figure 18. Agricultural lands in the Nova Scotia Northumberland Strait bioregion. 65

Figure 19. Pulp and Christmas tree plantations in the Nova Scotia Northumberland Strait bioregion. ... 66

Figure 20. Wind farms in the Nova Scotia Northumberland Strait bioregion. 67

Figure 21. Road fragmentation in the Nova Scotia Northumberland Strait bioregion. 68

Figure 22. Road density in the Nova Scotia Northumberland Strait bioregion. 69

Figure 23. Forest harvesting and silviculture in the Nova Scotia Northumberland Strait bioregion. 70

Figure 24. Shoreline armouring in the Nova Scotia Northumberland Strait bioregion. 71

Figure 25. Conservation priority habitat composite for the Nova Scotia Northumberland Strait bioregion. 74

Figure 26. Species composite for species at risk (COSEWIC assessed and NS ESA listed) and rare non-bird priority species in the Nova Scotia Northumberland Strait bioregion. 78

Figure 27. Species composite for non-bird species at risk (COSEWIC assessed and NS ESA listed) in the Nova Scotia Northumberland Strait bioregion. 79

Figure 28. Species composite for rare and at risk non-bird habitat limited priority species[1] in the Nova Scotia Northumberland Strait bioregion..... 80

Figure 29. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) terrestrial invertebrate priority species in the Nova Scotia Northumberland Strait bioregion. 81

Figure 30. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) reptiles in the Nova Scotia Northumberland Strait bioregion. 82

Figure 31. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) mammals in the Nova Scotia Northumberland Strait bioregion. 83

Figure 32. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) plant and lichen species in the Nova Scotia Northumberland Strait bioregion. 84

Figure 33. Relative abundance[1] species composite for rare, at risk (COSEWIC assessed and NS ESA listed), and priority bird species in the Nova Scotia Northumberland Strait bioregion. 85

Figure 34. Breeding evidence[1] species composite for rare, at risk (COSEWIC assessed and NS ESA listed), and priority bird species in the Nova -Scotia Northumberland Strait bioregion. 86

Figure 35. Species composite for bird species at risk (COSEWIC assessed and NS ESA listed) in the Nova Scotia Northumberland Strait bioregion (based on breeding evidence and relative abundance). 87

Figure 36. Breeding evidence composite for species at risk, rare and priority habitat limited bird species in the Nova Scotia Northumberland Strait bioregion. 88

Figure 37. Species composite for all rare, at risk (COSEWIC assessed and NS ESA listed), and priority priority species in the Nova Scotia Northumberland Strait bioregion. 89

Figure 38. Conservation Value Index for the Nova Scotia Northumberland Strait bioregion. 91

Figure 39. 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)..... 160

ACKNOWLEDGEMENTS

The primary authors of this document are John Wile and Pat Nussey - Nature Conservancy of Canada – Atlantic Region.

The authors would like to thank the following individuals for their input and advice into the development of this strategy:

Environment Canada: Al Hanson, Anne Benoit, Becky Whittam, Colleen McNeil, Colin MacKinnon, Jen Rock, Julie Paquet, Karel Allard, Kathyrn Parlee, Matthew Mahoney, Patricia Edwards, Samara Eaton, Sheri Faulkner-Jackson. Julie McKnight, Bruce Pollard, Alana Plummer

Nature Conservancy of Canada: Craig Smith, Margo Morrison, Josh Noseworthy

Nova Scotia Environment: Rob Cameron, Kermit deGooyer, Dave MacKinnon, Peter Bush, John Brazner

Nova Scotia Department of Natural Resources, Wildlife Division: Randy Milton, Mark Elderkin, Sean Basquill, Sherman Boates, Frances MacKinnon, Kim George, Mark Pulsifer, Ross Hall (retired)

Nova Scotia Department of Natural Resources, Forestry Division: Peter Neily, Bruce Stewart, Rob O'Keefe

Nova Scotia Nature Trust: Katie Porter

Atlantic Canada Conservation Data Centre: Sean Blaney

Bird Studies Canada: Becky Stewart, Sue Abbot, Kate Bredin, Andrew Couturier, Eva Jenkins

Cumberland Wilderness Society: Ron Patterson

Friends of Pugwash Estuary: Alice Power

The Ecology Action Centre: Jocelyn Rankin, Jennifer West

Habitat Unlimited: Kris Hunter

1. CONSERVATION CONTEXT

A. Bioregion Scope

i. Location and Size

The Nova Scotia Northumberland Strait (NSNS) bioregion is located in northern Nova Scotia and follows the shoreline of the Northumberland Strait between the New Brunswick border and the Strait of Canso (Figure 1). From the coast, the bioregion extends inland to encompass the headwaters of all rivers on mainland Nova Scotia flowing into the Northumberland Strait. The Chignecto Isthmus is a critical corridor for the movement of plant and animal species between the two provinces. This Habitat Conservation Strategy will also include the area of the Chignecto Isthmus that drains into the Bay of Fundy so that the isthmus is treated as a single unit. Urban centres from west to east include the towns of Amherst, Springhill, Pugwash, Tatamagouche, Pictou, New Glasgow, and Antigonish.

The bioregion contains a contiguous surface area of 654,032 ha, which represents 12% of the province. The bioregion falls within the Northern Appalachian/Acadian Ecoregion and encompasses portions of the Northumberland - Bras D'or Lowlands and Acadian Uplands subregions (Anderson *et al.* 2006). It contains parts of two Ecoregions along with all or some of the nine Ecodistricts nested within them, as delineated within the Nova Scotia Department of Natural Resources provincial ecological land classification scheme (Neily *et al.* 2003). The region includes all or a portion of 14 Natural Landscapes as defined by the Nova Scotia Department of Environment (2002). Finally, all of the terrestrial portions of Maritime Canada fall within the Atlantic Northern Forest Bird Conservation Planning Region 14 and the coastal portion of the bioregion is within Marine Biogeographic Unit 12 (Table 1; Environment Canada 2013.). The bioregion contains 925 km of shoreline, representing 10% of the province's entire coastline. The coastline consists primarily of shallow sloping tidal flats interrupted by numerous inlets and estuaries.

ii. Boundary Justification

The terrestrial boundary of the bioregion is the Nova Scotia Northumberland Strait and St. Georges Bay shorelines to the north and the boundaries of the primary watersheds of all rivers flowing in to the Northumberland Strait to the south. Also included are the watersheds of the Chignecto Isthmus, with the Missaguash (primary) and Laplanche River (secondary) watersheds draining to the Bay of Fundy, and the Tidnish and Shinimicas, both primary watersheds, draining to the Northumberland Strait (**Erreur ! Source du renvoi introuvable.**). 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 habitats (Environment Canada & Parks Canada Agency 2010). Watershed management is a common practice in many jurisdictions, and an operational landscape unit for local watershed and stewardship groups.

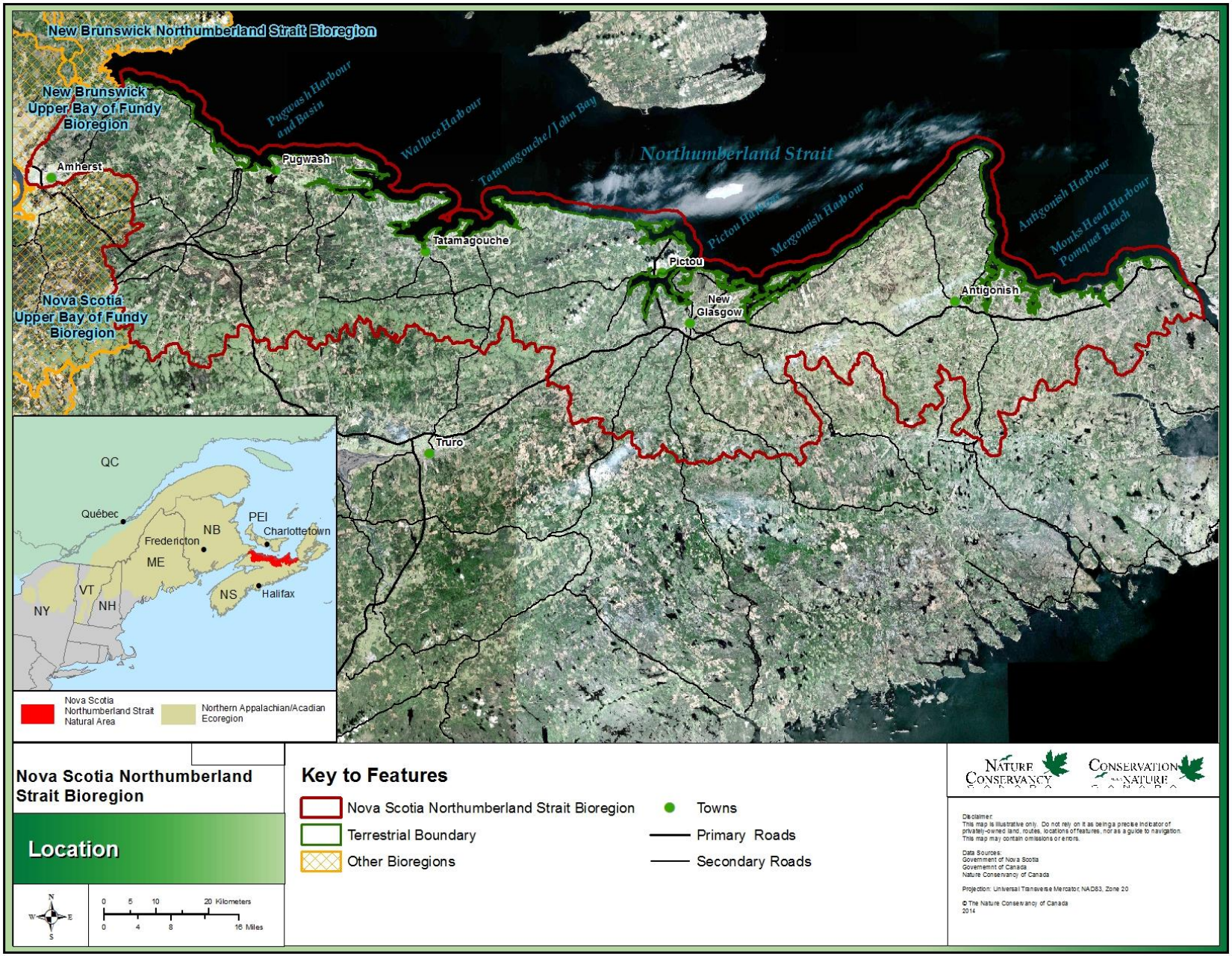


Figure 1. Nova Scotia Northumberland Strait bioregion.

Table 1. Ecological Land Classifications in the Nova Scotia Northumberland Strait bioregion.

NAAP Subregion[1]	Bird Conservation Region	Eco Region[2]	Ecodistrict[2]	NS Natural Landscape[3]*
Northumberland – Bras D'Or lowlands	Bird Conservation Region (BCR) 14; Atlantic Northern Forest. Marine Biogeographic Unit (MBU) 12	500 - Northumberland – Bras D'Or lowlands	520 - St. George's Bay 530- Northumberland Lowlands 540- Cumberland Hills 550- Tantramar Marshlands	#19 Chignecto Rigid Plain #20 Cumberland Foothills # 21 Tantramar Marshes # 22 Northumberland Strait Plain # 42 Pictou River Hills #45 South River Low Hills
Acadian "Uplands"		300 -Nova Scotia Uplands	330 – Pictou /Antigonish Highlands 340 -Cobequid Hills 360 -Mulgrave Plateau 370 – St Mary's River 380- Central Uplands	# 23 Cobequid Mountain # 26 Central Rolling Hills # 40 Aspen Drumlin Plain # 41 St Mary's Plain #43 McArras Brook Hills #44a/44b Pictou-Antigonish Hills (Pictou/Antigonish) # 46 Mulgrave Hills

[1] *Northern Appalachians-Acadian Plan (NAAP; Anderson et al. 2006)*

[2] *Nova Scotia Department of Natural Resources Ecological Land Classification (Neily et al. 2003)*

[3] *Nova Scotia Department of Environment and Labour Natural Landscape (NSDEL 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 natural landscapes found within this bioregion contain a diverse array of ecosystems and provide habitat for a wide range of species, including 28 COSEWIC assessed, 17 federally listed, and 21 provincially listed species at risk. The Northern Appalachian-Acadian Ecoregional Plan (NAAP; Anderson *et al.* 2006) identified a number of critical ecological systems for the bioregion, including large matrix forest, coastal beaches, salt marshes, tidal flats, and freshwater wetlands, riparian, and floodplain systems. The NAAP also identified species that cannot be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention, including the Piping Plover (*Charadrius melodus)*, Barrow's Goldeneye (*Bucephala islandica*), Bicknell's Thrush (*Catharus bicknelli*), Ipswich Sparrow (*Passerculus sandwichensis princeps*), Brook Floater (*Alasmidonta varicosa*), and Ram's Head Lady Slipper (*Cypripedium arietinum*). The presence of Piping Plover in the Pomquet Beach area has lead to its designation as an Important Bird Area. Important Bird Areas (IBAs) are areas recognized as being globally important habitat for the conservation of bird populations (IBA Canada 2012).

The bioregion contains 13% of the province's salt marshes, which are usually associated with estuaries in this bioregion. Collectively, the many large estuaries and coastal wetlands scattered along the 925 km of shoreline supply critical migration and staging habitat for waterfowl, waterbirds, and shorebirds for extended periods, especially during fall migration, which can last from late August until late December. The bioregion contains important ecosystems and species including 15 relatively unobstructed and highly productive river systems contained within eight primary watersheds that flow into the Northumberland Strait and the Bay of Fundy. These tidal river systems support populations of anadromous fish including Atlantic Salmon (*Salmo salar*). Large coastal estuaries and Eelgrass (*Zostera marina*) beds are important migration and staging areas for waterfowl, waterbirds, shorebirds, Bald Eagle (*Haliaeetus leucocephal)*, and Osprey (*Pandion haliaetus*). Biological productivity is high within the bioregion, driven by inherent soil fertility with its acid buffering capacity, and by long, warm growing seasons and suitable moisture regimes (Davis & Browne 1996a).

The bioregion also includes the Nova Scotia portion of the Chignecto Isthmus, an ecological land bridge connecting Nova Scotia with the rest of North America. Habitat fragmentation from development within the isthmus limits connectivity and may restrict wildlife population dispersal and gene flow between the two provinces (Nussey 2010).

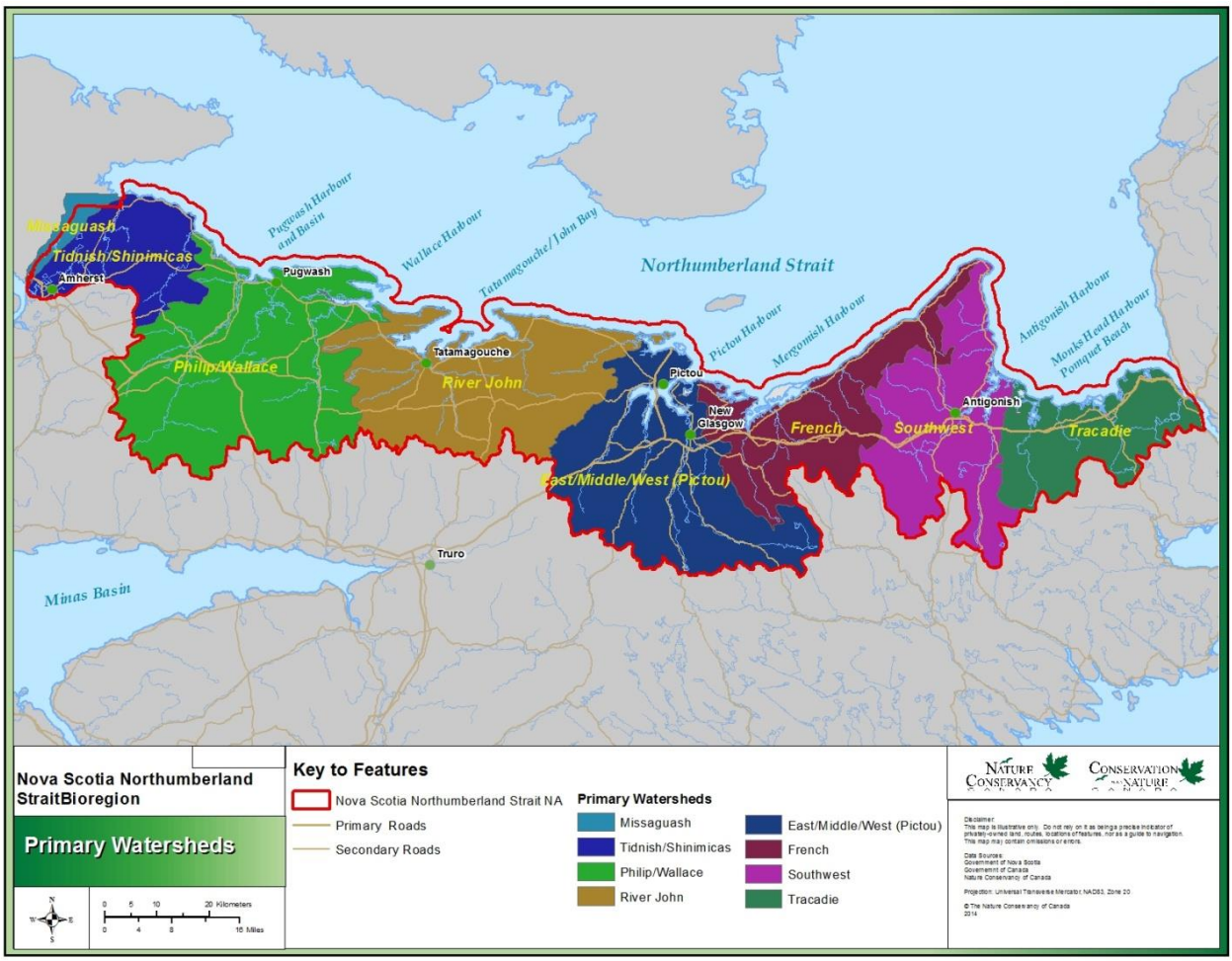


Figure 2. Primary watersheds within the Nova Scotia Northumberland Strait bioregion.

B. Ecological Context

i. Climate and geology

Influenced by the warm waters of the Northumberland Strait, the lowland region of the bioregion has a 140 frost free day growing period, facilitating relatively rapid forest regeneration. The higher elevations have a harsher climate with only 100 frost free days, summer fog, colder winters, and less precipitation than the lowland areas (Neily *et al.* 2003). This climatic difference favours slower growing deciduous dominated forests, which are found on higher elevations.

Terrestrial ecological processes acting within the bioregion are heavily influenced by the topography and soils (type, nutrient content, and drainage capacity) found in the two major biophysical regions – the lowlands, and the hills or highlands. Davis & Browne (1996b) describe the Carboniferous Lowland regions of Nova Scotia as being formed on sedimentary rocks on which deep soils have developed on a flat or gently rolling coastal plain. The Northumberland Plain, St. Georges Bay, and Tantramar Marshes subunits make up the lowland region within the bioregion. Within the Northumberland Plain and St. Georges Bay regions, deep soils have developed on erodible sandstone, and the presence of gypsum and limestone reduces soil acidity. The Tantramar Marsh lowlands are situated on the Chignecto Isthmus and, in contrast, the soils here developed from Bay of Fundy silts carried in with the tides, mixed with peat as you progress toward the Northumberland Strait. This low, flat, wet, and poorly drained area has developed into a complex of bogs, fens, marshes, and forested wetlands. The Cobequid Hills and Antigonish/Pictou Highlands are as high as 300 m above sea level and contain gravel-associated soils. Steep slopes found along river valleys, as well as the floodplain areas closer to the rivers, generate soil and hydrology processes unique to these areas.

ii. Priority species

Conservation priority species for the NSNS bioregion 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

There are 28 COSEWIC assessed, 17 SARA listed, and 21 provincially listed species at risk found in the NSNS bioregion (

Table 2). Additionally, a total of 12 global priority species (G1-G3G4) were identified within the bioregion, five of which are also federally listed species at risk (Table 3). Appendix B provides a complete glossary of biodiversity and conservation ranks. Appendices C and D each provide the complete list of priority species found within the NSNS bioregion with their conservation status and source of occurrence data, and coarse filter habitat associations respectively. This HCS primarily targets terrestrial species; the treatment of aquatic species is cursory in this report.

Table 2. Nationally assessed and provincially listed species in the Nova Scotia Northumberland Strait bioregion.

Common Name	*Scientific Name*	COSEWIC	SARA	NS ESA
Fish				
American Eel	*Anguilla rostrata*	Threatened		
Atlantic Salmon	*Salmo salar*	Special Concern	Endangered	
Striped Bass	*Morone saxatilis*	Special Concern		
Birds				
Bank Swallow	*Riparia riparia*	Threatened		
Barn Swallow	*Hirundo rustica*	Threatened		Endangered
Barrows Goldeneye (E.)	*Bucephala islandica*	Special Concern	Special Concern	
Bicknell's Thrush	Catharus bicknelli	Threatened	Threatened	
Bobolink	*Dolichonyx oryzivorus*	Threatened		Vulnerable
Canada Warbler	*Wilsonia canadensis*	Threatened	Threatened	Endangered
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened	Endangered
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened
Eastern Whip-poor-will	*Caprimulgus vociferus*	Threatened	Threatened	Threatened
Eastern Wood Peewee	*Contopus virens*	Special Concern		Vulnerable
Olive-Sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	Threatened
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		
Amphibians/Reptiles				
Snapping Turtle	*Chelydra serpentina*	Special Concern	Special Concern	Vulnerable
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatend	Threatened
Invertebrates				
Monarch	*Danaus plexippus*	Special Concern	Special Concern	
Brook Floater	*Alasmidonta varicose*	Special Concern	Special Concern	Threatened
Mammals				
Little Brown Bat	*Myotis lucifugus*	Endangered		Endangered
Moose (Mainland NS)	*Alces americanus*			Endangered
Northern Myotis	*Myotis septentrionalis*	Endangered		Endangered
Tri-colored Bat	*Perimyotis subflavus*	Endangered		Endangered
Plants				
Black Ash	*Fraxinum nigra*			Threatened
Eastern Baccharis	*Baccharis hamilifolia*	Threatened		Threatened
Eastern Lilaeopsis	*Lilaeopsis chinensis*	Special Concern	Special Concern	Vulnerable
Eastern White Cedar	*Thuja occidentalis*			Vulnerable
Rams-Head Lady's Slipper	*Cypripedium arietinum*			Endangered

Table 3. Global priority species (G1-G3G4) within the Nova Scotia Northumberland Strait bioregion.

Common Name	*Scientific Name*	Global Rank
Birds		
Piping Plover	*Charadrius melodus melodus*	G3TNR
Amphibians/Reptiles		
Wood Turtle	*Glyptemys insculpta*	G3
Invertebrates		
Brook Floater	*Alasmidonta varicosa*	G3
Salt Marsh Copper	*Lycaenado spassosi*	G2G3
Tidewater Mucket	*Leptodea ochracea*	G3G4
Mammals		
Little Brown Myotis	*Myotis lucifugus*	G3
Plants		
Fernald's Serviceberry	*Amelanchier fernaldii*	G2G4Q
Frankton's Saltbush	*Atriplex franktonii*	G2G3
Robinson's Hawkweed	*Hieracium robinsonii*	G2G3
Robinson's Hawthorn	*Crataegus robinsonii*	G2G4Q
Roland's Sea-Blite	*Suaeda rolandii*	G1G2
Rams-Head Lady's Slipper	*Cypripedium arietinum*	G3

Environment Canada Priority Bird Species

In 2013, Environment Canada completed a bird conservation strategy for Nova Scotia, including Bird Conservation Region (BCR) 14, as well as Marine Biogeographic Units (MBU) 11 and 12. This strategy is designed to serve as a framework for implementing bird conservation for the province's priority bird species, which include those species that regularly occur in the region that are vulnerable due to population size, distribution, population trend, abundance, and threats (Environment Canada 2013). Some widely distributed and abundant 'stewardship' species are also included because they typify the national or regional avifaunal 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 impacts on other species or habitats. There are 62 priority bird species identified in BCR 14 and 35 priority bird species identified in MBU 12 marine habitats in Nova Scotia (with some overlap; Table 4). The list is dominated by landbirds (40 species) but also includes 18 species of shorebirds, 18 species of waterbirds, and 12 species of waterfowl. Wetlands are used by the greatest number of species (45%), followed by forests (35%), and cultivated and managed areas (34%).

Significant forest associated species

Many avian species depend on intact, unfragmented woodlands with components of old forest. Several species of owls, bats and woodpeckers require large, partially decaying trees for nesting sites (Erskine 1992). Research suggests many bird species that show a preference for old forests, for example Yellow-bellied Sapsucker (*Sphyrapicus varius*), Blackburnian Warbler (*Setophaga fusca*), Brown Creeper (*Certhia americana*) and Northern Parula (*Setophaga americana*), are much less abundant in Nova Scotia than they would have been historically (Staicer 2001). There are breeding records of four COSEWIC assessed forest birds in the bioregion, the Olive-sided Flycatcher, Canada Warbler, Rusty Blackbird, and candidate Eastern Kingbird. These species are exhibiting declines across their ranges, as reflected by the results of

the recently completed second Maritime Breeding Bird Survey. Some of the priority breeding forest birds listed in the BCR 14 plan that are found in the bioregion include the Bay-breasted Warbler (*Dendroica castanea*), Cape May Warbler (*Dendroica tigarin*), and Eastern Wood-Pewee (*Contopus virens*).

The forests in the Northumberland Strait bioregion of Nova Scotia are also important habitat for wide ranging mammals, including Moose, Black Bear (*Ursus americanus*), and Bobcat (*Lynx rufus*). The mainland Nova Scotia population of Moose is of particular interest, having been listed as provincially endangered since 2003. Moose were the most common large mammal in Nova Scotia at the time of European settlement, with an estimated population of 15,000 individuals (Parker 2003). Declining Moose populations in the Maritime Provinces in the early 1900s resulted in hunting restrictions, however Moose in Nova Scotia continued to decline with an estimated population low of 357 individuals on mainland Nova Scotia in the mid 1990s (Parker 2003). The population was estimated at 1000 to 1200 individuals in most recent surveys (NSDNR 2007). The reasons for the the declines are not well understood, but may involve a complex set of threats including excessive hunting, poaching, climate change, increased road access to Moose habitat, spread of White-tailed Deer (*Odocoileus virginianus*) and the associated spread of a parasitic brain worm, high levels of cadmium and dietary deficiencies (e.g., cobalt), or an unknown viral disease (NSDNR 2007; Pulsifer & Nette 1995). Studies have shown low road density to be one of the best predictors of suitable Moose habitat in Nova Scotia (Beazley *et al.* 2004).

The recovery plan for mainland moose in Nova Scotia (2007) indicates that the Northumberland Strait bioregion contains habitat used by three disjunct subpopulations of mainland moose. An estimated 25 animals remain in the Pictou population and 40 in the Antigonish/Guysborough population. The bioregion includes a small portion of the Cobequid range that contains the largest population, an estimated 600 animals. A recent analyses of moose pellet counts and sightings have resulted in a better understanding of current moose distribution (Figure 3). The model, developed by NS DNR Wildlife Division in 2012, includes an estimate of total occupied range, relative population density, and significant population concentration areas. It was developed using 3272 moose observational records compiled between 1999 and 2011. A small population of moose can be found on the Nova Scotia side of the Chignecto Isthmus near the New Brunswick border, but it is quite likely derived from animals that moved in from New Brunswick which are genetically different (NSDNR 2007). The Canada Lynx is another species that may have been historically connected to populations in New Brunswick through the Isthmus. Canada Lynx are currently found only on Cape Breton Island, but once occupied higher elevations such as the Cobequid Hills on the mainland, close to the Isthmus (Parker 2001). A confirmed sighting of a Canada Lynx track on the Isthmus was made in 2008, indicating that these animals may still be moving through occasionally (MacKinnon 2008).

Significant flora found in the bioregion's forests includes Rams-Head Lady's Slipper and the Eastern White Cedar. The status report for Ram's Head Lady Slipper (Blaney & Mazerolle 2007) explains that the plant is found in forested areas near gypsum bedrock outcrops in only six locations in the province. It is found within this bioregion in central Cumberland County near Angevine Lake, but there is the possibility that it could exist in other karst forest locations, such as those found in the Antigonish area. Eastern White Cedar is listed as vulnerable in Nova Scotia and, while it grows in a variety of habitats, it prefers wet, nutrient rich and high pH soils (Lemieux 2010). Found in the five western counties of the province, it also exists in Cumberland County near Oxford where the Trans Canada highway was built through one stand (Newell 2005). A relatively large stand of white cedar (around 30 ha) exists along Race Track Brook near Oxford (Kim George, pers. comm.).

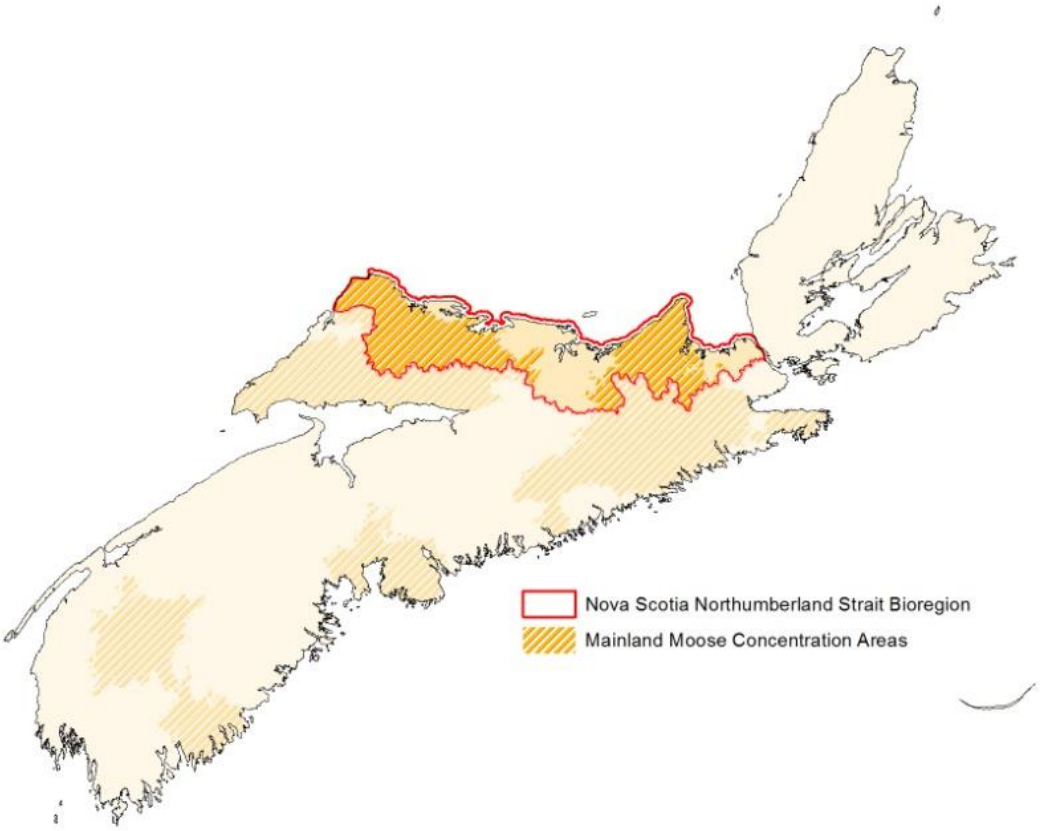


Figure 3. Nova Scotia Mainland Moose concentration areas (Source: NS DNR Wildlife Division 2012).

Table 4. Priority bird species in Bird Conservation Region 14, and Marine Biogeographic Unit 12 in Nova Scotia and justification for their priority status (Environment Canada 2013). Species are listed alphabetically by common name within their respective group. Adapted with permission from Environment Canada.

Common Name	*Scientific Name*	Group	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 12	Population Objective
Landbirds								
American Redstart	*Setophaga ruticilla*	Landbird				y		Maintain current
Bald Eagle	*Haliaeetus leucocephalus*	Landbird				y		Maintain current
Bank Swallow	*Riparia riparia*	Landbird	TH			y		Increase 100%
Barn Swallow	*Hirundo rustica*	Landbird	TH		EN	y		Increase 100%
Bay-breasted Warbler	*Dendroica castanea*	Landbird				y		Increase 50%
Belted Kingfisher	*Megaceryle alcyon*	Landbird				y		Increase 50%
Bicknell's Thrush	*Catharus bicknelli*	Landbird	TH		EN	y		Increase 50%
Black-and-white Warbler	*Mniotilta varia*	Landbird				y		Maintain current
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Landbird				y		Assess / Maintain
Blackburnian Warbler	*Dendroica fusca*	Landbird				y		Maintain current
Black-throated Green Warbler	*Dendroica virens*	Landbird				y		Maintain current
Blue-headed Vireo	*Vireo solitarius*	Landbird				y		Maintain current
Bobolink	*Dolichonyx oryzivorus*	Landbird	TH		VU	y		Increase 100%
Boreal Chickadee	*Poecile hudsonica*	Landbird				y		Increase 100%
Canada Warbler	*Cardellina canadensis*	Landbird	TH	TH	EN	y		Increase 50%
Cape May Warbler	*Dendroica tigrina*	Landbird				y		Increase 50%
Chimney Swift	*Chaetura pelagica*	Landbird	TH	TH	EN	y		Increase 100%
Common Nighthawk	*Chordeiles minor*	Landbird	TH	TH	TH	y		Increase 100%
Eastern Kingbird	*Tyrannus tyrannus*	Landbird				y		Increase 100%
Eastern Whip-poor-will	*Antrostomus vociferus*	Landbird	TH	TH	TH	y		Assess / Maintain
Eastern Wood-Pewee	*Contopus virens*	Landbird	SC		VU	y		Increase 50%

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

Common Name	*Scientific Name*	Group	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 12	Population Objective
Evening Grosbeak	*Coccothraustes vespertinus*	Landbird				y		Maintain current
Gray Catbird	*Dumetella carolinensis*	Landbird				y		Increase 100%
Gray Jay	*Perisoreus canadensis*	Landbird				y		Assess / Maintain
Magnolia Warbler	*Dendroica magnolia*	Landbird				y		Maintain current
Mourning Warbler	*Oporornis philadelphia*	Landbird				y		Maintain current
Nelson's Sparrow	*Ammodramus nelsoni*	Landbird				y		Assess / Maintain
Northern Parula	*Parula americana*	Landbird				y		Maintain current
Olive-sided Flycatcher	*Contopus cooperi*	Landbird	TH	TH	TH	y		Assess / Maintain
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	Landbird	SC	SC	VU	y		Assess / Maintain
Pine Grosbeak	*Pinicola enucleator*	Landbird				y		Increase 50%
Purple Finch	*Carpodacus purpureus*	Landbird				y		Maintain current
Ruffed Grouse	*Bonasa umbellus*	Landbird				y		Increase 50%
Rusty Blackbird	*Euphagus carolinus*	Landbird	SC	SC	EN	y		Increase 100%
Savannah Sparrow	*Passerculus sandwichensis princeps*	Landbird	SC	SC		y		Recovery objective
Short-eared Owl	*Asio flammeus*	Landbird	SC	SC		y		Increase 50%
Spruce Grouse	*Falcipennis canadensis*	Landbird				y		Increase 50%
Tree Swallow	*Tachycineta bicolor*	Landbird				y		Maintain current
Veery	*Catharus fuscescens*	Landbird				y		Maintain current
White-throated Sparrow	*Zonotrichia albicollis*	Landbird				y		Maintain current
Shorebirds								
American Golden-Plover	*Pluvialis dominica*	Shorebird				y		Assess / Maintain
American Woodcock	*Scolopax minor*	Shorebird				y		Increase 50%
Black-bellied Plover	*Pluvialis squatarola*	Shorebird					y	Assess / Maintain
Dunlin	*Calidris alpina*	Shorebird					y	Assess / Maintain
Hudsonian Godwit	*Limosa haemastica*	Shorebird					y	Assess / Maintain
Killdeer	*Charadrius vociferus*	Shorebird				y		Maintain current
Least Sandpiper	*Calidris minutilla*	Shorebird					y	Assess / Maintain

Common Name	*Scientific Name*	Group	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 12	Population Objective
Lesser Yellowlegs	*Tringa flavipes*	Shorebird				y	y	Assess / Maintain
Piping Plover	*Charadrius melodus melodus*	Shorebird	EN	EN	EN	y	y	Recovery objective
Purple Sandpiper	*Calidris maritima*	Shorebird					y	Assess / Maintain
Red Knot	*Calidris canutus rufa*	Shorebird	EN	EN	EN		y	Assess / Maintain
Sanderling	*Calidris alba*	Shorebird					y	Assess / Maintain
Semipalmated Sandpiper	*Calidris pusilla*	Shorebird					y	Assess / Maintain
Solitary Sandpiper	*Tringa solitaria*	Shorebird				y	y	Assess / Maintain
Spotted Sandpiper	*Actitis macularius*	Shorebird				y		Increase 100%
Whimbrel	*Numenius phaeopus*	Shorebird				y	y	Assess / Maintain
Willet	*Tringa semipalmata*	Shorebird					y	Increase 50%
Wilson's Snipe	*Gallinago delicata*	Shorebird				y		Increase 100%
Waterbirds								
American Bittern	*Botaurus lentiginosus*	Waterbird				y		Increase 50%
Black-legged Kittiwake	*Rissa tridactyla*	Waterbird					y	Maintain current
Bonaparte's Gull	*Chroicocephalus philadelphia*	Waterbird					y	Assess / Maintain
Common Loon	*Gavia immer*	Waterbird				y	y	Maintain current (BCR 14); Assess / Maintain (MBU 11)
Common Tern	*Sterna hirundo*	Waterbird				y	y	Assess / Maintain
Dovekie	*Alle alle*	Waterbird					y	Assess / Maintain
Great Cormorant	*Phalacrocorax carbo*	Waterbird					y	Assess / Maintain
Great Shearwater	*Puffinus gravis*	Waterbird					y	Assess / Maintain
Horned Grebe (Western)	*Podiceps auritus*	Waterbird	SC				y	Assess / Maintain
Ivory Gull	*Pagophila eburnea*	Waterbird	EN	EN			y	Assess / Maintain
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Waterbird					y	Assess / Maintain
Pied-billed Grebe	*Podilymbus podiceps*	Waterbird				y		Maintain current
Razorbill	*Alca torda*	Waterbird					y	Assess / Maintain
Red-necked Grebe	*Podiceps grisegena*	Waterbird					y	Assess / Maintain
Red-throated Loon	*Gavia stellata*	Waterbird					y	Assess / Maintain
Sooty Shearwater	*Puffinus griseus*	Waterbird					y	Assess / Maintain

Common Name	*Scientific Name*	Group	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 12	Population Objective
Sora	*Porzana carolina*	Waterbird				y		Maintain current
Virginia Rail	*Rallus limicola*	Waterbird				y		Assess / Maintain
Waterfowl								
American Black Duck	*Anas rubripes*	Waterfowl				y	y	Maintain current
Barrow's Goldeneye (Eastern)	*Bucephala islandica*	Waterfowl	SC	SC		y	y	Assess / Maintain
Black Scoter	*Melanitta americana*	Waterfowl						Assess / Maintain
Canada Goose (North Atlantic)	*Branta canadensis*	Waterfowl				y	y	Maintain current
Canada Goose (Temperate-breeding in Eastern Canada)	*Branta canadensis*	Waterfowl				y	y	Decrease
Common Eider	*Somateria mollissima*	Waterfowl					y	Maintain current
Common Goldeneye	*Bucephala clangula*	Waterfowl					y	Assess / Maintain
Green-winged Teal	*Anas crecca*	Waterfowl				y		Increase 50%
Long-tailed Duck	*Clangula hyemalis*	Waterfowl					y	Assess / Maintain
Mallard	*Anas platyrhynchos*	Waterfowl				y		Maintain current
Ring-necked Duck	*Aythya collaris*	Waterfowl				y		Increase 50%
Surf Scoter	*Melanitta perspicillata*	Waterfowl					y	Assess / Maintain

iii. 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 with associated ecosystem services and cultural values" (Dudley 2008). Legal protection for land for conservation within the bioregion is relatively low when compared with other bioregions in the Maritimes. Only 2.17% of the bioregion currently has some form of formal conservation designation (Table 5, Figure 4). This is due in part, to the large amount of privately owned land with high resource and recreational value, making land securement challenging and expensive. A low proportion of Crown land (16%) also limits the potential role of Government. Table 5 lists the various conservation areas within the bioregion generated from databases obtained from various provincial sources.

Federal Protected Areas

Federally protected lands within the bioregion include three National Wildlife Areas (NWA), established under the authority of the *Canadian Wildlife Act*, and managed by Environment Canada. These NWA (John Lusby Marsh, Chignecto, and Wallace Bay) provide habitat for migratory birds and other wildlife in the terrestrial and coastal environments and are described in their respective management plans (Environment Canada 2014a,b,c).

Provincial Protected Areas

There are four Wilderness Areas (WA), which are provincially-significant protected areas designated under *Nova Scotia's Wilderness Areas Protection Act* (1998). Two of the four, the Chignecto and Eigg Mountain/James River Wilderness areas, are completely within the boundary of the bioregion. The remaining two, Economy River and Gully Lake, have only 4% and 14% of the WA within the boundary respectively. These areas, managed by Nova Scotia Environment, provide protection for representative examples of Nova Scotia's natural landscapes, native biodiversity, and outstanding natural features (Nova Scotia Environment 2012). Within the bioregion there are also 18 provincial parks and 15 protected beaches that are managed by the Nova Scotia Department of Natural Resources. While biodiversity conservation is not the primary objective of Nova Scotia provincial parks and protected beaches, these areas do offer legal protection from resource extraction and contribute to overall conservation within the bioregion. There are also three Provincial Game Sanctuaries, managed by the Department of Natural Resources. These areas carry little legislated protection from resource extraction, though hunting and trapping is prohibited. The Game Sanctuaries within the bioregion were established primarily for the protection of waterfowl.

Private Land Trusts

The Nature Conservancy of Canada (NCC) is a non-profit charitable organization that works to directly conserve Canada's most important areas of natural diversity through property securement and long-term management and restoration. Over the last five years, NCC has secured 177 additional ha on the Chignecto Isthmus and 113 ha in the Pugwash River Estuary bringing NCC's total holdings in the bioregion to 2,320 ha across 19 properties.

Joint Ventures

In Nova Scotia, the Eastern Habitat Joint Venture (EHJV) secures, conserves, manages, and supports sustainable use of wetlands and associated uplands that benefit wildlife and their habitats. The EHJV currently manages eight properties totalling 390 ha within the bioregion. Ducks Unlimited, whose

priorities are focused around wetland conservation, have also secured 213 ha of land on the Chignecto Isthmus.

Table 5. Conservation lands within the Nova Scotia Northumberland Strait bioregion.

Site Name (Agency)	Area (ha)	% of Bioregion
National Wildlife Areas (Environment Canada)		
John Lusby Marsh	600	
Chignecto	475	
Wallace Bay	675	
Total for National Wildlife Areas	***1750***	***0.27***
Wilderness Areas (Nova Scotia Environment)		
Chignecto Isthmus	969	
Economy River	268	
Eigg Mountain/James River	5467	
Gully Lake	541	
Total for Wilderness Areas	***7245***	***1.10***
Game Sanctuaries (Nova Scotia Department of Natural Resources)		
Brule Point	76	
Hackmatack Lake and Round Lake	92	
Sunnybrae	335	
Total for Game Sanctuaries	***503***	***0.08***
Provincial Parks and Beaches (Nova Scotia Department of Natural Resources)		
Provincial Parks	1075	
Protected Beaches	662	
Total for Provincial Parks and Protected Beaches	***1726***	***0.26***
Lands Held Primarily for Conservation by Private Trusts and Government Collaboratives		
Nature Conservancy of Canada	2320	0.35
Eastern Habitat Joint Venture	966	0.15
Ducks Unlimited	213	0.03
***Total Existing Conservation Lands in the* bioregion**	***14,734***	***2.25***

Together these conservation areas total 14,734 ha, representing just over 2.25% of the bioregion. On February 28, 2013 the province of Nova Scotia announced the possibility of significant additions to their parks and protected areas (Government of Nova Scotia 2013). A total of 9,457 ha of new protected areas have now been approved and 8,307 ha are pending with conditions. Once approved, there is the potential to add 17,764 ha (2.7% of the bioregion) to the existing protected areas (Table 6). Both the existing and proposed conservation areas within the bioregion can be seen in Figure 4.

Within the coastal zone of the bioregion there is one nationally designated Important Bird Areas (IBA) which is an area of global significance to birds. Canada's Important Bird Areas Program is a science-based initiative to identify, highlight, conserve, and monitor a network of sites that provide essential habitat for Canada's bird populations (IBA Canada 2012). These areas of international or regional significance for the conservation of birds may support threatened species, large groups of gregarious species, and species restricted by range or by habitat, however the designation does not imply that these areas are legally protected (IBA Canada 2012). IBAs may encompass private or public land, and

they may or may not overlap partially or entirely with legally protected sites. Pomquet Beach (IBA NS009) was established mainly due to the presence of breeding Piping Plovers.

Table 6. Proposed (approved and pending) conservation lands in the Nova Scotia Northumberland Strait bioregion, including new conservation lands and expansions to existing conservation lands.

Site Name (Agency)	Status	Area (ha) No Conditions	Area (ha) Some Conditions	% of Bioregion
Wilderness Areas (Nova Scotia Environment)				
Chase Lake	New	0	876	
Chignecto Isthmus	Expansion	2791	4083	
Douglas Meadow Brook	New	0	599	
Economy River	Expansion	1431	0	
Eigg Mountain	Expansion	2190	259	
Giants Lake	New	246	149	
Gully Lake	Expansion	20	131	
Polly Brook	New	763	0	
Tracadie River	New	104	905	
Upper Stewiacke	New	0	32	
Wentworth Valley	New	626	1099	
Total for Wilderness Areas		***8171***	***8133***	***2.5***
Nature Reserves (Nova Scotia Environment) *				
Angevine Lake	New	272	0	
Barney's River	New	550	12	
Caribou Rivers	New	33	0	
Dalhousie Mountain	New	46	0	
Docherty's Brook	New	12	0	
Drug Brook	New	35	0	
Hurlburt Brook	New	0	162	
Lighthouse Beach	New	8	0	
MacKay Brook	New	20	0	
Ohio River	New	24	0	
River John	New	44	0	
Slade Lake	New	24	0	
South River	New	15	0	
Steepbank Brook	New	203	0	
Total for Nature Reserves		***1286***	***174***	***0.2***
Total Proposed Land for Protection		***9457***	***8307***	***2.7***

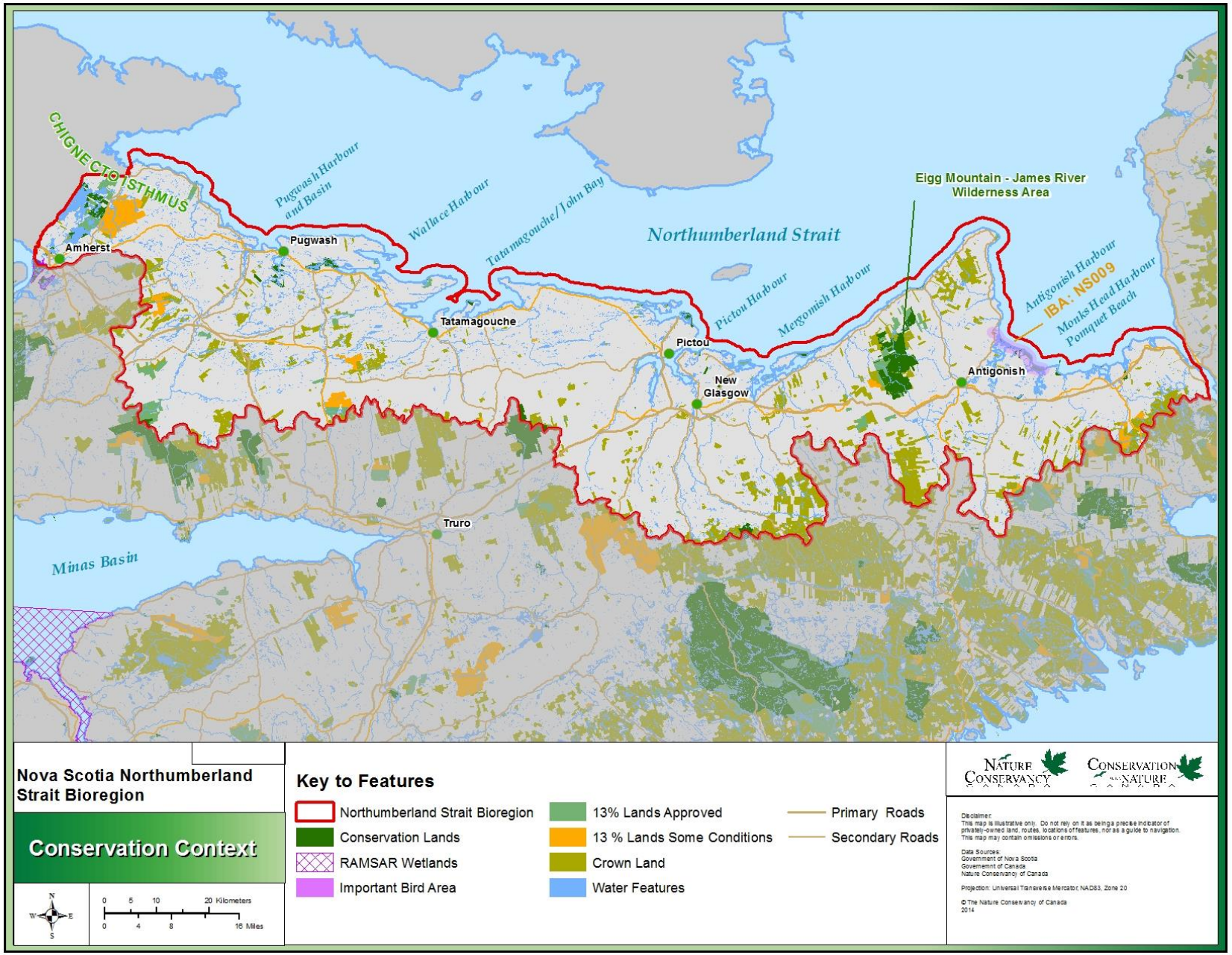


Figure 4. Conservation lands in the Nova Scotia Northumberland Strait bioregion.

iv. Social and Economic Considerations

Social Considerations

There is little archaeological evidence of pre-European contact native encampments along the Northumberland Strait shores, possibly due to the highly erodible shoreline. However, early records of European settlers describe a number of Mi' kmaq camps set up at the mouths of rivers, taking advantage of the rich marine food sources found there in the summer months (Pictou County GenWeb 2000). Many of the present day place names found in the bioregion such as Antigonish, Shinimicas, Tatamagouche, and Pugwash are derived from the Mi' kmaq language. Small French Acadian communities were established by 1700 and evidence of their salt marsh dyking activity can still be seen near Tatamagouche. By the mid 1700s, settlers from New England and Europe began establishing family farms on the fertile soils along the shoreline and river valleys. Some of the once cleared farmland has reverted to forest with the abandonment of many farms following World War II.

The Northumberland Strait has the warmest salt water north of the Carolinas due to natural ocean currents and shallow conditions found here (Pictou County GenWeb 2000). Because of this, many of the most spectacular beaches and swimming sites in Nova Scotia can be found in the area. Tourism is important in the region, with many seasonal cottage communities scattered along the north shore and over a dozen golf courses along with local vineyards. While the population size of year round residents in the urban centers is stable or declining slightly (Table 7), the summer months see a dramatic increase in the human population in the bioregion, which nearly doubles as people inhabit the numerous seasonal residences to take advantage of the warm water beaches. This increased activity puts added pressure on species and ecosystems found along the Northumberland Strait coastline.

There are four major towns located in Cumberland County – Amherst, Springhill, Pugwash, and Oxford – with smaller communities such as Tatamagouche and Wallace located in Colchester County. Industrial towns found in Pictou County include New Glasgow, Pictou, Stellarton, Trenton, and Westville. Aboriginal communities in Pictou County include Fisher's Grant, Pictou Landing, and Merigomish Harbour. Antigonish is the major town in Antigonish County, home to Saint Francis Xavier University. Antigonish County is also home to Pomquet Village, a small Acadian village dating back to 1774. The median household income for the four counties in the region is $43,567 (Statistics Canada 2012a,b,c,d).

Economic Considerations

Today, year-round human settlement is concentrated in towns and villages found mainly along the coast, usually at the mouth of rivers. While livestock and dairy farming remains active along the coast and in the fertile river valleys, a decline in farming activity continues. A review of the 2011 census data pertaining to agriculture shows a slight decline in land used for crop production in the four counties that make up the bioregion (NSDA 2010). Lobster fishing is the economic mainstay of many of the smaller coastal communities, although tourism and industries such as vinyards (e.g., Jost Vinyard at Malagash) are providing increasing economic opportunities. Blueberry production has increased significantly in the area, with the low bush variety occupying many of the old abandoned farm fields and newly cut-over woodlots. There is a large processing plant for blueberries in the town of Oxford, which calls itself the "Blueberry Capital of Canada". World-wide interest in wild blueberries for their nutritional and health benefits continues to make this a viable and expanding industry. Some attempts at aquaculture have occurred, but shallow water, heavy winter sea ice and public opposition have made the development of this industry in the bioregion difficult. There is a large underground salt mining operation in the village of Pugwash, while the forestry industry in the bioregion is centered on supplying fiber to large pulp mills in Pictou and Port Hawkesbury that were established in the early 1970s.

The majority of the land holdings in the bioregion are private, with a high propoertion of small, individual cottage properties along the shoreline that are less than one hectare. Original farm properties were 80 ha on average, but consolidation over the years has resulted in fewer but larger working farms. Large forest product companies own or lease significant blocks of land, while some forest management cooperatives exist to manage the smaller private woodlots. The bioregion contains a very small amount of Crown Land (16%) when compared to other areas of the province.

Table 7. Population of year round residents by County in 2006 and 2011 (Statistics Canada 2012 a,b,c,d).

County	2006	2011
Cumberland County	35,000	31,353
Colchester County	50,000	50,968
Pictou County	50,000	45,643
Antigonish County	20,000	19,589
Total	**155,000**	**147,553**

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 the conservation priority species identified within the bioregion. Priority habitats are the native biological entities (i.e., ecological systems, communities, and/or species[1]) that the HCS is aiming to conserve. Identifying conservation priority habitat types for the NSNS 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 priority habitat types in the NSNS 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 12 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 NSNS bioregion includes seven ecological systems:

1) Beaches and dunes
2) Salt marshes
3) Tidal flats
4) Riparian and floodplain systems
5) Freshwater wetlands
6) Acadian forest mosaic
7) Grasslands/agro-ecosystems

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 NSNS 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

---

[1] ***Ecological systems****: Assemblages of ecological communities that occur together on the landscape and share common ecological processes (e.g., flooding), environmental features (e.g., soils and geology) or environmental gradients (e.g., temperature).*

Communities*: Groupings of co-occurring species, including natural vegetation associations and alliances.*
-Major groupings of targeted species that share common natural processes or have similar conservation requirements (e.g., forest-interior birds, freshwater mussels)
-Globally significant examples of species aggregations (e.g., migratory shorebird stopover area)

Species*: Types of species targets may include:*
-Globally imperilled and endangered native species (e.g., G1 to G3G4)
-Species of concern due to vulnerability, declining trends, disjunct distributions or endemism
-Focal species, including keystone species, wide-ranging regional species and umbrella species

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 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 8 (adapted from The Nature Conservancy; Low 2003). A summary of the number of priority species associated with each priority habitat type is provided in Table 9, whereas the full list of priority species nested within priority habitat types is provided in Appendix C. The locations of priority habitat types are mapped in Figure 5 to Figure 14. Note that areas of targets on maps may have been slightly enlarged for visual clarity and are not to scale.

Table 8. Description of the assessment ranks of ecological integrity of the conservation priority habitat types for the Northumberland Strait 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.

Table 9. Priority species associated with each conservation priority habitat type in the Nova Scotia Northumberland Strait bioregion (see Appendix D for the complete list of priority species with fine-filter habitat associations).

Habitat Type	BCR 14/ MBU 12 priority birds	Rare (S-rank) bird species	Priority inverte-brate species	Priority reptile species	Priority mammal species	Priority plant species	Total rare (S-rank) species	Species at risk	Total unique species[1]	Total priority species
Beaches and dunes	19	7	0	0	0	8	15	5	3	29
Salt marshes	17	5	2	0	0	11	18	4	1	30
Tidal flats	25	7	0	0	0	6	14	6	2	36
Freshwater wetlands	29	14	9	1	2	37	58	12	25	91
Riparian and floodplain systems	26	5	12	1	2	56	81	13	22	106
Acadian forest mosaic	30	13	9	0	2	46	67	20	42	106
Grasslands/agro-ecosystems	14	6	4	1	1	37	53	11	8	62

[1] *Species that are unique to that particular coarse-filter habitat type and are not associated with any of the other coarse-filter habitat types, based on literature review.*

i. Priority Habitat: *Beaches and Dunes*

Beaches are accumulations of unconsolidated marine deposited, well-sorted sand, cobble, or stone deposited on a shore, or in active transit along it, whereas dunes are transient mounds of loose, windblown sand, sometimes stabilized by vegetation (Anderson *et al.* 2006). Beaches and dunes are ecologically linked but form distinct habitats, the former being periodically inundated and the latter dry and distinguished by vegetation adapted to constant sand burial. Beaches and dunes are ecologically significant ecosystems as they host a number of rare and at risk species including Piping Plover, Red Knot, and Savannah Sparrow. They provide critical nesting habitat for a number of bird species, including plovers and terns, which lay eggs in shallow scrapes on exposed sand and cobble and rely on isolation to reduce the likelihood of predation by mammals and other birds. Many of these species are in decline, partly due to loss or degradation of breeding habitat and anthropogenic disturbances. They are also particularly important for a number of gregarious shorebirds, including the Semipalmated Sandpiper, Black-bellied Plover, Killdeer, Sanderling, and Dunlin; as a group, shorebirds have been exhibiting major declines across North America (NABCI 2012). Dunes containing low shrub communities are also of particular conservation interest (S. Blaney, pers. comm.).

The beaches and dunes found in the central and eastern section of the NSNS bioregion from Pictou to Pomquet provide important habitat for nesting Piping Plover, which breed exclusively on beaches from May to August. They prefer flat beach areas with sand and cobble substrate above the high tide line, habitat that is maintained by storm surges, which deposit over-wash. The bioregion contains 11 beaches tentatively identified by the species recovery team as potential critical habitat for Piping Plover (Environment Canada 2012b). Threats to the persistence of Piping Plover in the region include habitat loss and degradation, predation pressures, and human disturbance during the breeding season. This subpopulation's small size, isolation, limited suitable habitat, and low reproductive success contribute to higher risk of continued decline and possible extirpation from the region.

Conservation of beach and dune habitat within the bioregion will contribute to the conservation of 29 priority species (Table 9). The locations of beaches and dunes are displayed in Figure 5.

Landscape context assessment of beaches and dunes: Fair

The average Landscape Context Index (LCI) [1] for beaches and dunes in the bioregion is 38. This is considered fair as it is above the critical LCI score of 30. This indicates that the beach and dune systems are at some risk from surrounding coastal development. Shoreline fragmentation by roads and other developments impact connectivity of these systems. Though the coastal sensitivity to sea level rise is moderate along the bioregion's coast (Shaw *et al.* 1998), continued shoreline armoring and development will impact the landward migration of beaches following a rise in sea level. Armouring also changes shoreline geomorphic dynamics – sand doesn't accumulate/erode at the same rate and in the same locations as it would along an un-armoured shore (S. Basquille, pers comm.). With no coastal development strategy and regulations in place in Nova Scotia, coastal systems, especially beaches and dunes, are at risk of further impacts.

[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).*

Condition assessment of beaches and dunes: Poor
Beaches and dunes face growing pressures from development, recreational activities, and climate change effects. They are both created and destroyed by wind and storm tides, and as such require both room to move and a sediment supply. The adjacent upland buffer is therefore an essential part of this ecological process. Approximately 77% of beaches and dunes in the bioregion are within 250 m of development, however almost 23% of those are protected from further development. Dune structure stability is enhanced if vegetated. Though younger dunes are naturally un-vegetated and essential for dune replacement of older dunes, a measure of the condition viability of dunes would be the percentage of the dune systems that are vegetated with native species. At this time, the data to perform this analysis has not been developed.

According to the Piping Plover recovery plan, the bioregion contains 11 beaches that are considered critical habitat, the most important of which is Pomquet Beach, an IBA, where the plovers have maintained a stable population. An ongoing stewardship program by Bird Studies Canada is helping with the conservation effort of the species. As well, the province has been identifying and conserving the most important beach and dune systems in the province through the Protected Beaches Act. This prevents development within 100 m of the designated beaches. Some beach areas are set up as provincial parks and attract large numbers of people each summer, which could have some negative impact on the condition of the beaches and dunes at those locations.

Rugosa Rose (*Rosa rugosa*) is an emerging invasive that has been documented within the bioregion. Once established on sandy coasts, this dense shrub out-competes most native vegetation species (MTRI 2012). Hill *et al.* 2010, found Rugosa Rose to be present on two of the nine beaches surveyed within the bioregion.

Size assessment of beaches and dunes: Good
Within the bioregion there are 97 beaches (>2 ha) with a total area of 980 ha and an average size of 10 ha, which is greater than the NAAP critical size of 8 ha (Anderson *et al.* 2006). Many of the beaches within the bioregion are experiencing severe erosion as a result of more frequent storms and associated tidal surges, which may increase in frequency and severity as a result of climate change. Storms may create blow outs and transform a barrier beach into a series of sandy islands (DFO 2007a). Shoreline hardening also prevents natural landward migration. Twenty percent of the beach dune complexes in the bioregion have been identified as critical in the NAAP ecoregional assessment, representing 10% of all critical occurrences in the province.

Overall assessment of beach and dune habitat in the NSNS bioregion: Fair

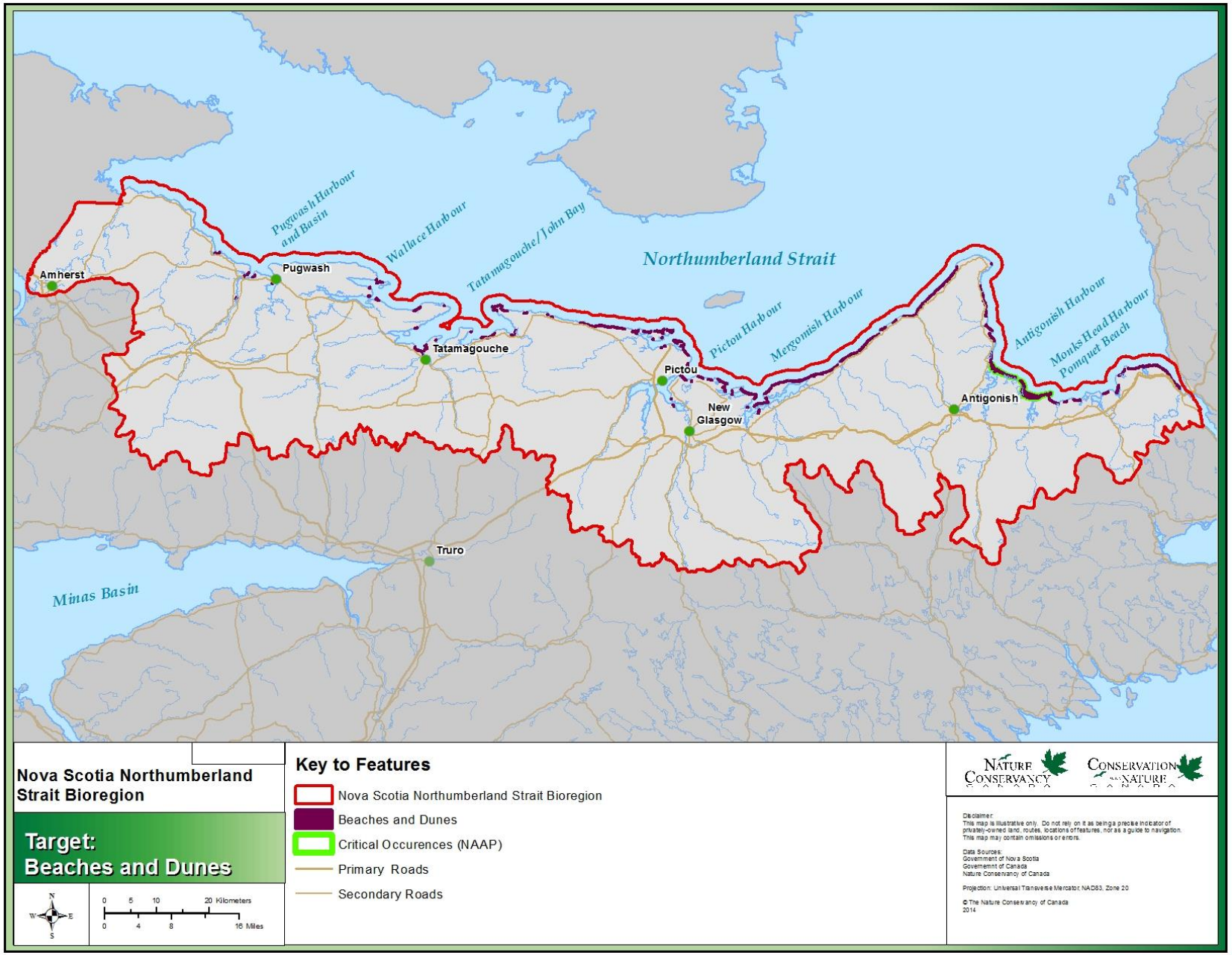


Figure 5. Beach and dune habitat within the Nova Scotia Northumberland Strait bioregion

ii. Priority Habitat: *Salt Marshes*

Salt marshes are poorly-drained, grass-dominated habitats that are subject to regular inundation by salt water (Anderson *et al.* 2006). Generally dominated by *Spartina* grasses, they are influenced by gradients associated with the duration of tidal flooding and the extent of freshwater influx (Olsen *et al.* 2005; GOMC 2010; Bowron *et al.* 2012). The duration and frequency of tidal flooding in the coastal zone determines where species occur (Bertness 1999; Olsen *et al.* 2005). Brackish marshes occur in areas where there is significant mixing of fresh and salt water, such as the mouth of a large river. Tidal marshes serve important functions in flood protection, erosion control, supporting coastal and marine food webs, and removal of contaminants, nutrients, and suspended sediments from the water column.

Individual salt marshes found along the Northumberland Strait tend to be small in physical size when compared with those on the Bay of Fundy, due to the much smaller tidal range found in the Gulf of St. Lawrence (Hanson 2004a; Thurston 2011). However, collectively they represent 14% of the provincial total. Salt marshes usually occur in association with estuaries and are important habitats for birds such as Nelsons Sharp-tailed Sparrow and Willet (*Tringa semipalmatus*; Hanson 2004a). *Eastern Lilaeopsis* is a small, semi-aquatic plant species that is found in the intertidal zone of the River Phillip. Observations of butterfly species Salt Marsh Copper (*Lycaena dospassosi*) and Bronze Copper (*Lycaena hyllus*) have occurred in the salt marshes found in the bioregion. The plant Estuary Beggars Ticks (*Bidens hyperborean*) has been observed in the estuary complexes. Conservation of tidal marsh habitat within the bioregion will contribute to the conservation of 30 priority species (Table 9).

Coastal marshes respond to gradual sea level rise by growing vertically and transgressing inland, provided there is a sufficient sediment supply, and human activity on the upland does not prevent inland migration (Redfield 1972). A 275-metre buffer will be considered around salt marshes to protect the ecological functions and integrity of the target and maintain nesting areas for wildlife (e.g., waterfowl; EC, OMNR & OME 1998) and allow for landward migration in the face of sea-level rise due to climate change. All provincially delineated salt marsh and NAAP critical occurrences are mapped in Figure 6.

Landscape context assessment of salt marshes: Fair
The average Landscape Context Index (LCI) for salt marshes in the bioregion is 56 (Critical value = 30), which is considered poor (calculated from NAAP data). However, 90 percent of upland habitat adjacent to salt marshes (within 275 metres) contains natural cover, which does not exclude areas impacted by forest harvesting. To protect infrastructure and development from coastal erosion due to sea level rise and land subsidence, shoreline armouring is a common practice. The hardening of coastlines can result in insufficient sediment supply which in turn can limit the ability of salt marshes to migrate inland in response to natural and anthropogenic sea-level rise. Since European settlement of Nova Scotia in the early 1700's, Nova Scotia has seen extensive loss of tidal marsh habitat, primarily to dyking for agriculture. Estimates of tidal marsh loss are as high as 65% of original tidal marshes province-wide, and 85% along the Bay of Fundy (Reed & Smith 1972; NSE 2012b).

Condition assessment of salt marshes: Good
With the exception of the salt marshes at the southern end of the Chignecto Isthmus, most salt marshes along the Northumberland Strait are not deeded, and there was less dyking of salt marshes compared to the Bay of Fundy. Salt marshes were, however, ditched and hayed in many locations (Hanson 2004a). Aquaculture does not yet have much presence here and most roads were built across tidal rivers with large span bridges allowing for normal tidal exchange. Therefore, tidal flow and connectivity of habitats

are functioning at a high level. The ability of the intertidal zone to move inland with rising sea levels is, however, somewhat restricted due to shoreline armouring (Watt *et al.* 2010).

The majority of species that use salt marsh habitat within the bioregion are either NAAP critical species targets, BCR 14 priority birds, or COSEWIC listed. To date, there have been no invasive species of major concern reported within salt marshes in eastern Canada (Mal & Narine 2004). Reed canary, phragmites, and loosestrife are present in the bioregion, mainly on abandoned and poorly drained dykeland soil and disturbed areas, but not in the actual salt marshes. Loosestrife appears to be restricted to road ditches and there is strong evidence that the biological control work done in the late 1990's is working. None of these species are threatening actual salt marsh habitats (John Wile, pers. obs.).

Size assessment of salt marshes: Fair
Salt marshes in the bioregion are generally small in size. However, collectively there are over 2,429 ha of them, 98% of which are critical within the NAAP. The average size of salt marshes in the bioregion is 6 ha. The NAAP critical size is 24 ha, however salt marshes in this bioregion are naturally much smaller then they are on the ecoregional scale. The size ranking was adjusted to reflect this local variation. The combined area within the bioregion represents 14% of salt marshes within the province.

Overall assessment of salt marsh habitat in the NSNS bioregion: **Fair**

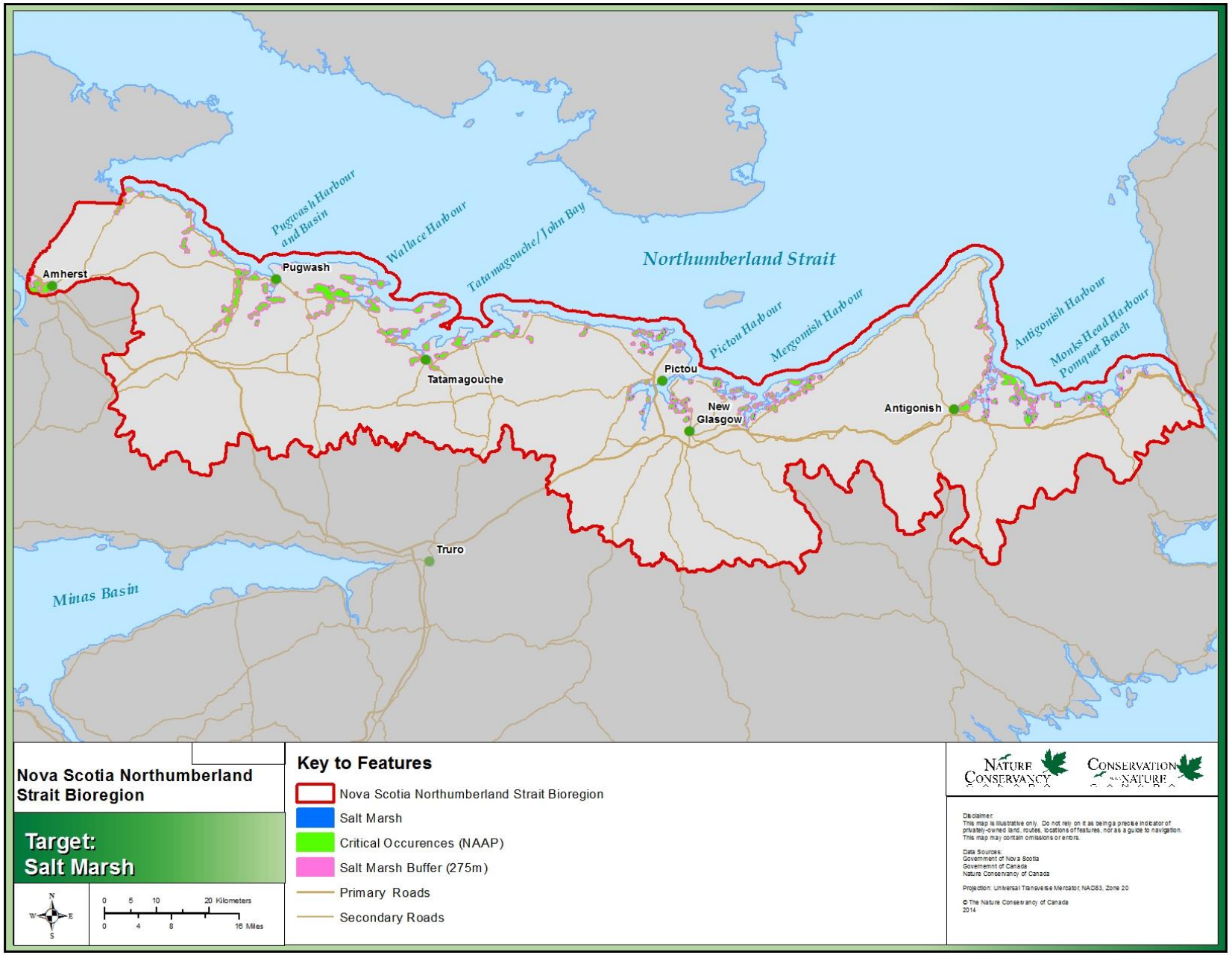


Figure 6. Salt marsh habitat within the Nova Scotia Northumberland Strait bioregion.

iii. Priority Habitat: *Tidal Flats*

Tidal flats are another common coastal feature of the bioregion, particularly in the many large shallow estuaries, which, due to low stream gradients, extend far inland from the mouths of 15 major river systems in the bioregion. They consist of extensive, horizontal tracts of unconsolidated clays, silts, sands, and organic materials that are alternately covered and uncovered by the tide. Tidal flats are a key component of estuaries and are extremely rich environments, as they receive nutrients and oxygen from freshwater inputs and also from the sea, and provide habitat for a diverse bird fauna, as well as for marine organisms including fish, and shellfish. These estuaries are used for extended periods of time by waterfowl, waterbirds, and shorebirds during spring and fall migration (Allard *et al.* 2014). Several thousand waterfowl forage on tidal flats from late August to freeze-up in December as a fall staging area, and to a lesser degree in the spring as a migration stop. Shorebirds, while not found in large numbers, are found foraging in the tidal flats during late summer and early fall (Environment Canada 2009). One of the largest estuaries in the bioregion is the Pugwash River Basin. Other important estuaries for shore birds occur in Fox Harbour, Northport, and Tatamagouche Bay (Julie Paquet, pers. comm.).

Also occurring within the bioregion are extensive beds of Eelgrass, a highly productive perennial aquatic plant that is a 'keystone species' found on coarse sand to mud bottoms in low intertidal and sub-tidal environments (Hanson & Calkins 2006; Neckles *et al.* 2009; DFO 2009). Eelgrass has been identified as an ecologically priority species in that it creates habitat used preferentially by other species, provides protection for associated communities, and has substantial influence over the ecology of the habitat (DFO 2009). Photosynthetic energy and nutrients are captured by Eelgrass beds and released into the marine food chain as the annual crop of vegetation decomposes as a part of the detritus cycle. While serving as a nursery for several species of marine life, Eelgrass supplies food for Canada geese (*Branta canadensis*) and Brant geese (*Branta bernicla*) (DFO 2009; Thurston 2011).

Eelgrass declines in recent decades have been reported in the southern Gulf of St. Lawrence and on the Atlantic Coast of Nova Scotia (e.g. Seymour *et al.* 2002). Possible contributing factors to the observed declines in Eelgrass distribution include disease, eutrophication, human activities, environmental changes, and disturbance by invasive European Green Crab (*Carcinus maenas*) (DFO 2009; Hanson 2004b). Associated with these dramatic declines in Eelgrass biomass within estuaries in Maritime Canada, significant changes in the distribution and declines in the abundance of fall-staging waterfowl have been observed (Seymour *et al.* 2002). Historical evidence suggests that if Eelgrass declines were to become widespread, there would be major impacts on waterfowl feeding behaviour, migration patterns, and over-winter survival (Hanson 2004b).

Conservation of tidal flats within the bioregion will contribute to the conservation of 23 priority species (Table 9). All provincially delineated tidal flats and NAAP critical occurrences are mapped in Figure 7.

Landscape context assessment of tidal flats: Fair

The average Landscape Context Index (LCI) for tidal flats in the bioregion is 43, which is above the NAAP critical threshold value of 30 (a lower LCI is a more intact habitat). A high percentage of the coastline is under private ownership, however in Nova Scotia a grant of land typically only extends to the ordinary high water mark of tidal or coastal land; land between the mean high and low water marks of coastal water is considered to be Crown land under management by the Nova Scotia Department of Natural Resources (CBCL Ltd. 2009; NSDNR 2013c). In addition to this, tidal flats do not have a great deal of development potential, although they may be severely impacted by adjacent onshore development if there are resulting changes to nutrient availability, sedimentation patterns, or an increase in urban

waste water, agricultural, forestry, or industrial effluents. While almost the entire Northumberland coastline is fringed by tidal flat habitat, extensive tracts of tidal flats are bordered by agricultural land, roads and residential areas which may impact their ability to migrate inland in response to sea-level rise.

Condition assessment of tidal flats: Unknown
The nature of tidal flats being inundated daily has limited the amount of direct anthropogenic disturbance, with the exception of localized activities such as shell fish harvesting. Priority species that depend on tidal flats are generally restricted to shorebirds and include NAAP critical species targets, BCR 14 priority birds and COSEWIC listed species. Although the invasive European Green Crab (*Carcinus maenas*) has been documented within the Northumberland Strait (Belliveau 2012) the extent of invasion and the duration of their impact to tidal flats are unclear.

Size assessment of tidal flats: Very Good
Tidal flats are extensive in the bioregion, with over 27,905 ha present according to the provincial wetland database. The average size of tidal flats is 498 ha, which is considered very good as it well exceeds the NAAP critical size threshold of 40 ha for this target. Of all tidal flats within Nova Scotia, 16% occur within the bioregion.

Overall assessment of tidal flat habitat in the NSNS bioregion: **Good**

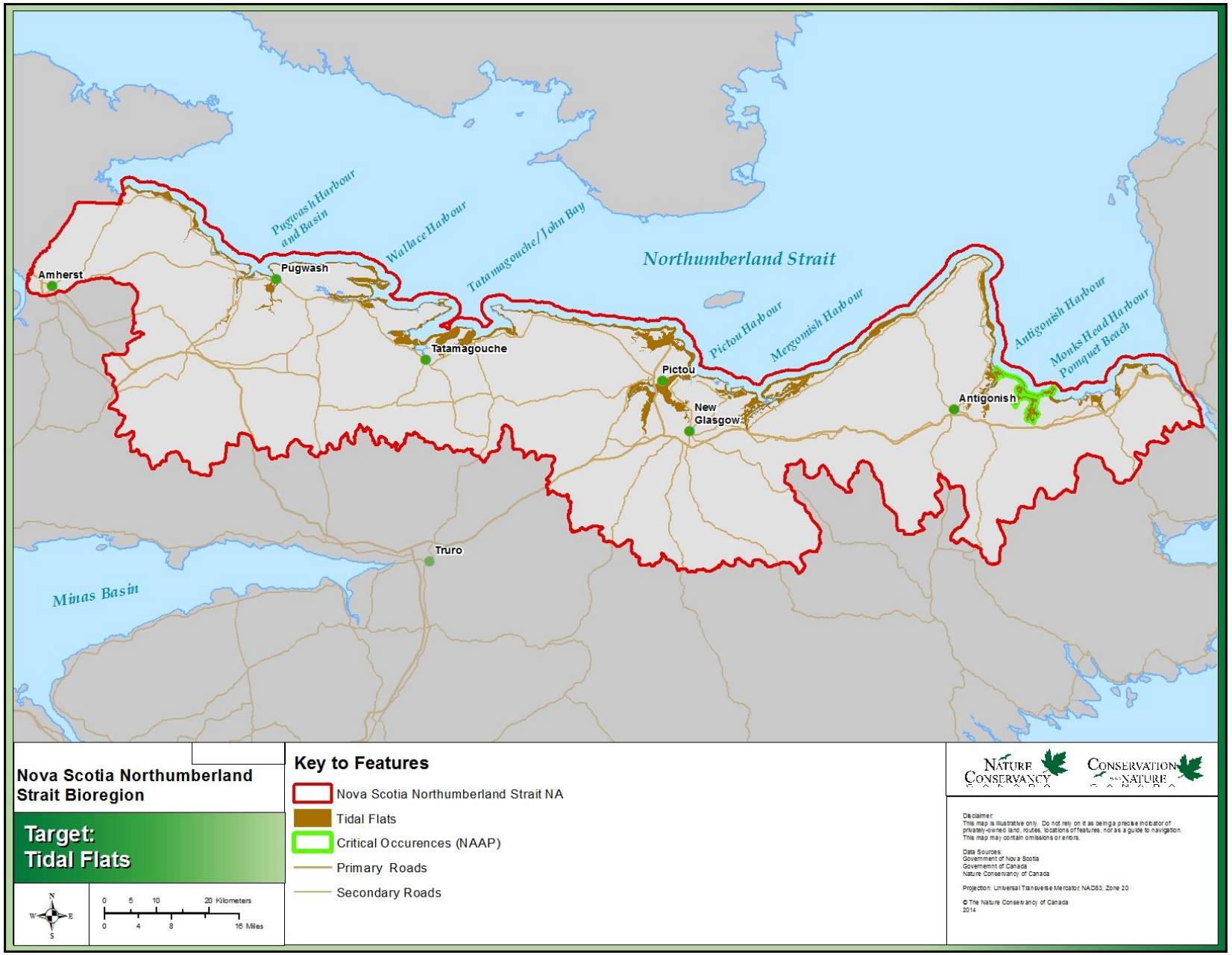


Figure 7. Tidal flat habitat within the Nova Scotia Northumberland Strait bioregion.

iv. Priority Habitat: *Riparian and Floodplain Systems*

Nova Scotia's relatively cool climatic conditions result in a hydrologic cycle in which precipitation exceeds evapotranspiration, and consequently the province has no shortage of freshwater (Davis & Browne 1996a). Approximately 5% of the land area in Nova Scotia is covered in fresh water in the form of lakes, rivers, and wetlands. The freshwater ecosystems of the NSNS bioregion have been classified as having a higher level of productivity than the rest of mainland Nova Scotia due to the buffering capacity of the bedrock and soils (Underwood *et al.* 1987). Relatively little surface water exists in the form of lakes. Some of the few natural lakes that are present in the highland areas were created when glacial till blocked the outlets in mountain passes. The natural lakes, ponds, and gypsum "sink holes" in the lowlands tend to be small and shallow, but with high biological productivity (Davis & Browne 1996a; Sean Blaney, pers. comm.).

The bioregion's major river systems are grouped within eight primary watersheds, most of which flow from the Cobequid Hills and Pictou and Antigonish Highlands to the Northumberland Strait, although the La Planche River on the Chignecto Isthmus flows into the Bay of Fundy. The main stems of the rivers that flow to the Northumberland Strait are short in length, averaging about 30 km and, while fast flowing on the steeper and less erodible highland soils, they tend to flatten out as they flow through the more erodible soils found in the lowlands, forming narrow floodplains and valleys. Here ecological processes such as seasonal flooding and the subsequent deposition of alluvial silts sustain the riparian flora. Narrow bands of unique floodplain forest exist along the major rivers containing trees rarely found elsewhere in the province, including Green Ash (*Fraxinus pennsylvanica)*, Black Ash (*Fraxinus nigra*), and Black Cherry (*Prunus serotina*). Here, an understory of vascular plant communities develops and includes the Cut-leaved Coneflower (*Rudbeckia laciniata var. Gaspereauensis)*, Blue Cohosh (*Caulophyllum thalictroides*), and Black Snake-Root (*Sanicula odonrata*).

The riparian habitats along River Philip and Wallace River were identified in the NAAP Blueprint (Anderson *et al.* 2006) as critical habitats; however, there is little published information available on these rivers. Other important river systems found in the bioregion are the East River of Pictou, Middle River of Pictou, River John, West River of Pictou, Pomquet River, Pugwash River, Shinimicas River, and South River (D. MacKinnon, S. Basquill, pers. comm.). The rivers flowing to the Northumberland Strait are relatively unobstructed and have good water quality. Clear, cool, well-oxygenated water is critical for salmonid survival in these rivers (COSEWIC 2010), maintained in part by the shade and bank stabilization provided by a mature riparian forest. Rivers in the bioregion support anadromous fish populations including the Atlantic Salmon (Southern Gulf of St. Lawrence population), and Brook Trout (*Salvelinus fontinalis*) as well as the catadromous American Eel (*Anguilla rostrata*). Atlantic Salmon populations in rivers flowing into the Northumberland Strait are more stable than populations in rivers flowing to the Bay of Fundy or Atlantic Ocean. The rivers also provide spawning habitat for large spring runs of Alewife (*Alosa pseudoharengus*) and Blue-backed Herring (*Alosa aestivalis*), which provide a timely food supply for Bald Eagle and Osprey that nest along these tidal rivers (J. Wile, pers. obs.). Wood Turtle (*Glyptemys insculpta*), a species listed as threatened by the COSEWIC, also inhabits riparian systems in small numbers in most of the river systems.

Conservation of riparian systems within the bioregion will contribute to the conservation of 106 priority species (Table 9). The spatial extent of the riparian zone is being defined using the Ecological Landscape Classification scheme developed by the NS Department of Natural Resources. Ecosections composed of low sloping alluvial deposits were selected out to spatially represent riparian area and floodplains along rivers as well as NAAP critical floodplain occurrences (size>= 40 ha; Anderson *et al.* 2006). Riparian areas for the bioregion are mapped in Figure 8.

Landscape assessment of riparian and floodplain systems: Fair
The average Landscape Context Index (LCI) for the riparian system in the Northumberland Strait is 41. To be considered a relatively intact landscape, the LCI should be under 20. The highest LCI values (i.e. higher values indicate less intact landscape conditions) were found around Pictou, Antigonish and Pomquet Harbours.

The riparian and floodplain systems found within the bioregion are relatively free of obstructions such as dams and shoreline protection activity (J. Wile, pers. obs.). This allows for natural seasonal flooding to occur, which is the main ecological process maintaining the floodplain forest. Aquatic connectivity for fish is unrestricted on the primary watercourses except for a few natural barriers which are present. Such a condition exists on the Waughs River where a steep elevation change occurs at the beginning of the assent to the Cobequid Hills. The Department of Fisheries and Oceans has recently installed a fish ladder built into the bedrock in order to assist fish passage through this steep and rapid flowing section of river (MacDonald 2013).

A review of recent aerial imagery for the bioregion clearly shows the impact of forest product harvesting here that began in the early 1970's and continues today. While the required, yet narrow, 20 m riparian buffers on the major rivers seem to be intact, the clearing of trees and associated disturbance on the remaining forest would most certainly impact the hydrological features of the rivers. Erosion and sedimentation is of major concern where natural cover has been removed. Fifty-eight percent of the riparian areas remain in natural cover; however, this does not exclude areas impacted by forestry. Further down the watersheds, impacts such as agricultural activity and gravel mining are evident. Once cleared of trees, the rich alluvial soils found in the river valleys have been used for pasture, hay and other crops including carrots and strawberries, as seen today along the River Philip in the Oxford area.

Condition assessment of riparian and floodplain systems: Good
Acid rain is not a limiting factor to biological productivity on the rivers within the bioregion, since it is offset to a large extent by the buffering capacity of limestone and gypsum present in the soils. For example, the West River of Antigonish has a pH range of 7.5 to 8.0, while the pH range of the South and Wallace Rivers are 6.3 to 6.8 and 6.4 to 7.5 respectively (MacMillan & Madden 2007). When a river's pH reading drops to 5.4, Atlantic Salmon reproduction begins to fail. At 4.6 or below, salmon reproduction is impossible (Atlantic Salmon Federation 2013).

A GIS analysis completed for the bioregion's riparian floodplain zones revealed that 42% of the forest cover has been lost over time. While land clearing associated with forestry and agriculture has impacted the river systems to some extent, they contain self-sustaining salmonid fish populations. While warm water and low flow conditions reduce salmonid habitat in summer, it is not as severe as river systems found elsewhere in the province (MacMillan & Madden 2007). In forested areas, a 20 m wide buffer is maintained along the rivers and tributaries, offering some protection from the impacts of forest harvest operations. Invasive species are not a major issue within these riparian systems currently, although Glossy Buckthorn (*Frangula alnus*) is found in all but the eastern most watersheds and does grow in moist soil conditions and is found in the bioregion (Belliveau, 2012).

Size assessment of riparian and floodplain systems: Fair
The average length of the main rivers found in these hydro riparian systems is around 30 km (MacMillan & Madden 2007), however because there are 15 of them in the bioregion, their collective size is significant at a landscape level. The riparian component for each river tends to be narrow with only 80 ha being identified on the Wallace River and River Phillip systems through the coarse filter NAAP

assessment process. The average size of identified contiguous riparian habitat patches in the bioregion is 28 ha, which falls short of the NAAP critical size of 40 ha. This size measurement may be underestimated do to the limited riparian data available upon which the size was based.

Overall assessment of riparian and floodplain systems in the NSNS bioregion: **Fair**

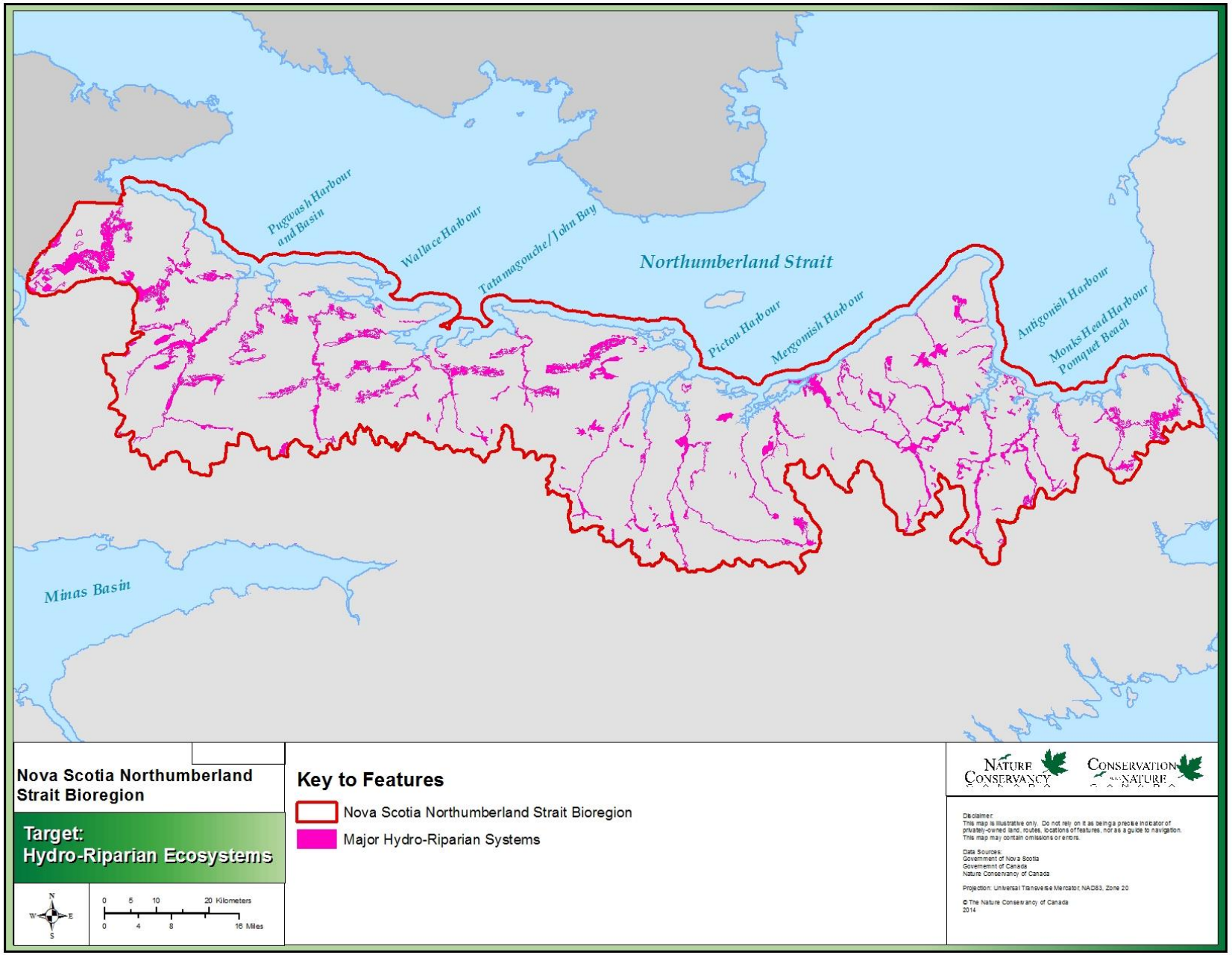


Figure 8. Riparian and floodplain systems within the Nova Scotia Northumberland Strait bioregion.

v. Priority Habitat: *Freshwater Wetlands*

Freshwater wetlands are dynamic ecosystems that occur in areas containing a high water table or where surface water flow becomes obstructed. The extent and type of freshwater wetlands that occur in a given watershed are functions of climate, surface configuration of the land, type of bedrock and soil (mineral or organic), degree of inundation or flooding, and nutrient status of the water supply (Davis & Browne 1996a). The majority of wetlands in Nova Scotia are peatlands—wetlands characterized by an accumulation of peat. Over time, lakes, ponds, and freshwater marshes can become slowly in-filled with organic and inorganic sediments, eventually becoming invaded by peat-forming vegetation (e.g., *Sphagnum* mosses) and developing into peatlands (Davis & Browne 1996a). Similarly, bogs and fens can be lost to forest encroachment over time as a result of changes to the hydrology of a site. Climate change and activities such as forest harvesting and draining can alter nutrient flows and/or the hydrology of wetlands, resulting in changes in the ecological integrity of these sensitive ecosystems.

The predominant wetland type within the bioregion is swamp, while marsh and peatlands (bogs and fens) make up the remainder (Figure 9). The lowland component of the bioregion contains many meadow or shrub swamp wetlands found on the smaller tributaries of the major river systems. Beaver activity might very well be considered an ecological process here with their cyclical construction and abandonment of dams that transform wetlands from one type to another over time. The Chignecto Isthmus region contains a high concentration of marsh, swamps, bogs, and fens totaling 4,931 ha. This accounts for 20% of the total freshwater wetlands (25,439 ha) found in the bioregion, or 4.5% of the bioregion's total area. Ducks Unlimited Canada, in cooperation with the Provincial and Federal governments, has restored and manages several large wetland complexes located on the Isthmus and scattered along the lowland region of the Northumberland Strait.

The highly productive and nutrient rich wetlands near the coast on agricultural land within the bioregion are particularly important for breeding American Black Ducks (*Anas rubripes*) and other dabblers, such as Green-winged Teal (*Anas crecca*), Ring-necked Duck (*Aythya collaris*), and American Wigeon (*Anas americana*) (Hanson 2001). Cavity nesting waterfowl, including Wood Duck (*Aix sponsa*) and Hooded Merganser (*Lophodytes cucullatus*), are found breeding in the freshwater wetlands (Erskine 1992), and the larger managed marshes in the bioregion have attracted rare or uncommon ducks, including the Northern Shoveler (*Anas clypeata*), Gadwall (*Anas strepera*), and Ruddy Duck (*Oxyura jamaicensis*). Marsh birds occur here as well, including Pied-billed Grebe (*Podilymbus podiceps*), American Bittern (*Botaurus lentiginosus*), and Sora Rail (*Porzana carolinna*) (Erskine 1992). A review of the Eastern Habitat Joint Venture Agricultural Plot breeding waterfowl survey data, which includes several survey plots within the bioregion, suggests that the density of breeding waterfowl pairs is between 2.5 and 5 times higher than the forested habitats elsewhere in the Maritimes (Pollard 2009).

Conservation of freshwater wetlands within the bioregion will contribute to the conservation of 91 priority species (Table 9). All freshwater wetlands, including critical occurrences from the NAAP (size >= 20 ha; LCI < 20; Anderson *et al.* 2006) are mapped in Figure 10. A 275 m buffer will be considered around all freshwater wetlands to protect the ecological functions and integrity of the target and maintain nesting areas for various wildlife species (EC, OMNR & OME 1998).

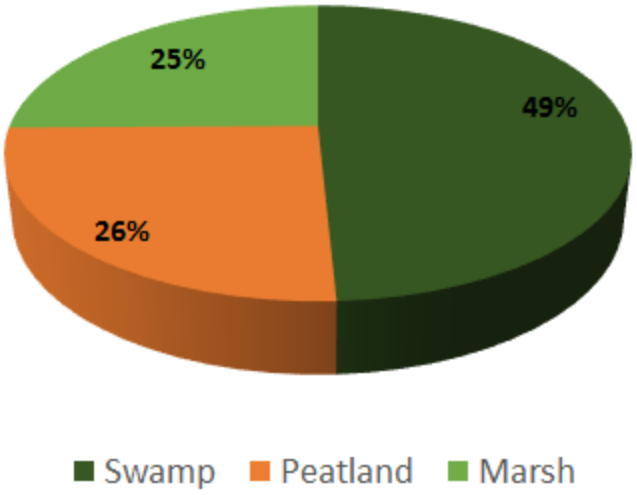


Figure 9. Composition of freshwater wetlands within the Nova Scotia Northumberland Strait bioregion according to the provincial wetland classification and inventory.

Landscape assessment of freshwater wetlands: Fair

The average Landscape Context Index (LCI) for freshwater wetlands in the bioregion is 25**,** which is above the critical value of 20 and considered to be an indication that, on average, wetlands in the bioregion are under threat from encroaching development or resource activity (calculated using NAAP data). Approximately 7% of the bioregion land area is comprised of freshwater wetlands according to the provincial wetland database, which does not include the 381 forest vernal pools thought to exist in the bioregion (NSDE data). The provincial database is based on remote derived (primarily air photo) identification and delineation of wetlands and is known to greatly underestimate forested and shrub wetlands. Over 210,957 ha of freshwater wetland buffer habitat have been identified and approximately 34% of this has been altered by anthropogenic disturbance[1].

Condition assessment of freshwater wetlands: Fair

In 2011, the Province of Nova Scotia released the Nova Scotia Wetland Conservation Policy, which provides a direction and framework for the conservation and management of wetlands in Nova Scotia, and identifies specific objectives intended to prevent the net loss of Nova Scotia's wetlands into the future (Government of Nova Scotia 2011). This policy should help to limit any further loss of freshwater wetland habitat in the province. Nova Scotia Department of Environment has the primary regulatory and enforcement responsibilities for wetlands. In addition, current forest harvesting regulations in Nova Scotia require that all forestry operations leave a minimum 20 m forested buffer along watercourses, including wetlands, though some level of harvesting is permitted within these buffers. Other human activities, including residential and cottage development, agricultural practices, road construction, infilling, and climate change may also impact the hydrology or nutrient flows of freshwater wetlands, which can lead to changes in the vegetation community and potentially impact habitat of sensitive species. Approximately 12% of freshwater wetlands in the bioregion are currently protected.

[1] Wetland buffer is the area within 275 m of the wetland's edge.

Size assessment of freshwater wetlands: Fair
The total freshwater wetland area in the Northumberland Strait bioregion is 45,659 ha represented in over 12,624 individual wetlands. The majority of these are small, isolated occurrences and are dominated by shrub vegetation along riparian areas. The average size of freshwater wetlands is 4.5 ha which is well below the critical NAAP size of 20 ha and is considered poor. However, wetlands are naturally smaller in the bioregion and several wetlands of the same or different type may form wetland complexes connected through above and below ground water flow which would drastically increase the overall size. For this reason, the viability ranking was increased to Fair.

Overall assessment of freshwater wetland habitat in the NSNS bioregion: **Fair**

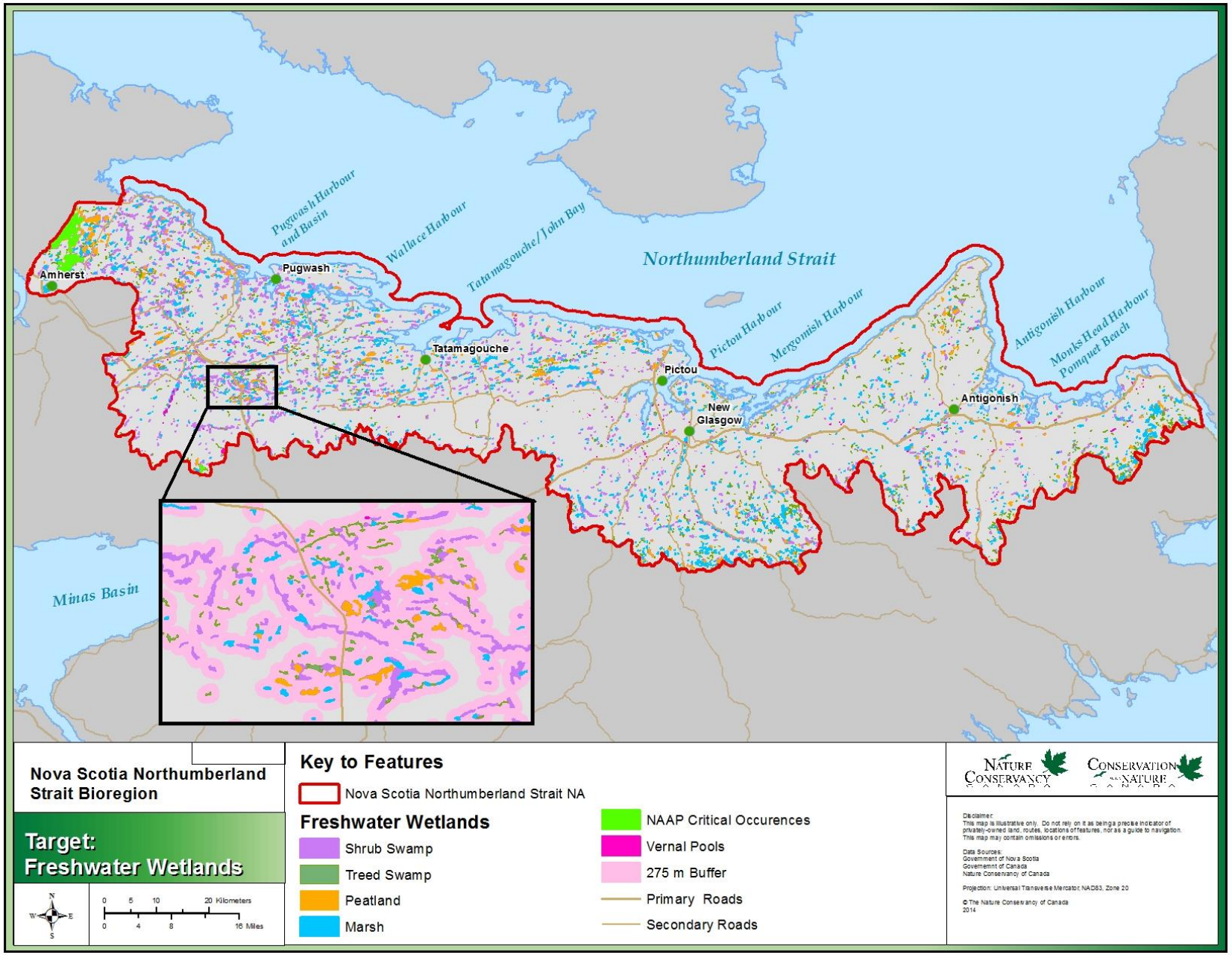


Figure 10. Freshwater wetland habitat within the Nova Scotia Northumberland Strait bioregion.

vi. Priority Habitat: *Acadian Forest Mosaic*[1]

The bioregion is part of the Acadian Forest region, a transitional zone of mixed forest between the deciduous forests of the northeast United States and the coniferous boreal forests of the north. The climax forest tree species composition is determined by the soil, nutrient, and drainage characteristics associated with the ecosites in which they are found (Keys *et al.* 2011). The poorly drained lowland areas contain Black Spruce (*Picea mariana*), Eastern Larch (*Larix laricina*) and Balsam Fir (*Abies balsamea*), while pure stands of Red Spruce (*Picea rubens*) and mixed stands of Red Spruce, Hemlock (*Tsuga canadensis*), White Pine (*Pinus strobes)*, Sugar Maple (*Acer saccharum*), White Birch (*Betula papyrifera*), and Yellow Birch (*Betula alleghaniensis*) are found on better drained soils and on higher elevations. On the highest slopes, the forest consists of nearly pure stands of deciduous hardwood species, mainly maple, birch, and American Beech (*Fagus grandifolia*) associations. Peter Neily (pers. comm.) notes that there is a difference in the forest species composition between the forests found in the lowland areas west of Sutherlands River and those to the east. This can be attributed to there being slightly higher elevations in the eastern areas with better soil drainage. West of Sutherlands River there is more Black Spruce due to wetter soil conditions, whereas east of Sutherland River, more Red Spruce and Hemlock are found. Once much more prevalent, the bioregion contains the best representation of a Red Spruce dominated forest called "Red Spruce Flats" in the province, extending from the lower slopes of the highland regions to the coastline of the Northumberland Strait on the better drained soils (Sean Basquill, pers. comm.)

uman activity on the landscape has resulted in the emergence of large stands of fire adapted tree species including Black Spruce and Jack Pine (*Pinus banksiana)* (Neily *et al.* 2003). Statistics Canada data show that as much as 40% of Nova Scotia was once cleared farmland, but today this has been reduced to approximately 10%. The NSNS bioregion has had large areas of cleared land revert back to forest. Often the succession sequence for these abandoned farm fields is alder (Alnus sp.) to White Spruce (*Picea glauca*) and various poplar species (Populus sp.), with Eastern Larch (*Larix laricina*) occupying the wetter and more poorly drained soil areas (Neily *et al.* 2003). The rich alluvial soils found in parts of the river valleys support unique intervale forests which include such species as White Ash (*Fraxinus americana*), Sugar Maple, and Black Cherry, with rarer occurrences of species such as Black Ash and Green Ash.

A Tier One Matrix Forest[2] (Figure 11) is situated on the Nova Scotia New Brunswick border region on the Chignecto Isthmus. Intact Acadian Forests located in key connectivity corridors, such as the Chignecto Isthmus and the Cobequid Hills, support mainland moose populations and other wide ranging terrestrial mammals. Intact Acadian Forests on calcareous soils supports unique flora such as the Rams Head Lady Slipper and Northern White Cedar. This 14,100 ha Matrix Forest corresponds with the extensive Northumberland Lowlands and the eastern edge of the Acadian upland section. Located within the Tantramar Marsh Ecodistrict, this forest is a blend of wetland tolerant tree species, growing in deep peat wetlands, with mixed conifer and hardwood forests on the higher ridges.

---

[1] *Indicators used to define viability for Acadian Forest Mosaic were calculated based on the best available data, however based on up-to-date satellite imagery, many of the intact stands identified in the data have since been cut-over. Viability has therefore been adjusted to account for this.*

[2] *Matrix Forest: a widespread forest community which dominates the landscape and forms the background in which other smaller scale communities occur. Identified in the NAAP (Anderson et al 2006).*

Once the dominate forest in the bioregion, large and intact Acadian Forests are becoming increasingly rare due to intense forest harvesting and silviculture activities that favour softwood species for pulp fibre and lumber. The World Wildlife Fund has designated the New England Acadian Forest as critically endangered due to the long history of settlement and land clearing that has occurred here. In Canada it is estimated that less than 5% remains in pre-settlement condition, with at least 50% heavily altered, mainly due to logging and land clearing for agriculture (Davis *et al.* 2013). Most of the forested land base here is privately owned or leased by the province to the forest industry. This preponderance of managed forest occupies most of the landscape and does not support the array of flora and fauna once prevalent in the Acadian Forest.

The forests of the Northumberland Strait bioregion have experienced a shift from late succession shade tolerant species including Eastern Hemlock and Yellow Birch to a less diverse forest of early succession species such as Black Spruce and poplar species (*Populus* sp.) (Thurston 2011; Anderson *et al.* 2006). One exception to this is found in the steep valley slopes adjacent to the rivers in the lowland area, where species such as Eastern Hemlock and Sugar Maple can be found (Sean Blaney, pers. comm.). These narrow linear vestige forests have been protected over time because the steep slopes on which they grow makes harvest difficult.

According to the Nova Scotia Department of Natural Resources' Forest Resource Inventory, 101,375 ha of late successional forest (i.e., development class mature or multi-aged with a seral score of 38-50) occur within the bioregion. The distribution of late-successional forest types among shade-tolerant hardwood, shade-tolerant mixedwood, and three shade-tolerant softwood forest types is shown in Figure 12.

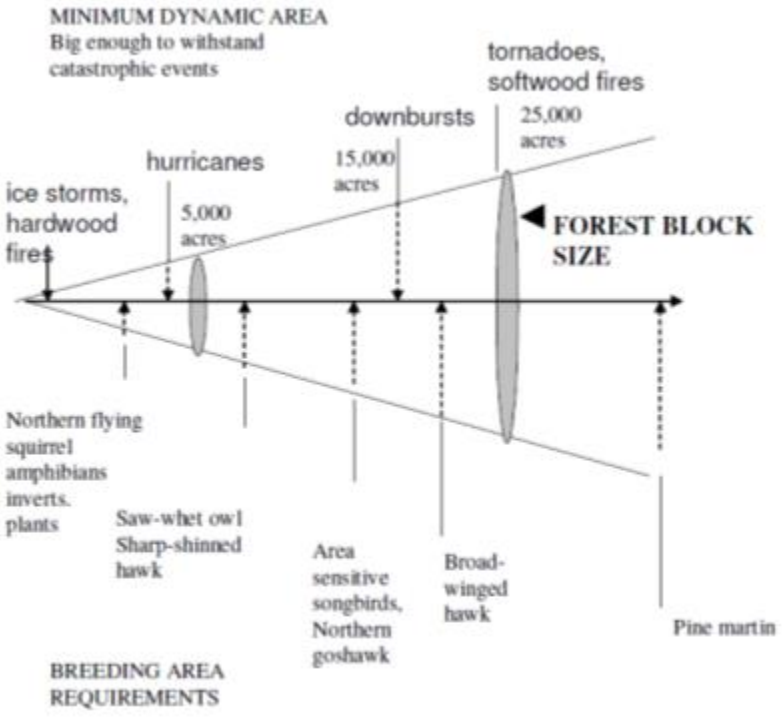


Figure 11. Scaling factors for matrix forming forest in the Northern Appalachian/Acadian Ecoregion showing rationale for minimum core protected area (forest block size) (Anderson *et al.* 2006).

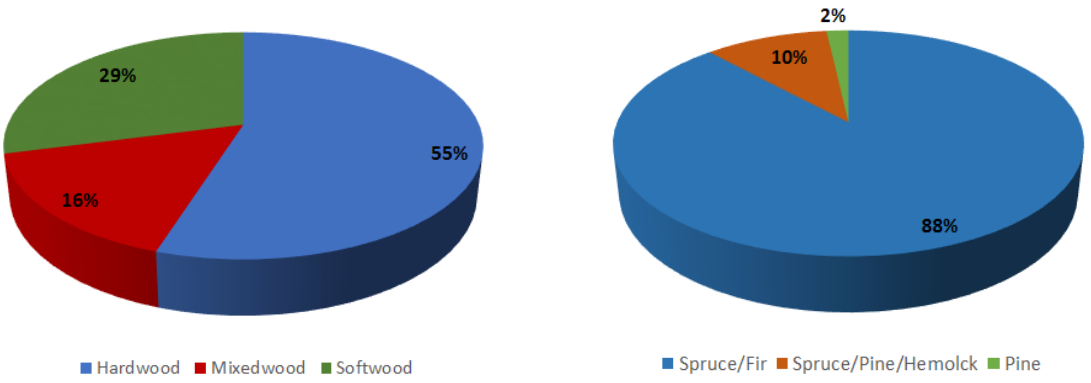


Figure 12. Composition of late-successional forest types within the Nova Scotia Northumberland Strait bioregion.

Conservation of forested ecosystems within the bioregion will contribute to the conservation of 106 priority species (Table 9). Late successional Acadian forest types within the bioregion are displayed in Figure 13**.**

Landscape assessment of Acadian Forest mosaic: Fair

From a coarse filter perspective, the bioregion would appear to be in 'natural' cover. However, the forests are currently for the most part, not in their 'natural' state. The history of land clearing for agriculture and subsequent human settlement, along with large-scale forest harvest operations has created a very fragmented forested landscape containing a network of highways and logging roads on the patchwork of smaller properties found there. Once harvested areas are subtracted, only 40% of the forest remains in seven of the eight primary watersheds in the bioregion. According to Environment Canada's "*How much habitat is enough?"*, this equates to a medium risk approach. This is likely to support only half of the potential species richness and moderately healthy aquatic ecosystems. Based on the NS Provincial forest inventory data, there are between 12 and 15 contiguous 375 ha forest patches within each primary watershed. Recent satellite imagery however, reveals that much of those remaining patches have been clear-cut since the inventory was last updated. A minimum forest patch size of 375 ha is deemed appropriate to support a diverse array of interior forest species (Betts & Forbes 2005).

Condition assessment of Acadian Forest mosaic: Fair

Human influence over the past 200 years has simplified forest structure, composition and age class distribution resulting in a decline in old forest communities (Erdle & Sullivan, 1998). 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 & Ives 2003; Mosseler *et al.* 2003). In 2000, it was estimated that 91% of Nova Scotia's forests consisted of even-aged stands less than 100 years old (NSDNR 2000; Stewart *et al.* 2003), though Lynds & LeDuc (1995) estimated that the percentage of Acadian Forest greater than 100 years old was less than 1%. The current forest mosaic is that of a disturbed, young regenerating conifer/aspen dominated forest, with lower species diversity than would be found in an intact Acadian Forest. Without human disturbance, the forest would, over time, return to an Acadian Forest Mosaic, however much of the land is owned by small woodlot owners who sometimes managed their woodlot for timber extraction. Larger

intact Acadian Forest components are desirable here especially in strategic locations to support habitat connectivity or to improve water quality within the aquatic systems.

Mature, late-successional forest constitutes 23% of the current forested area and only 19% of the historical forested area within the bioregion. The remaining 77% of forested land is comprised of young and/or regenerating stands. Of the remaining late successional mature forests 11% is currently managed for conservation, most of which is within the Eigg Mountain-James River Wilderness Area.

Road density, thought to be an indicator of forest condition and suitability for Mainland Moose (Beazley *et al.* 2004), is 2.3 km/km^2 within the entire bioregion includes paved roads, primary and secondary logging roads). Road density only drops to 2.0 km/km^2 when only forested areas are included. Both measures are however above the 0.6 km/km^2 recommended as a target road density identified by Betts & Forbes 2005, to reduce the impact to wildlife from fragmentation and collisions with vehicles.

Size assessment of Acadian Forest mosaic: Fair

Mosseler *et al.* (2003) suggest that old forest communities (mature and overmature) within the Acadian Forest used to occupy an estimated 50% of the land base prior to European settlement. As mentioned above, only 23% of the remaining forested area is classified as such. When permanently converted forest lands are included, the percentage is reduced to 19%, as approximately 16% of the bioregion's forest land has been permanently altered since settlement.

Fragmentation from roads has also had a considerable impact on the size of intact contiguous tracks of forest in the bioregion. Only 18% of the remaining late successional forests occur in patches greater than 375 ha. This value is used as the minimum patch size to capture breeding populations of all old-forest dependant species.

Overall assessment of Acadian Forest mosaic: Fair

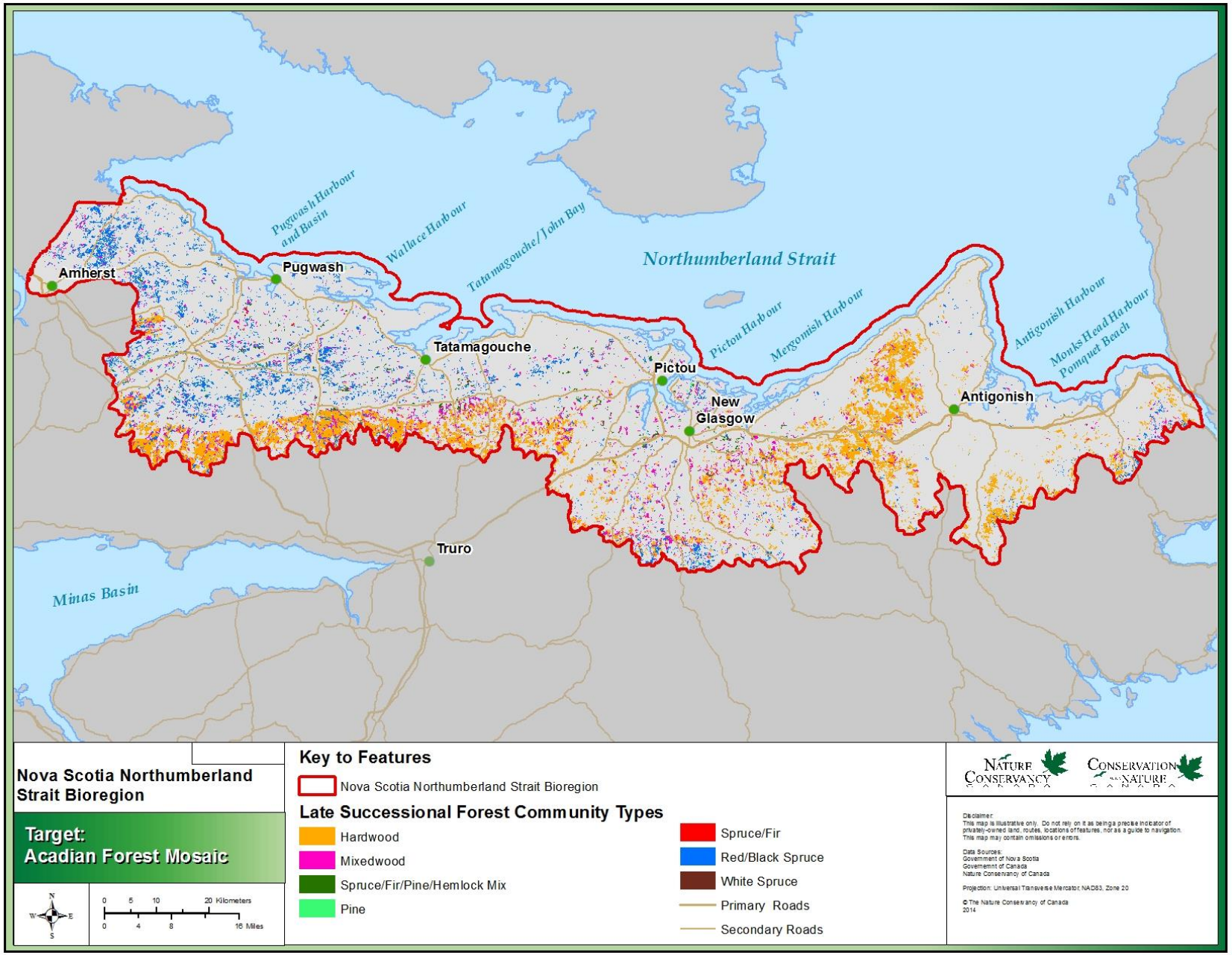


Figure 13. Late successional Acadian Forest matrix habitat within the Nova Scotia Northumberland Strait Bioregion

vii. Priority Habitat: *Grasslands*

Grasslands are open, herbaceous habitats dominated by assemblages of grasses and forbs. Prior to European settlement, natural grasslands were extremely rare and fragmented within the bioregion and historically have been associated with various types of agricultural lands (e.g., hayfields, pasture lands), which may serve as habitat for grassland-associated wildlife (McAlpine & Smith 2010). These cultivated and managed areas, particularly those near water, are used by a broad variety of species and can be areas of high biological diversity (Environment Canada 2013). There are a number of federally listed and BCR 14 priority bird species within the bioregion that are strongly associated with this habitat type and require grasslands for nesting and foraging habitat, especially agricultural hayfields in eastern North America (Environment Canada 2013). Several of these grassland-associated species are exhibiting major continent-wide declines, including the Bobolink, Savannah Sparrow, Short-eared Owl, Rusty Blackbird, Barn Swallow, and Common Nighthawk (Environment Canada 2013; NABCI 2012). A variety of non-grassland dependent species also use this habitat type for foraging and nesting, including waterfowl and Wood Turtle. Threats to grassland-associated species include incompatible farming practices such as mowing during the breeding season, the loss of pasture lands to cropland and old field succession, and contamination of food sources, declines in prey availability, or direct mortality as a result of pesticide use (Environment Canada 2013). Abandoned farmland provides a brief period of old field successional grass and shrub habitat before regenerating into forest. Many of the old abandoned farm fields, especially those on higher elevations, are now being managed for low bush blueberry production. Abandoned beaver ponds often go through a brief grass dominated meadow phase before they transition into shrub swamps or become re-flooded by beavers again.

Conservation of grassland and agro-ecosystem habitats within the bioregion will contribute to the conservation of 62 priority species (Table 9). Figure 14 shows the location of all lands used for agriculture, including lands used for tilled crops, pasture, hayfields, and orchards; therefore, only some proportion of these areas represent suitable habitat for grassland-associated species.

Landscape context assessment of grasslands: Good

According to the provincial forest inventory, agricultural lands (hay field, pasture, tilled crops, orchards) account for 15% of the bioregion's land base, two times the provincial average. Compared to historical levels in Nova Scotia, there are fewer but larger farms employing more intense farming practices occurring on approximately 7% (400,000 ha) of the provincial land base; forage (i.e., hay) makes up over 70,000 ha of this value (Province of Nova Scotia 2012). Many marginal farmlands have been abandoned, which results in succession by shrub and forest species (Neily *et al.* 2003). Further losses of grasslands occur when agricultural lands used for hay and pasture lands are converted to other uses, such as tilled cropland or development.

Condition assessment of grasslands: Unknown

Grasslands within the bioregion are both dependent upon and threatened by human land-use practices. In addition to habitat loss as a result of changes in agricultural land-use practices (i.e., the loss of hay fields and pasture lands to cropland or old field succession), threats to grassland-associated species include incompatible farming practises such as mowing during the breeding season, and pesticide application (Environment Canada 2013). Early and more frequent (i.e., more than once a season) hay harvests do not allow for sufficient time for breeding birds to complete their nesting cycle.

Size assessment of grasslands: Unknown

It is difficult to assess the size viability of grasslands within the bioregion, because they are not permanent natural landscape features, often used as a part of a crop rotation system. Historically there

had been a general conversion of abandoned agricultural areas to low bush blueberry fields or reversion to early successional forest vegetation types in the bioregion, and consequently a reduction in the abundance and availability of grassland habitat. In 2006, active farmland represented only about one-third of that used in 1901 (NSALRC 2010), and agricultural lands continue to decline as a result of urban development (Environment Canada 2013).

Overall assessment of grasslands in the NSNS bioregion: Good

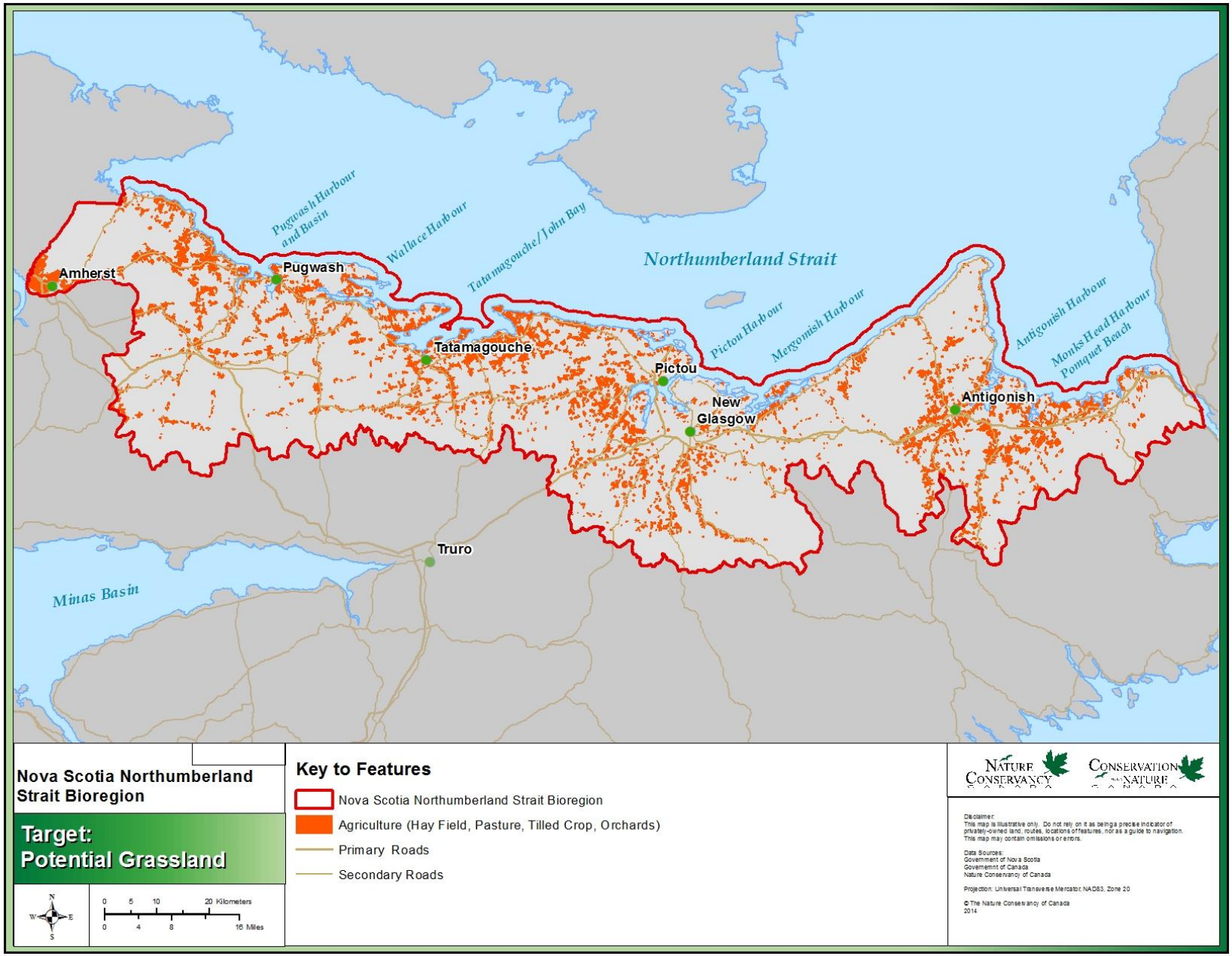


Figure 14. Potential for grassland habitat within the Nova Scotia Northumberland Strait bioregion.

Summary of Habitat Conservation Priority Assessments

The overall assessment of the conservation priority habitat types in the Nova Scotia Northumberland Strait Bioregion is Fair (Table 11). Only 2 out of the 7 habitat conservation priorities received "good" ranks. Their structure, species composition, and key ecological processes and functions are somewhat impaired by anthropogenic stresses but they are functioning within a range of acceptable variation compared with the natural or historic range of variation for that ecosystem, however may require some management. The remaining 5 habitat conservation priorities received 'Fair' assessment ranks, meaning that their structure, species composition, and key ecological processes and functions are impaired by anthropogenic stresses, and are functioning below the range of acceptable variation compared with the natural or historic range of variation for that ecosystem, and require management, without which the habitat conservation priority will be vulnerable to serious degradation.

Table 10. Assessment ranks of ecological integrity for the habitat conservation priorities in the Nova Scotia Northumberland Strait Bioregion.

Priority Habitat	Landscape Context	Condition	Size	Assessment Rank
Beaches and dunes	Fair	Poor	Good	**Fair**
Salt marshes	Poor	Good	Fair	**Fair**
Tidal flats	Fair	Unknown	Very Good	**Good**
Freshwater Wetlands	Fair	Fair	Fair	**Fair**
Riparian systems	Fair	Good	Fair	**Fair**
Acadian Forest Mosaic	Fair	Fair	Fair	**Fair**
Grasslands	Good	Unknown	Unknown	**Good**
Overall assessment of habitat conservation priorities in the bioregion				**Fair**

B. Threats

Threats are the proximate activities or processes that have caused, are causing, or may cause the destruction, degradation and/or impairment of one or more of the identified biodiversity targets. Threats impact the target's viability and/or key ecological attributes.

Threats to the biodiversity targets were identified by the Nova Scotia Northumberland Strait bioregion project team, using past studies, local expert knowledge and a review of the literature. The threats identified within this Habitat Conservation Strategy are thought to be comprehensive for the bioregion's habitat types. These threats were ranked based on their scope, scale, and irreversibility of damage to targets over a 10-year period using the Conservation Action Planning Workbook (Low 2003), and were categorized using established international taxonomy (IUCN-CMP 2006a), with local descriptions (see below). Table 11 provides a summary of the threats identified for the area. The overall threat status for the NSNS bioregion is High. Threats identified for BCR 14 and MBU 12 (Environment Canada 2013) were also examined for specific relevancy to the NSNS bioregion and are listed in Table 12 and in Figure 15. The geographic extent of each identified threat is indicated, where known, in Figure 16 to Figure 24.

Table 11. Summary of threats to the Nova Scotia Northumberland Strait bioregion.

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

Threats[1] Across Habitats	Acadian Forest Mosaic	Hydro Riparian Systems	Beaches and Dunes	Tidal Flats	Salt Marsh	Freshwater Wetlands	Grasslands	Overall Threat Rank
5.3 Forest Product Harvesting	High	Medium				High		**High**
2.1 Blueberry, Grain and Crop Production	High	Medium				Medium	Low	**Medium**
4.1 Road Fragmentation	High	Medium				Medium		**Medium**
9.3 Agricultural and Forestry Effluent		High				Medium		**Medium**
8.1 Invasive European Green Crab				High	Medium			**Medium**

[1] *Threat nomenclature is based on the IUCN classification of direct threats (IUCN-CMP 2006a).*

Threats[1] Across Habitats	Acadian Forest Mosaic	Hydro Riparian Systems	Beaches and Dunes	Tidal Flats	Salt Marsh	Freshwater Wetlands	Grasslands	Overall Threat Rank
2.2 Large Scale Pulp and Christmas Tree Plantations	High							**Medium**
1.1 Residential and Seasonal Cottage Development	Low	Medium	Medium	Medium				**Medium**
8.1 Invasive Glossy Buckthorn	Medium	Medium				Medium		**Medium**
1.3 Recreational Development	Medium		Medium		Medium			**Medium**
6.1 Recreational Beach Use			Medium	Medium				**Medium**
11.3 Temperature Extremes		Medium	Medium					**Medium**
9.1 Urban/ Industrial Effluents	Low				Medium		Low	**Low**
7.3 Shoreline Armouring			Medium	Low				**Low**
3.3 Wind Farms	Low						Low	**Low**
Threat Status for Habitats and Overall	**High**	**High**	**Medium**	**Medium**	**Medium**	**Medium**	**Low**	**High**

Table 12. Relative magnitude of identified threats to priority species within BCR 14 NB, and MBU 12 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 12 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**	**M**	**L**	
1. Residential & commercial development	L	L	L	L	L	L	H	M	L	M	M	L	**M**		L		**L**
2. Agriculture & aquaculture	M	M	M	L		H		M		L	L		**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	M		**M**
7. Natural system modifications	L	L	L	L		L		L		M	L		**L**		M		**L**
8. Invasive species & other problematic species and genes	L	L	L	L	L	L	L	L	L	M	L		**L**	L	M	L	**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	

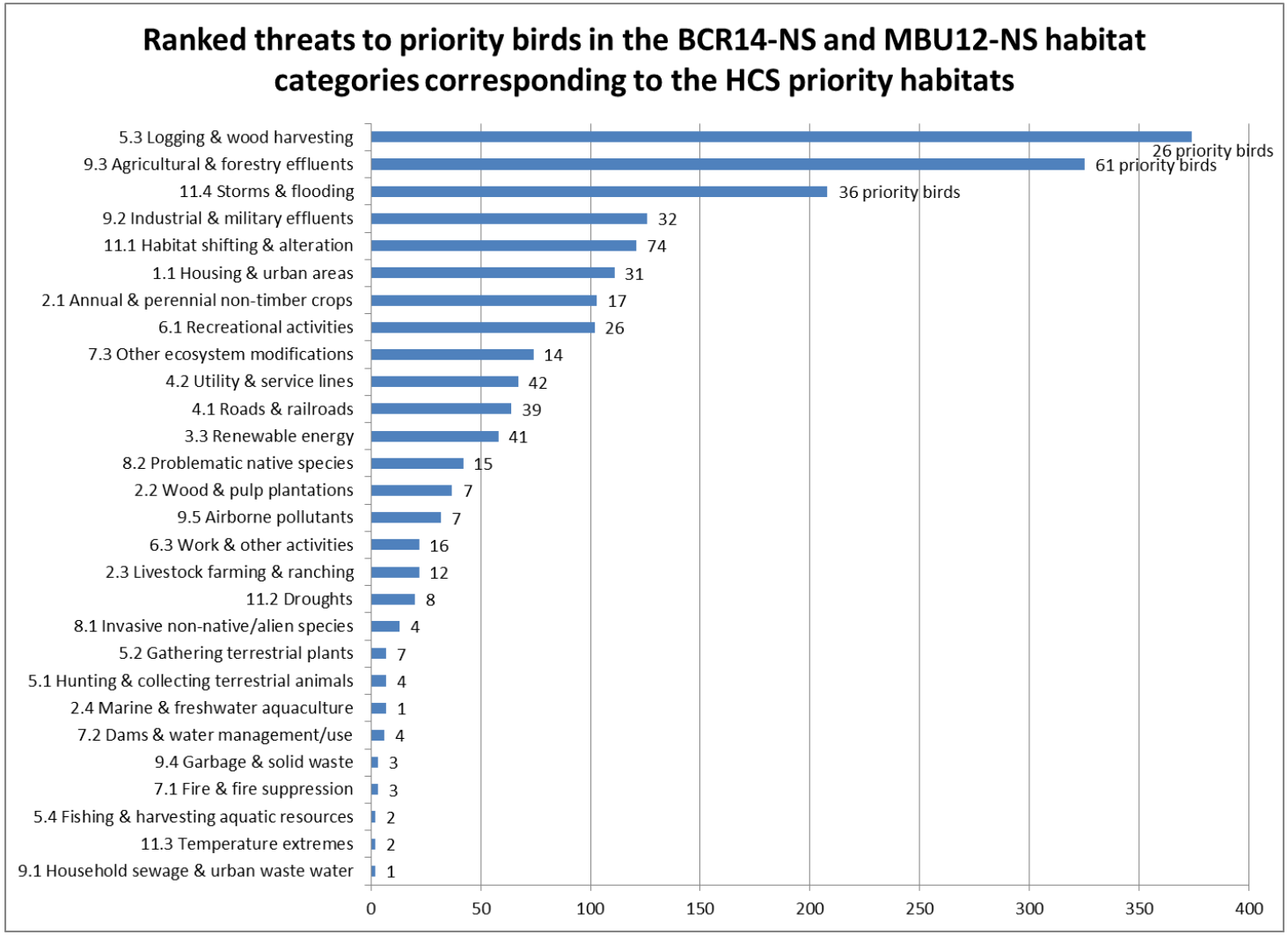


Figure 15. Ranked IUCN sub-categories of threats to priority bird species within BCR 14 NS and corresponding to priority habitats based on the number of priority bird species affected and the magnitude of the threats (calculated using an inverse of the 3:5:7 rule; Salaksky 2003). The number of priority birds affected by threats within a particular IUCN threat sub-category is provided at the end of each bar. Modified from Environment Canada 2016 by A. R. Benoît.

i. Current Threats

1.1 Cottage and residential development (Threat Status: Medium)

Demographic changes within the bioregion appear similar as elsewhere in Nova Scotia with a decrease in the rural population (2011 Census data). Interest in seasonal or vacation properties, however, has been strong after a brief decline during the recessional years of 2008 and 2009 (Peter Finley pers. comm.). While new cottage development is somewhat limited due to high land values and lack of available building lots, there is continued interest in developing the more available and less expensive shorelines associated with harbours and tidal rivers (Peter Finley, pers. comm.).

Ongoing property protection activities, such as shoreline armouring to prevent coastal erosion, continue to impact the bioregion's beaches and estuaries. Cottage development is continuing to expand along the shorelines of the tidal rivers, where land is still available. The development of permanent housing continues in urban areas close to larger coastal towns such as New Glasgow and Antigonish. The Human Footprint index, developed by the Wildlife Conservation Society (Woolmer *et al.* 2008), is a good indication of the scale of impact and threat of development as it is derived from layers of anthropogenic infrastructure. The human footprint impact in the bioregion is mapped in Figure 16.

Nova Scotia is one of only a few jurisdictions in North America with no overarching coastal zone management strategy, which has contributed to problems, including inappropriate and impactful developments. However, a detailed report *State of the Coast* was released in 2009 (CBCL Limited 2009), followed by a *Coastal Management Framework,* and a coastal zone 'policy' is in the later stages of development (expected 2013 release delayed). It is expected that the policy will begin to address issues surrounding coastal zone development, though complicated jurisdictional issues between federal, provincial, and municipal governments will remain.

1.3 Recreational development (Threat Status: Medium)

The development of tourism recreational facilities such as golf courses and resorts (e.g., Fox Harbour Resort) has the potential to create a substantial ecological footprint. Golf appears to be an economically sustainable tourism and recreational industry with those courses situated on the coast known as 'Links' style courses being most in demand. While opportunities for such large developments are limited, their impacts can be cumulative.

2.1 Annual and perennial non-timber crops (Threat status: Medium)

Low bush blueberry production continues to thrive in the area, with Cumberland County's acreage alone increasing 23% from 8,118 to 10,015 ha between the years 2006 and 2011 (Statistics Canada 2012c), although some of this activity would be outside of the bioregion. Wild low bush blueberry production has the potential to convert natural forest cover on a large scale. Blueberries are also grown on marginal abandoned farm land that might otherwise revert back to forest.

Crops such as corn and soy bean are now being grown in the fertile soils along the Northumberland Strait in response to recent high commodity prices (John Wile, per. obs.). With recent interest in grain and soybeans, and ongoing interest in potato and carrot production, the potential for increased agricultural activity within the productive soil zones the bioregion exists, as world food demand rises. Currently these corn and bean crops are being grown on existing farmland which is readily available for lease to these non- resident farmers, but with an abundance of class 1 to 4 agricultural soil available in the area, more intensive crop production is a distinct possibility.

Mortality of Wood Turtles has been documented when hay is harvested in fields close to rivers containing wood turtle populations. Wood Turtles use the hay fields during summer as foraging sites and are sometimes unintentionally killed by hay harvesting equipment (Mark Pulsifer, pers. comm.)

There is additional good agricultural soil in the area that was once cleared and farmed, but with lack of use has reverted back to forest. This forested land could once again be cleared if demand was there for food crops.

2.2 Wood and pulp plantations (Threat Status: Medium)

Large scale tree planting and plantations work against the natural regeneration process, which would result in a much more diverse forest ecosystem. Forest plantations may act as fragmentation features across the forested landscape for some species (Christian *et al.* 1998) and are associated with other fragmentation features such as roads and cut blocks. Plantations were once a much more common silviculture technique in the bioregion, especially in old field applications (John Wile, pers. obs.). Single species softwood was planted in situations where natural regeneration of softwood was not likely to occur. While these pulpwood plantations were not very large individually, many exist in small monotype stands. According to the NS forest inventory there are just over 54,000 ha of pulp and Christmas tree plantations in the bioregion, representing 10.3 % of the forested area. This is more than 5 times the area currently protected in the bioregion. Softwood species are predominantly used for planting and frequently followed up by herbicide spraying to remove competition from hardwood species. Christmas tree plantations consist mainly of Balsam Fir. These plantations are normally developed in forest clear cuts where Balsam Fir regenerates prolifically. Highly managed, Christmas tree plantations become small monoculture forests. Statistics Canada census data show a slight decline in Christmas Tree plantations in the area over the past 5 years, dropping from 1,834 ha in 2006 to 1,738 ha in 2011. Due to competition from U.S. growers, as well as increase use of artificial trees, growers are currently experiencing a downturn in the industry.

The conversion of mixed species or hardwood forests to even age, single species coniferous forests are the biggest threat to the forests of the bioregion (Peter Neily, pers.com.).

3.3 Wind energy production (Threat Status: Unknown)

The bioregion contains three large wind farm operations and several smaller, community based turbines. Two of the larger ones are in the Cobequid Hills and Pictou Antigonish Highlands, while another is situated on the Tantramar Marsh. These larger wind farms contain 15 to 30 turbines that stand 80 to 90 m at the hub with 40 m blades. Wind Farm construction and maintenance requires a network of wide straight roads. Environmental concerns of wind farms are centered on bird strikes, habitat loss and fragmentation. Wind Farms require an intense amount of preliminary environmental assessment and post construction monitoring. All of the large wind farms in the Bioregion are less than three years old and so the impacts are still being assessed. There are no new large wind farm developments planned for the area for the immediate future. The Nova Scotia Department of Energy's Renewable Energy Plan (April 2010) indicates that that the existing provincial power grid system has limitations to increasing, importing and exporting power. In view of this, the current threat status for wind farms is considered to be unknown.

4.1 Roads and railroads (road fragmentation) (Threat Status: Medium)

Road construction has long been linked to habitat fragmentation with associated negative impacts to many wildlife species (Beazley *et al.* 2004) and is a major concern for wide-ranging mammals. Forest roads fragment and open up interior habitats to off-road vehicles, act as barriers to wildlife movement,

facilitate illegal activities such as poaching, as well as creating potential opportunities for the spread of invasive species (Forman 1995). Road density is high within the Bioregion due to the high population density and resource extraction industries that occur here. There are a total of 6,477 km (distance from Halifax to Moscow) of roads in the bioregion (Figure 21), with a road density of 2.3 kilometres per square kilometer. The Chignecto Isthmus is of particular concern because it acts as a bottleneck, where wide-ranging species are funneled and must cross major highways. Road construction can have a negative impact on freshwater wetlands, tidal marshes, and estuaries as a result of changes to hydrology and direct loss of habitat (Environment Canada & Parks Canada Agency 2010).

5.3 Forest harvesting practices (Threat Status: High)

Forest product harvesting has and continues to have a profound impact on natural forest ecosystems in the Bioregion. With 87% of the forested land being privately owned and only 2.2% set aside for conservation, the forest resource is available for exploitation by the forest industry, mostly for pulp fiber. Global Forest Watch (Cheng & Lee 2009) examined recent (1990 - 2007) anthropogenic change within Nova Scotia's forests. This detailed analysis indicated that 12% of the province's forests underwent anthropogenic change. The four counties represented in the Northumberland Strait Bioregion, however, were impacted to a greater extent: Antigonish County 13.4%, Pictou County 20.5%, Colchester County 27.3% and Cumberland County 15.7%. The forests found in the Northumberland and Bras d'Or lowlands and Nova Scotia Uplands Ecoregions experienced a 13% and 18.2% change respectively.

The major source of this change in the bioregion is believed to be forest harvesting, as there are no other activities that result in major widespread land conversion. Almost all of the harvesting is by clear-cut, a technique that does not mimic the small-scale, canopy-gap disturbance regime of this conifer-dominated Acadian Forest. The minimum required riparian buffer is 20 m in Nova Scotia, and within those 20 m, harvesting can still occur as long as a certain basal area remains. Heavy equipment is permitted to operate as close as 7 m from watercourses (Province of Nova Scotia 2009).

Lee and Cheng (2009) indicate that there are currently no intact forest fragments in the bioregion larger than 5000 ha and only a few in the 1000 ha to 5000 ha size range. Older, intact Acadian Forests, upon which many species depend, are clearly under represented now within the bioregion. With increased demand for pulp fiber and proposals to use wood bio-mass to produce electricity, the threat to the remaining intact forest is High.

6.1 Recreational beach use (Threat Status: Medium)

The bioregion contains 17 coastal provincial parks that receive high public use from late May through to the end of August. Most are day-use picnic parks, but there are also some camping parks as well. Scattered among these public beach areas are dense cottage developments, so that now much of the shoreline is being used for recreational purposes during summer. Fortunately, 14 of the most important beaches are now under the *Protected Beaches Act*, which prevents development within 100 m, although this does not mean that there are no human impacts to wildlife. Bird Studies Canada monitors Piping Plover breeding success on beaches in the area and notes that human activity and disturbance during the nesting period can greatly reduce fledgling success. Use of beaches by off-road vehicles is still occurring in some more remote areas such as Monks Head Beach (John Wile, pers. obs.), even though it is strictly prohibited. Fragile dune systems can be damaged by foot traffic, and even more so by ATV's, although this behavior has been greatly reduced through education and enforcement in recent years.

7.3 Other ecosystem modifications (shoreline armouring) (Threat Risk: Low)

The sandstone and clay shoreline found along the Northumberland Strait is highly erodible and with rising sea levels and frequent storm surges, it is not uncommon to see erosion extend several meters inland each year at some property locations (John Wile, pers. obs.). To prevent or slow down the shoreline erosion, cottage owners are armouring their shorelines by placing rip-rap or building seawalls to protect their properties. This causes increased erosion of adjacent properties that don't have protection, loss of the sediment supply to maintain coastal systems, especially beaches, and the inability of the coastal systems to migrate inland over time as sea levels rise (Natural Resources Canada 2008). While most of the more erodible sections of shoreline are already armoured, the prediction of increased sea level rise and storm surges will make shoreline armouring an ongoing process (Figure 24).

8.1 Invasive non-native species – European Green Crab (Threat Risk: Medium)

The European Green Crab is commonly found in the shallow waters of salt marshes, beaches and rocky coasts or in vegetation. It first appeared in the Bay of Fundy in the 1950s and has since become common along most of Nova Scotia's coastline. It is a voracious consumer of plants and animals, especially soft shell clams, oysters, quahogs and mussels. It uproots and destroys beds of Eelgrass, an important habitat-forming species for native fish, invertebrates and waterfowl. Dramatic declines have been seen in Eelgrass beds in estuaries along the North Atlantic coast, with an estimated overall decrease of 50% of Eelgrass over the last century (GOMC 2007). A similar collapse of Eelgrass populations in Antigonish Harbour occurred in 2000 and 2001, resulting in a decrease in the winter population of Canada Geese and Common Goldeneye (*Bucephala clangula*) by about 50% (Seymour *et al.* 2002). Between 2001 and 2002, Locke (2005) reported declines in the above ground biomass of Eelgrass in four estuaries within the NSNS bioregion as follows: Caribou (8.7%), Merigomish (37.8%), Pomquet (22.6%), and Tatamagouche (61.1%). The cause of Eelgrass collapse is unknown but thought to be a complex interaction of many factors, such as disturbance by the invasive European Green Crab, eutrophication, and environmental changes (Hanson 2004). Currently, Eelgrass beds appear to be recovering around the Province, including the eastern section of the Northumberland Strait, which may be partly due to a stabilizing of the European Green Crab populations (Randy Milton, pers. comm.). So, while European Green Crabs are known to be present in the area, their long term impact on the coastal ecosystem is still unclear and so the risk is considered to be Medium.

8.1 Invasive non-native species – Glossy Buckthorn (Threat Status – Medium)

This invasive shrub or small tree is well established in the western half of the bioregion. It is most commonly found in wet to moist old field habitats, but is also found in forests, shorelines and open wetlands. Although it has been in North America since the 1700s when it was introduced as a hedge and ornamental species, it wasn't considered a serious threat to native species until the early 1900s. The Mersey Tobeatic Research Institute's invasive alien species information guide (Belliveau 2012) suggests that Glossy Buckthorn, being highly adaptable to a variety of habitat and soil conditions, may represent the greatest threat to plant communities in Nova Scotia.

9.1 Household sewage and urban waste water (Threat Status – Medium)

Residential population centres found in the bioregion range in size, but many have only 100 or so residents. A 2007 report on the Northumberland Strait Ecosystem Overview prepared for Fisheries and Oceans Canada by AMEC is quoted as saying "*A significant environmental concern from the presence of these communities is sewage effluent that contains high concentrations of nutrients and human pathogens. While sewage treatment can reduce the concentrations of these contaminants, not all communities have treatment facilities and not all treatment facilities are 100% effective*." There are

hundreds of cottage septic systems, installed as far back as the 1950s, that are not functioning properly. The area is not highly industrialized, although pulp mills and fish processing plants do contribute effluent as well. Upgrades to existing aging treatment systems are ongoing, such as that in the village of Pugwash, which now effectively treats wastewater from 520 households that eventually discharges into Pugwash Harbour. The town of Pictou, with a population of 4000, was directly discharging wastewater into the Northumberland Strait until 2011 when a treatment facility was constructed. While steps are being taken to slowly deal with urban and industrial effluent, the threat to coastal ecosystems, such as estuaries and Eelgrass beds, from eutrophication is of concern.

9.3 Agricultural and forestry effluents (Threat Status: Medium)

The impacts of agricultural and forestry activities on the uplands include the run-off of nutrients, sediments, pesticides, and pathogens that can end up in watersheds and estuaries (DFO 2007b). Increased crop production, particularly corn and soybeans, has resulted in more farm fields becoming exposed to erosion during the fall and winter months. The problem is more acute on steeper slopes. The use of grass waterways and buffer areas of unploughed land help reduce sediment loads. Forest harvesting can contribute large amounts of sediment loading to watersheds if roads are poorly located and/or constructed.

Nutrient run-off from livestock operations can also contribute to eutrophication of receiving waters, although livestock farming in the area has declined over the past 5 years. A review of data collected on farming related activities between 2006 and 2011 in the 4 counties containing the Northumberland Strait Bioregion reveals a 39% reduction in the number of beef farms (111 farms) and a 16% reduction in the number of dairy farms (21 farms). At the same time the number of sheep farms has increased by 34% and the number of so called hay farms has increased by 48% (94 farms). A further look through the data indicates that overall there is an increase in the number of farms of 43, but slightly less land is being farmed (-2,848 acres) (Agriculture Census Data Statistics Canada 2011).

In spite of an apparent decline in livestock production, farming is a relatively common land use along the Northumberland Strait and some river valleys where the soil capability for agriculture is high. With declining numbers of livestock on the landscape and much improved soil conservation and environmental farm plan standards and practice, the threat to the areas biodiversity from agricultural run-off is Medium.

ii. Emerging Threats

A number of emerging threats are broad scale and so will likely affect not only the Nova Scotia Northumberland Strait bioregion, but the whole of Atlantic Canada. Some of the threats currently exist, but are expected to increase in intensity or frequency.

Climate Change and Severe Weather

11.1 Habitat shifting and alteration (Threat Status: 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; US CCSP 2009). 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 increasing challenges for species' adaptation (Nicholls *et al.* 2007). In the Atlantic Provinces mean temperature and summer rainfall are expected to increase by 3^{o}C and 0% 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 Speckled 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 (Threat Status: Medium)

Two associated effects of climate change that are expected to have dramatic impacts on the bioregion's coastal ecosystems are global sea-level rise and an increase in the frequency and intensity of storms, and consequently coastal erosion (US CCSP 2009). Global sea levels have risen approximately 120 m due to natural processes (post-glacial sea-level rise, regional subsistence) since the height of the most recent glacial period (i.e., the Wisconsin Glaciation; US CCSP 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 region range from 45 to 80 cm by 2055, and 1.2 m to 1.73 m by 2100 (CBCL Ltd. 2009; Greenburg *et al.* 2012; Richards & Daigle 2011). This will have profound effects on the bioregion's coastal ecosystems through increased coastal erosion, inundation, and frequency of flooding (US CCSP 2009). At present, 620 km of dykes protect approximately 17,400 ha of land in Nova Scotia, along with approximately 600 residential and commercial buildings, as well as roads and railroads (NSDA 2007). Van Proosdij *et al.* (2013) estimates that all of the dykes within Nova Scotia are below the predicted rates of sea-level rise by 2055, which will result in more flooding, potential damage to coastal infrastructure and property loss, potential loss of life, coastal erosion, freshwater flooding, and dam failure in the dykelands (Van Proosdij & 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 (US CCSP 2009). Shoreline hardening (see 1.1.1 Cottage and Residential Development) effectively prevents the inland migration of these priority 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.

11.3 Changes in temperature regimes (Threat Status: Medium)

The impacts of extreme temperature variations is another important threat associated with climate change. Most of eastern Canada has experienced the warmest average temperatures on record recently and predictions are for continued warming and temperature extremes (Environment Canada 2012a). An excerpt from the 2007 Fisheries and Oceans Canada Northumberland Strait Ecosystem Overview (2007b) serves to explain the potential impacts of warmer temperatures on the marine systems:

"*As air and water temperatures increase in coastal areas, there could be impacts on primary productivity, species migration, and the colonization of invasive species. Growth rates, age of sexual maturity, and distribution of some marine fish species is sensitive to water temperatures and warmer temperatures could result in earlier spawning and a shift in distribution to the north.*"

Elsewhere in the bioregion, extreme warm temperatures would likely impact salmonid populations in freshwater rivers, which are dependent upon cool, clear, well oxygenated freshwater for reproduction, and summer refugia. Intense forest harvest activities and inadequate riparian buffers have already reduced the ability of the surrounding landscape to maintain cool water temperatures.

11.5 Severe/extreme weather events – Storm-induced coastal erosion (Threat Status: 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 (US CCSP 2009). Associated with increased intensity, projections also suggest that tropical storms in the Northern Hemisphere will track further north than ever 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 previously, particularly low-lying areas, such as the Acadian dykelands, and areas with frequent storm conditions, such as the Atlantic Coast (CBCL Ltd. 2009).

8.1 Invasive non-native/alien species/diseases (Threat Status: Medium)

A number of invasive alien insects pose significant threats to forests within eastern Canada. A number of species are already present within the adjacent Upper Bay of Fundy bioregion, such as Gypsy Moth (*Lymantria dispar*), a defoliator of over 200 hardwood tree species, Mountain Ash Sawfly (*Pristiphora geniculata*), a defoliator of Mountain Ash, and Balsam Woolly Adelgid (*Adelges piceae*), which attacks and kills Balsam Fir. These species have yet to cause widespread damage across the Bioregion, but populations are expanding continuously. Brown Spruce Longhorn Beetle (*Tetropium fuscum*), which attacks and kills spruce trees, is currently in the province but has not reached the bioregion as of yet. Emerald Ash Borer (*Agrilus planipennis*) is a highly destructive invasive insect that preys on ash trees. It is currently not in the province but has been moving east from Ontario very rapidly and is expected to arrive in the near future.

2.1 Annual & perennial non-timber crops (Threat Status: Medium)

Emerging threats that could impact the bioregion more specifically are anthropogenic, such as those associated with the agricultural industry's response to the increasing demand for food as the world's population and standard of living continues to grow. Higher commodity prices for foods such as soy and corn has already spawned increase production in the bioregion and will continue to do as long as there is demand. With an abundance of good quality underutilized agricultural soil in the bioregion, land clearing and conversion to row crops would result in less grass and natural cover on the landscape.

5.3 Logging & wood harvesting – biomass energy (Threat Status: Unknown)

The development of biomass energy would result in increased logging and wood harvesting activities on an already over exploited forest fibre resource. One such generating system is already in place at Port Hawksbury. However, with public opposition to whole tree harvesting for the purposes of generating electricity, it is not known if this activity will be expanding in the future.

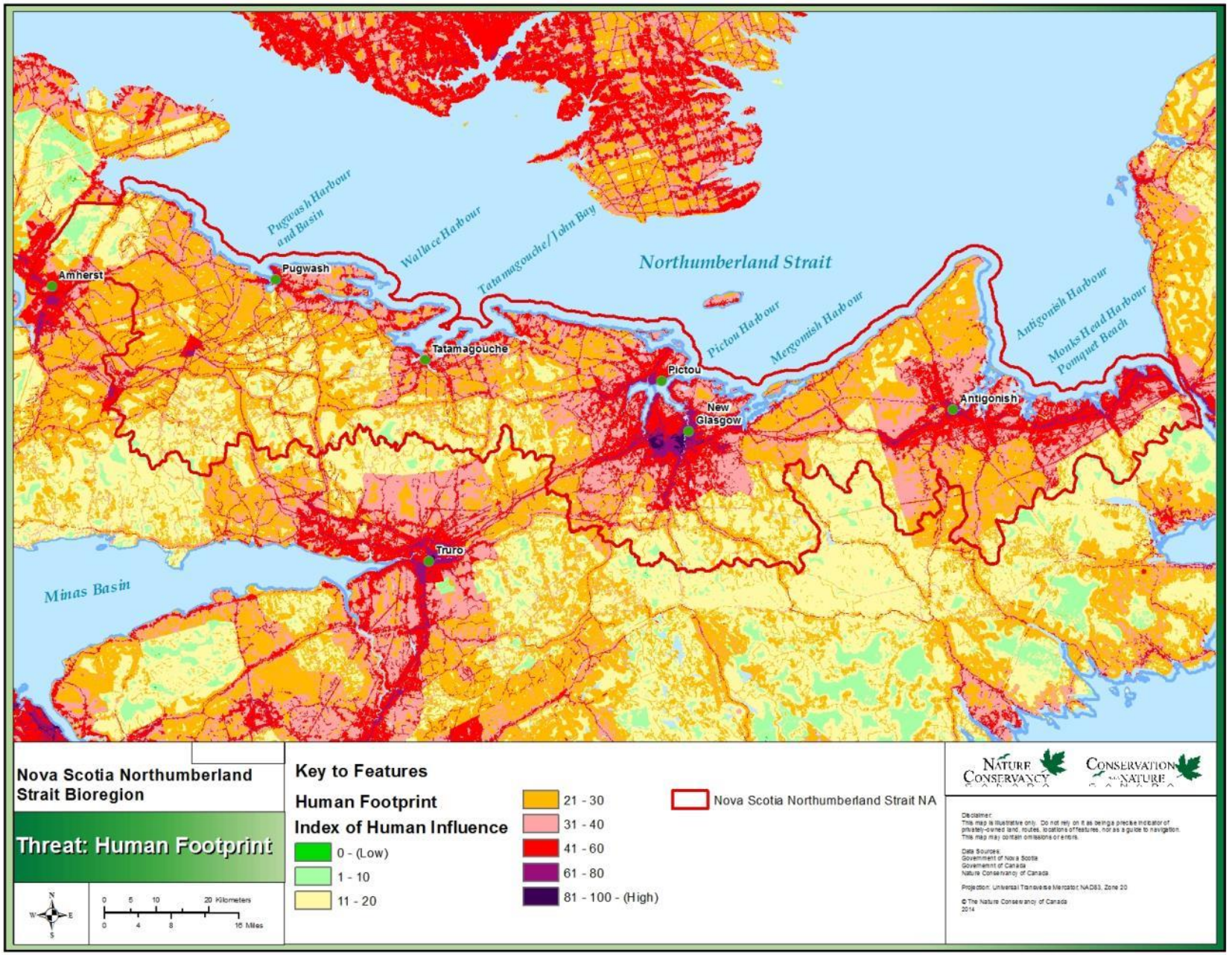


Figure 16. Human Footprint Index in the Nova Scotia Northumberland Strait bioregion.

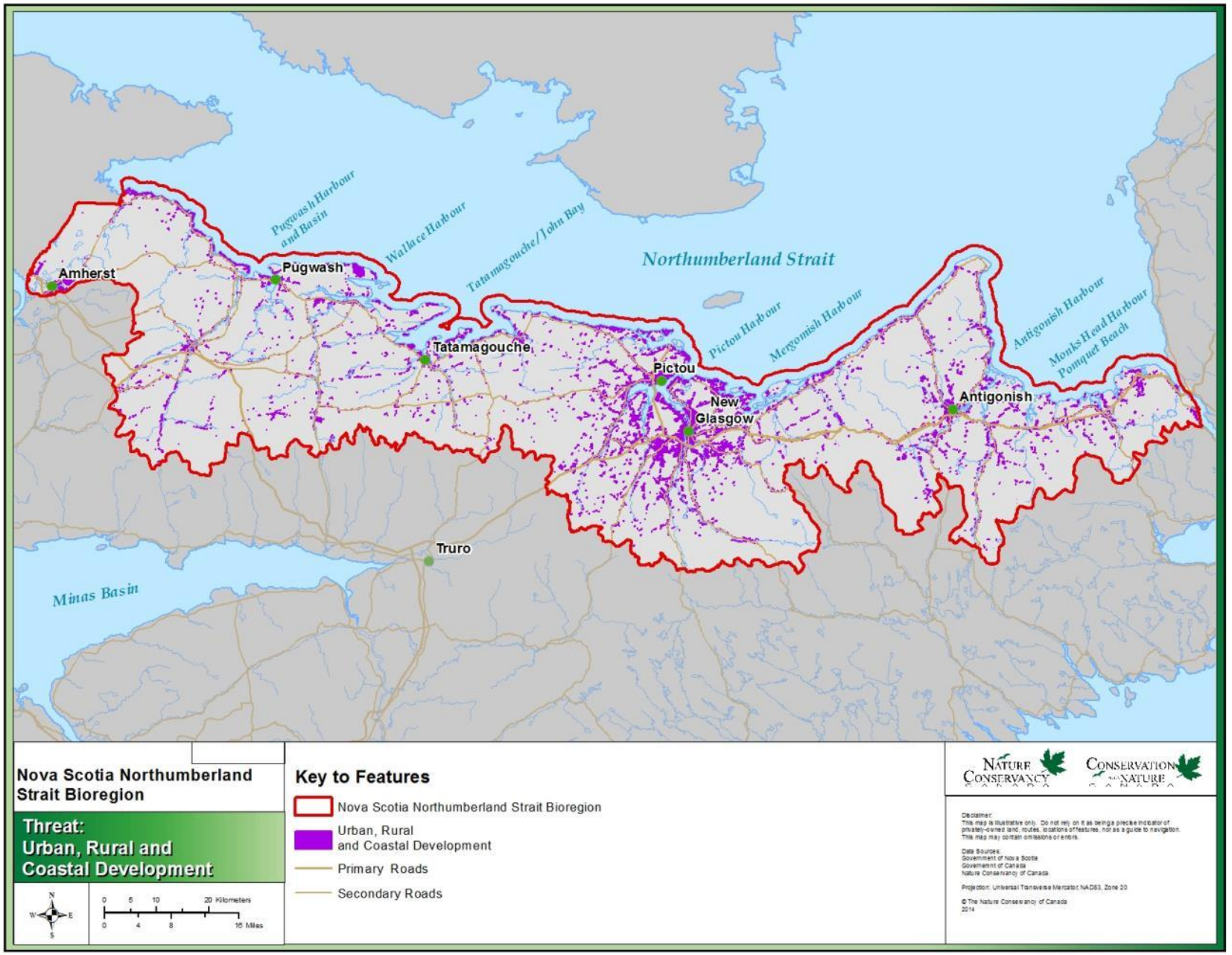


Figure 17. Urban, rural, and coastal development in the Nova Scotia Northumberland Strait bioregion.

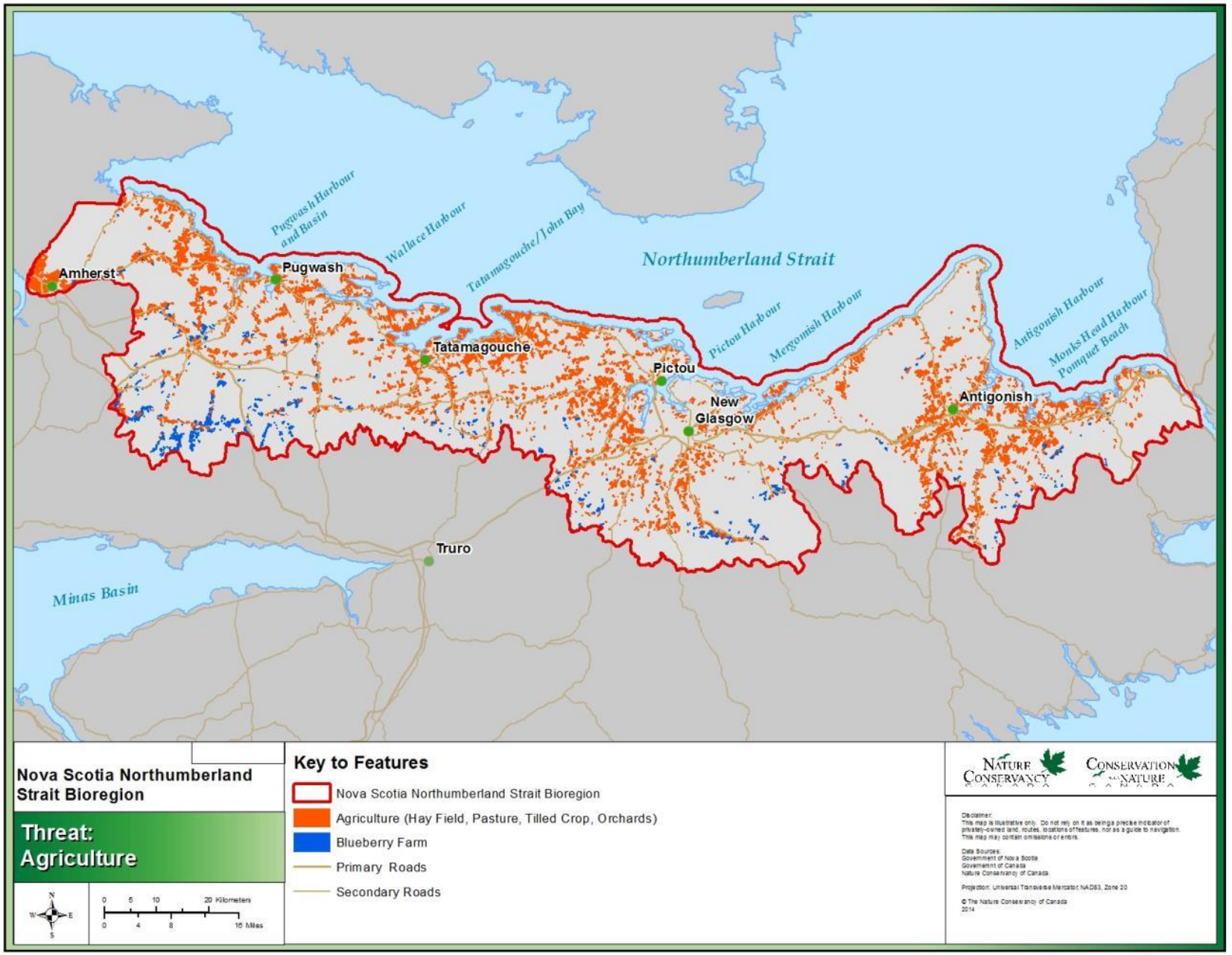


Figure 18. Agricultural lands in the Nova Scotia Northumberland Strait bioregion.

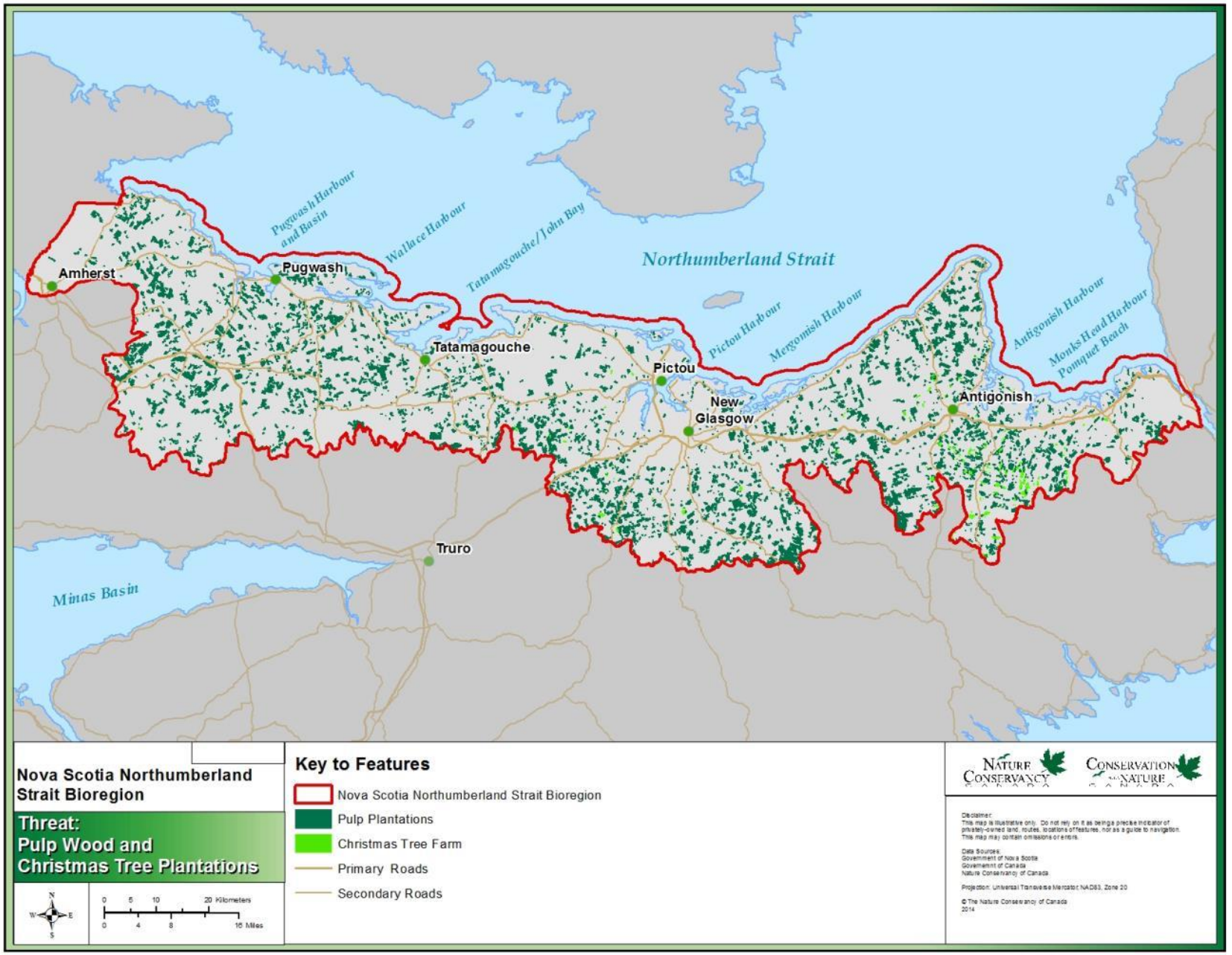


Figure 19. Pulp and Christmas tree plantations in the Nova Scotia Northumberland Strait bioregion.

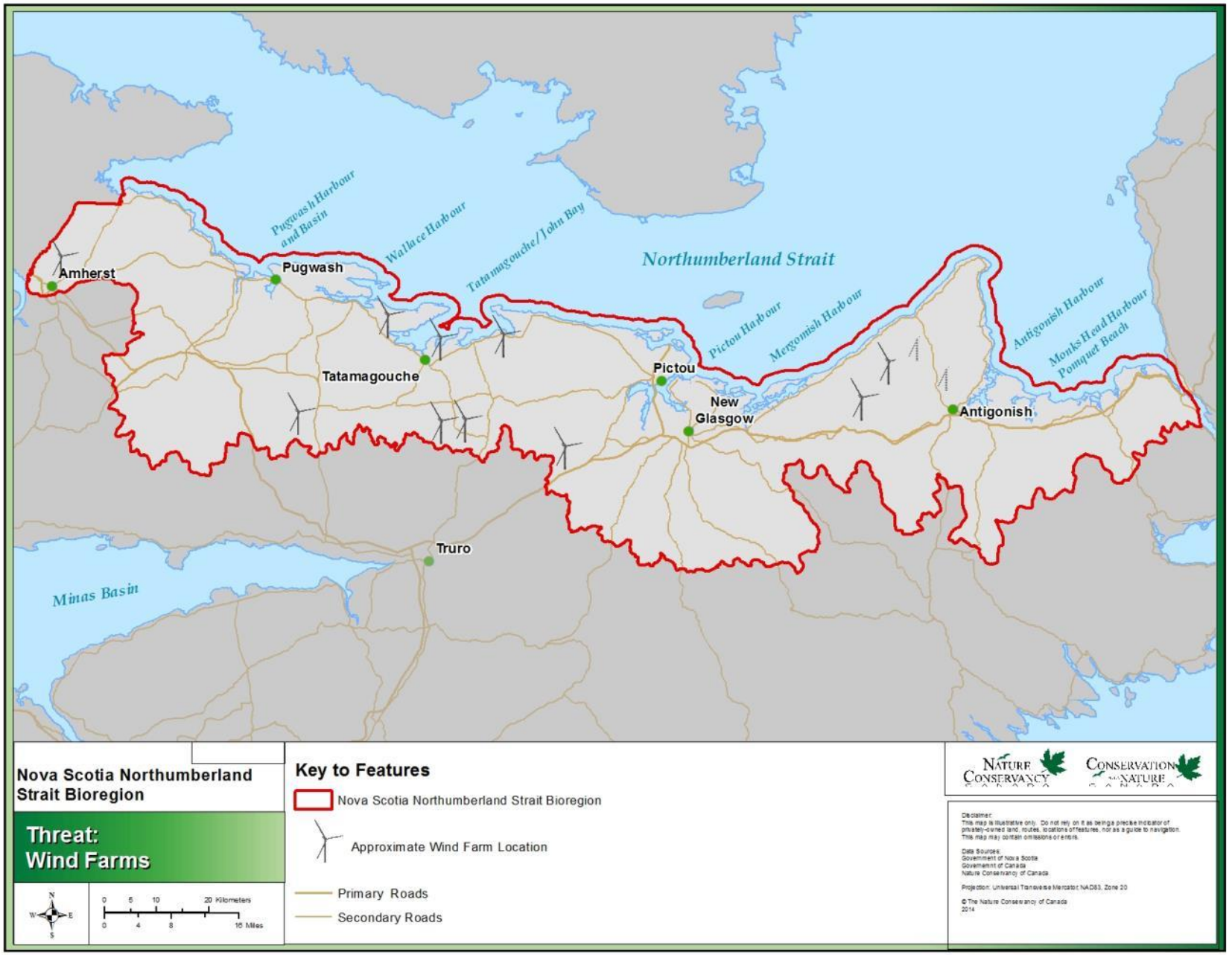


Figure 20. Wind farms in the Nova Scotia Northumberland Strait bioregion.

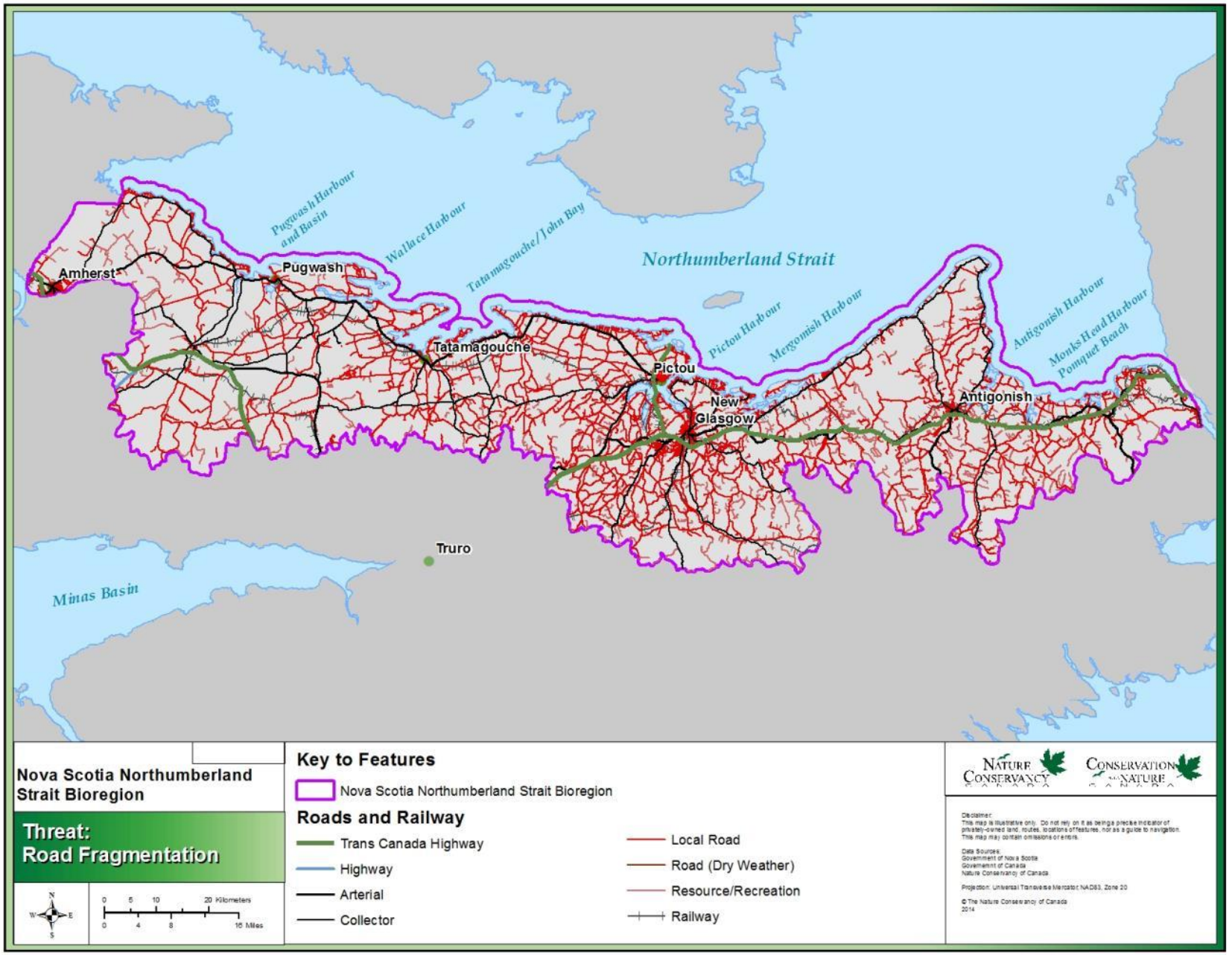


Figure 21. Road fragmentation in the Nova Scotia Northumberland Strait bioregion.

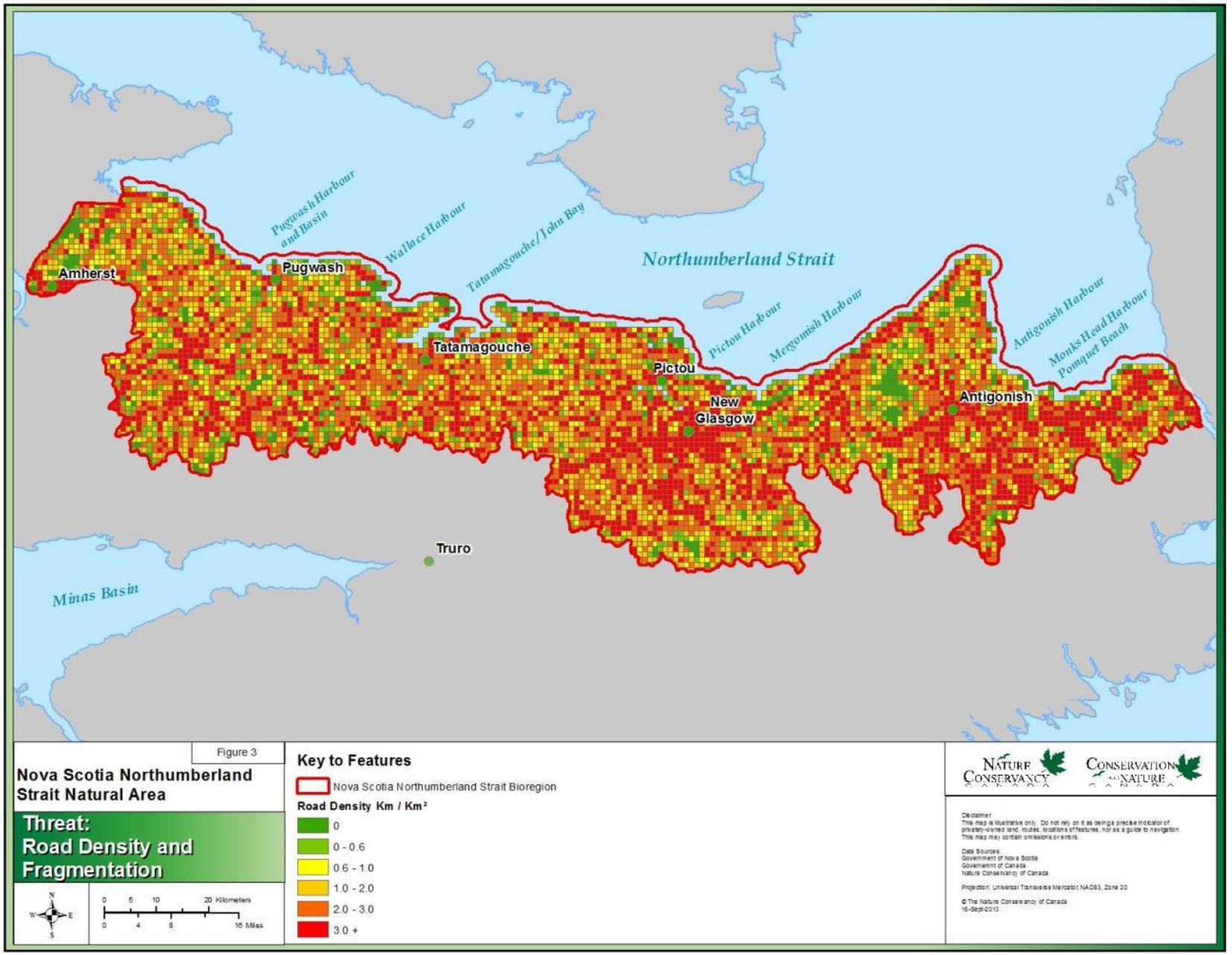


Figure 22. Road density in the Nova Scotia Northumberland Strait bioregion.

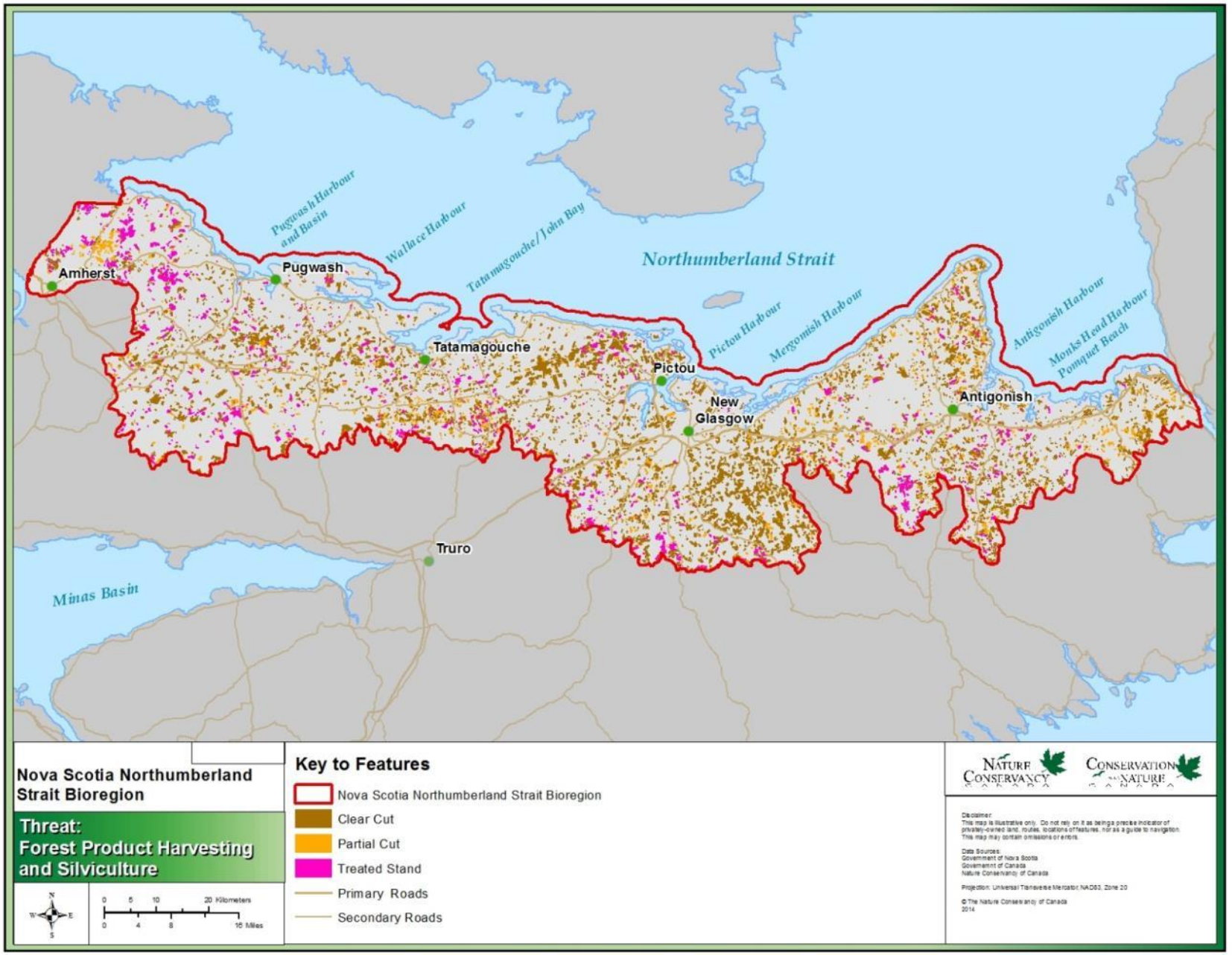


Figure 23. Forest harvesting and silviculture in the Nova Scotia Northumberland Strait bioregion.

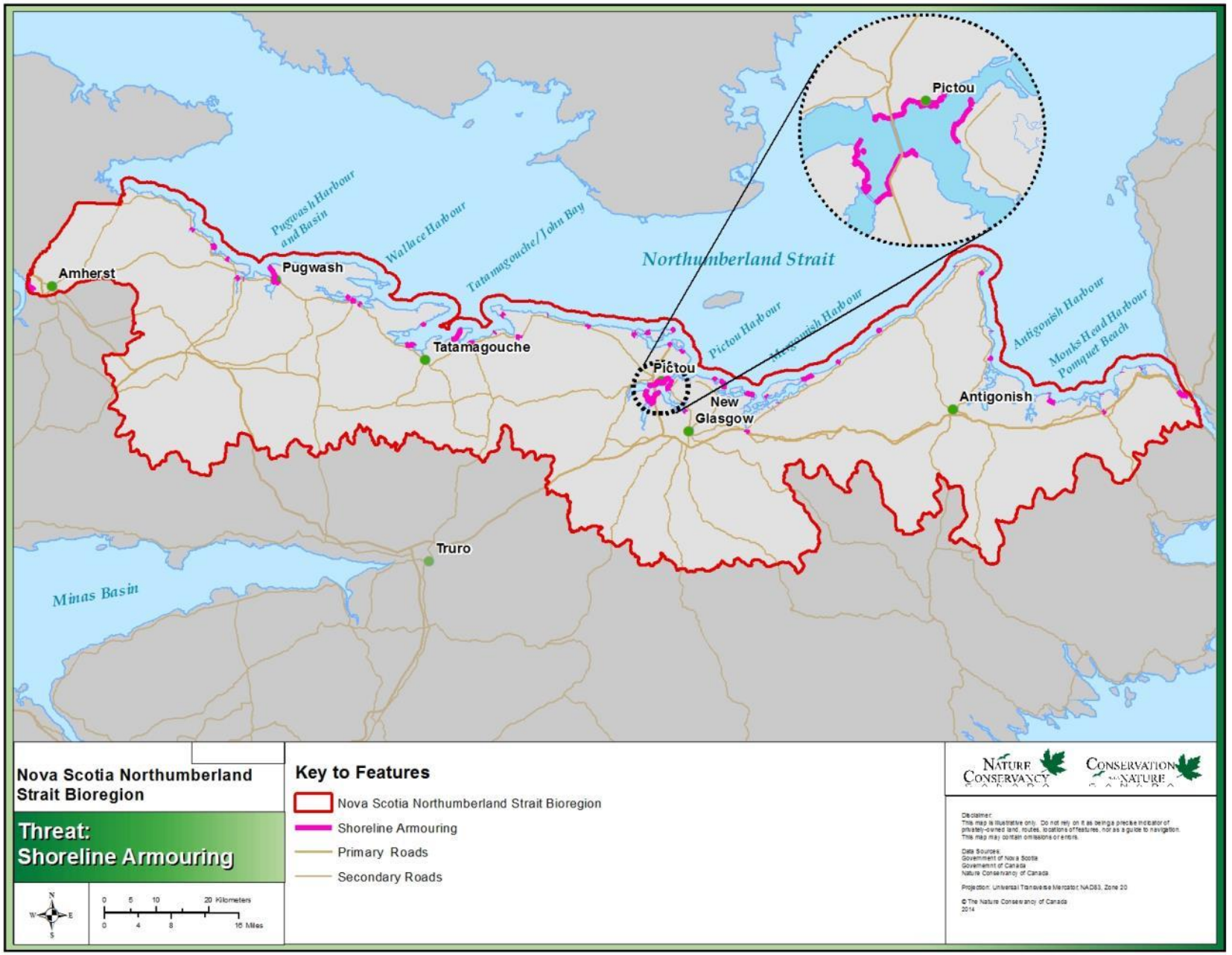


Figure 24. Shoreline armouring in the Nova Scotia Northumberland Strait bioregion.

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 NSNS bioregion that have high conservation value. The goal is to achieve the best possible impact of collective conservation actions in the bioregion in those areas that are the most important for 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, 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 analy please refer to Appendix E.

Habitat patch weighting

The process for assigning priority ranks to habitats within the NSNS bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. Freshwater wetland and Acadian Forest mosaic habitat occurrences were scored using a three-tiered equation that equally divides the scoring by size (minimum patch size), representivity (by ecodistrict), and uniqueness (rarity within each ecodistrict and within the bioregion). All other habitat types were weighted according to size or presence/absence of certain characteristics. For a detailed explanation of the habitat weighting process, please refer to Appendix E. The methodology was deliberately designed to emphasize parcels of land that contain larger patches of priority habitats, were not adequately represented within an ecodistrict, and/or contain rare habitat occurrences. The more high quality priority habitat 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 E.

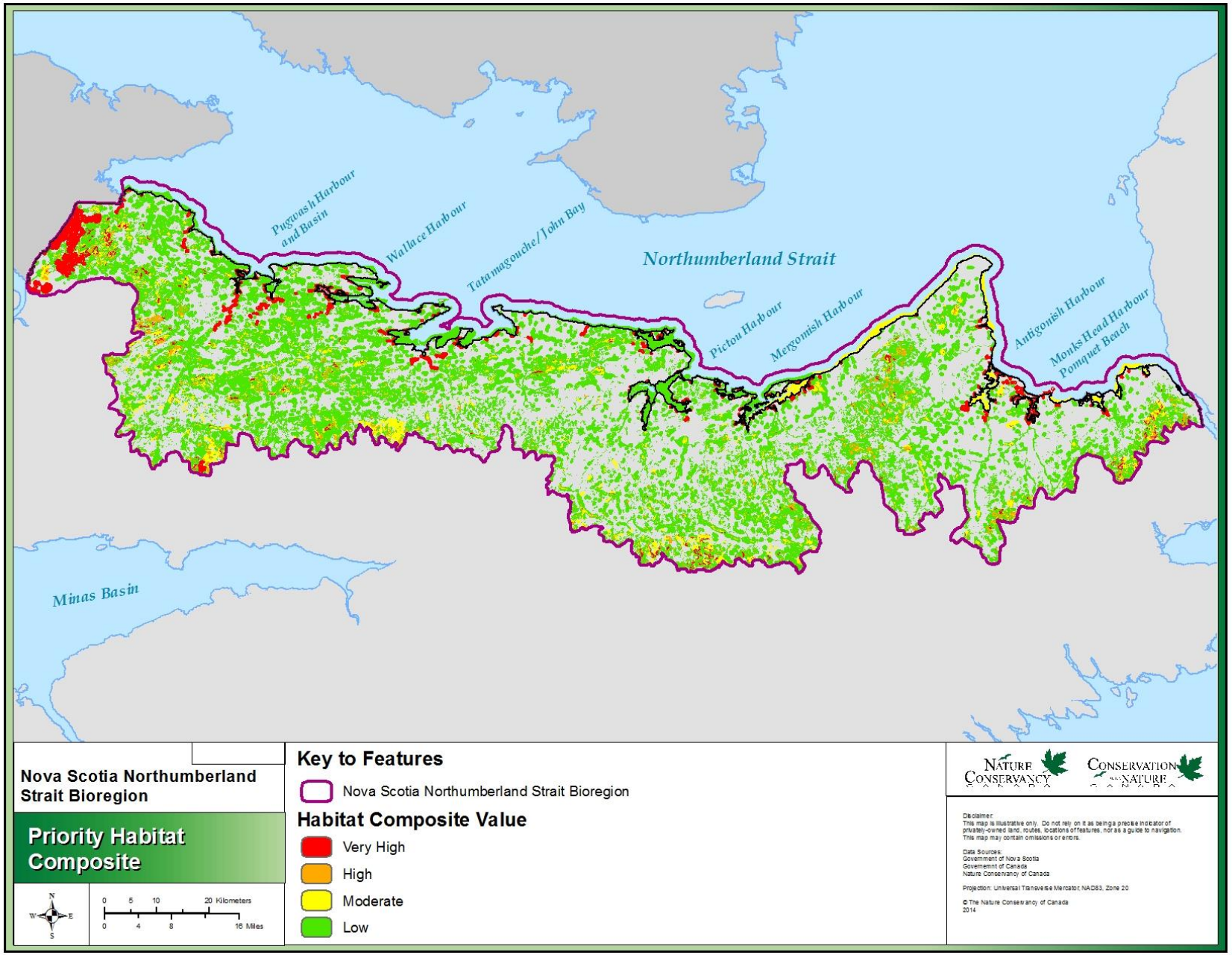


Figure 25. Conservation priority habitat composite for the Nova Scotia Northumberland Strait bioregion.

ii. Species Composites

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

Species occurrence data

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

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 37). 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 13 below provides a description of the various priority species composites that were generated, and the information they present in Figure 26 to Figure 37. A detailed description of the methodology used and species data sources can be found in Appendix F. Lists of the priority species, including their conservation status, habitat associations, and occurrence data soures are provided in Appendices 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 13. Priority habitat and species composites generated and spatial data sources used.

Fig.	Map Title	Description	# Sp.	Data Source(s)
26	Priority Habitat Composite	Priority habitat rank assessment based on consideration of the uniqueness, representivity, and size of individual habitat patches.	n/a	NS Wetlands Inventory NS Forest Resource Inventory NS Small Patch Ecosystems NAAP Critical Occurrences
27	SAR[1] and Rare[2] Non-Bird Species Composite	Likelihood of occurrence of all non-bird priority species.	220	ACCDC Point Occurrence SAR Critical Habitat
28	SAR Non-Bird Species Composite	Likelihood of occurrence of all non-bird species at risk.	37	ACCDC Point Occurrence SAR Critical Habitat
29	Habitat-Limited[3] Non-Bird Species Composite	Likelihood of occurrence of non-bird habitat-limited priority species.	84	ACCDC Point Occurrence SAR Critical Habitat
30	SAR and Rare Invertebrate Species Composite	Likelihood of occurrence of all invertebrate priority species.	31	ACCDC Point Occurrence
31	SAR and Rare Reptile Species Composite	Likelihood of occurrence of all significant reptiles.	2	ACCDC Point Occurrence SAR Critical Habitat
32	SAR and Rare Mammal Species Composite	Likelihood of occurrence of all mammal priority species.	5	ACCDC Point Occurrence
33	SAR and Rare Lichen and Plant Species Composite	Likelihood of occurrence of all plant and lichen priority species.	173	ACCDC Point Occurrence SAR Critical Habitat
34	SAR, Rare, and Priority[4] Bird Species Relative Abundance Composite	Likelihood of occurrence of bird priority species for which sufficient relative abundance data was available.	32	MBBA Relative Abundance
35	SAR, Rare, and Priority Bird Species Breeding Evidence Composite	Likelihood of occurrence of bird priority species for which relative abundance data was not sufficient and therefore breeding evidence data was used.	67	MBBA Breeding Evidence

[1] *All COSEWIC assessed endangered, threatened, and special concern species at risk, and* Nova Scotia Endangered Species Act *listed species.*
[2] *ACCDC assessed S1, S2, and S3 (G1, G2, or G3) species.*
[3] *This subset, developed through expert review, includes 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.*
[4] *BCR 14 NS and MBU 12 NS Priority Bird Species (Environment Canada 2013).*

Fig.	Map Title	Description	# Sp.	Data Source(s)
35	SAR Bird Species Composite	Likelihood of occurrence of all bird species at risk.	22	MBBA Relative Abundance MBBA Breeding Evidence SAR Critical Habitat
36	Habitat Limited Bird Species Composite	Likelihood of occurrence of all habitat limited bird priority species.	8	MBBA Breeding Evidence
37	All Priority Species Composite	Likelihood of occurrence of all priority species.	313	ACCDC Point Occurrence SAR Critical Habitat MBBA Relative Abundance MBBA Breeding Evidence
38	Conservation Value Index	An index of conservation value based on the distribution of ranked priority habitats and the likelihood of occurrence of all priority species.	313	Priority Habitat Composite (Figure 25) Priority species Composite (Figure 37)

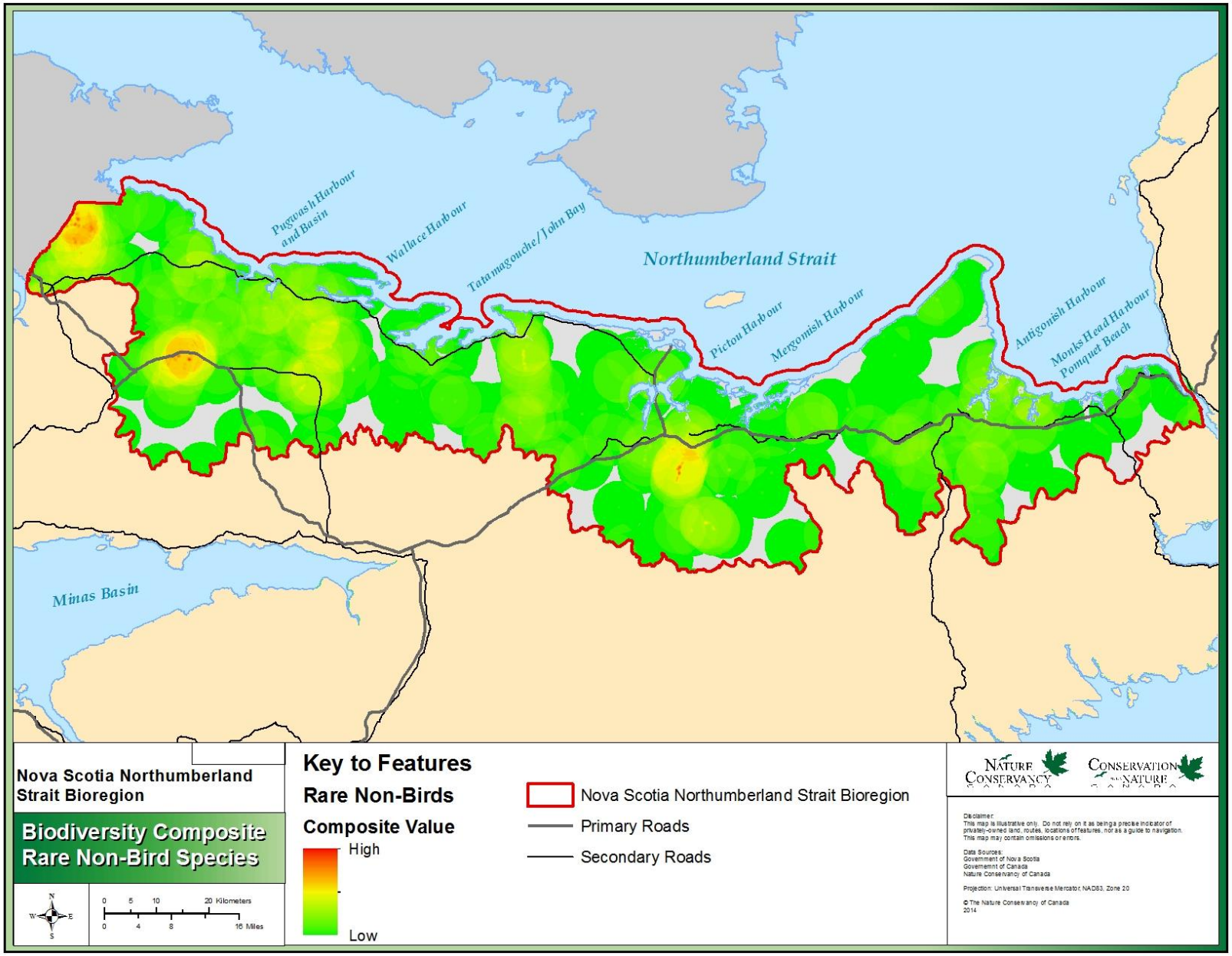


Figure 26. Species composite for species at risk (COSEWIC assessed and NS ESA listed) and rare non-bird priority species in the Nova Scotia Northumberland Strait bioregion.

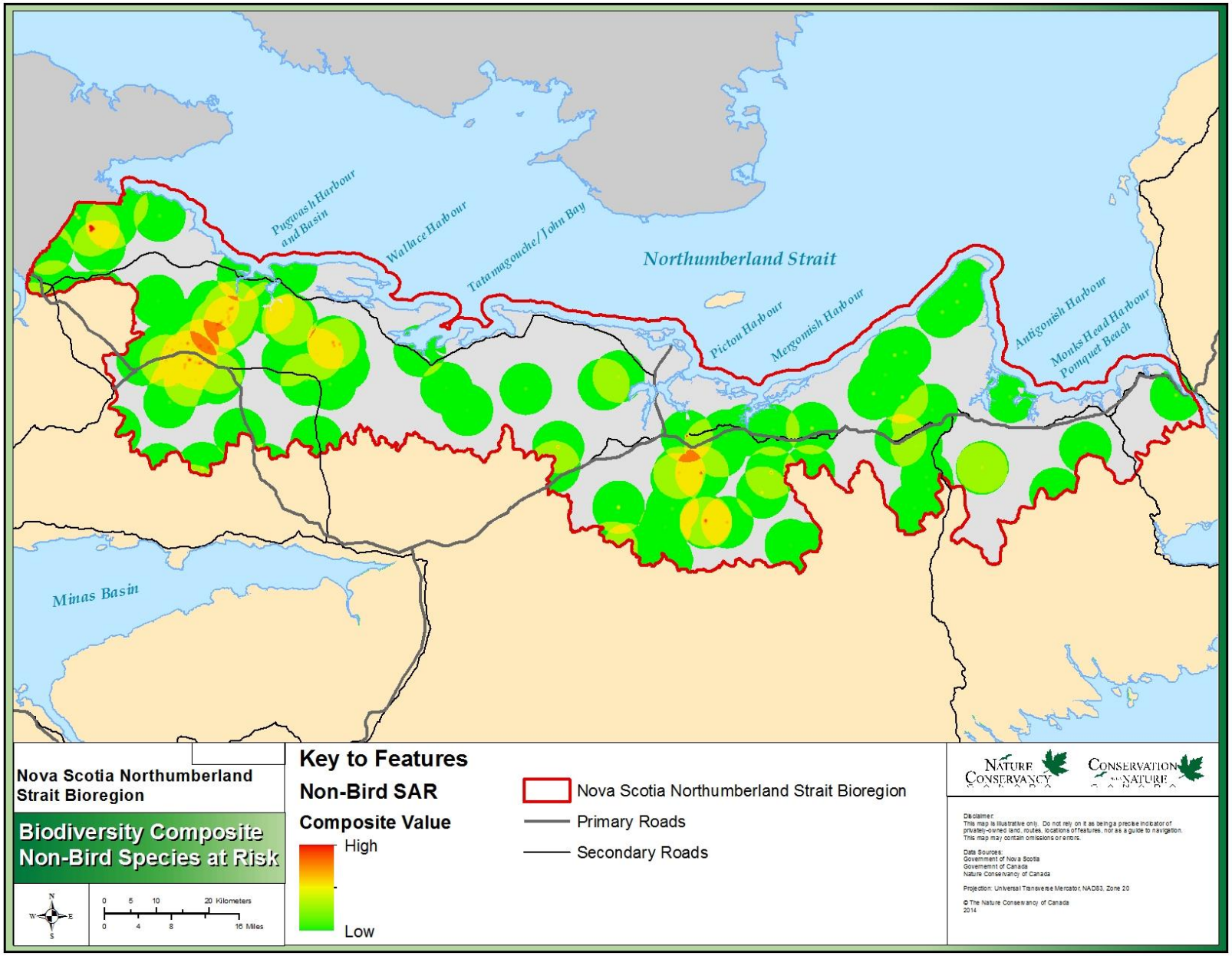


Figure 27. Species composite for non-bird species at risk (COSEWIC assessed and NS ESA listed) in the Nova Scotia Northumberland Strait bioregion.

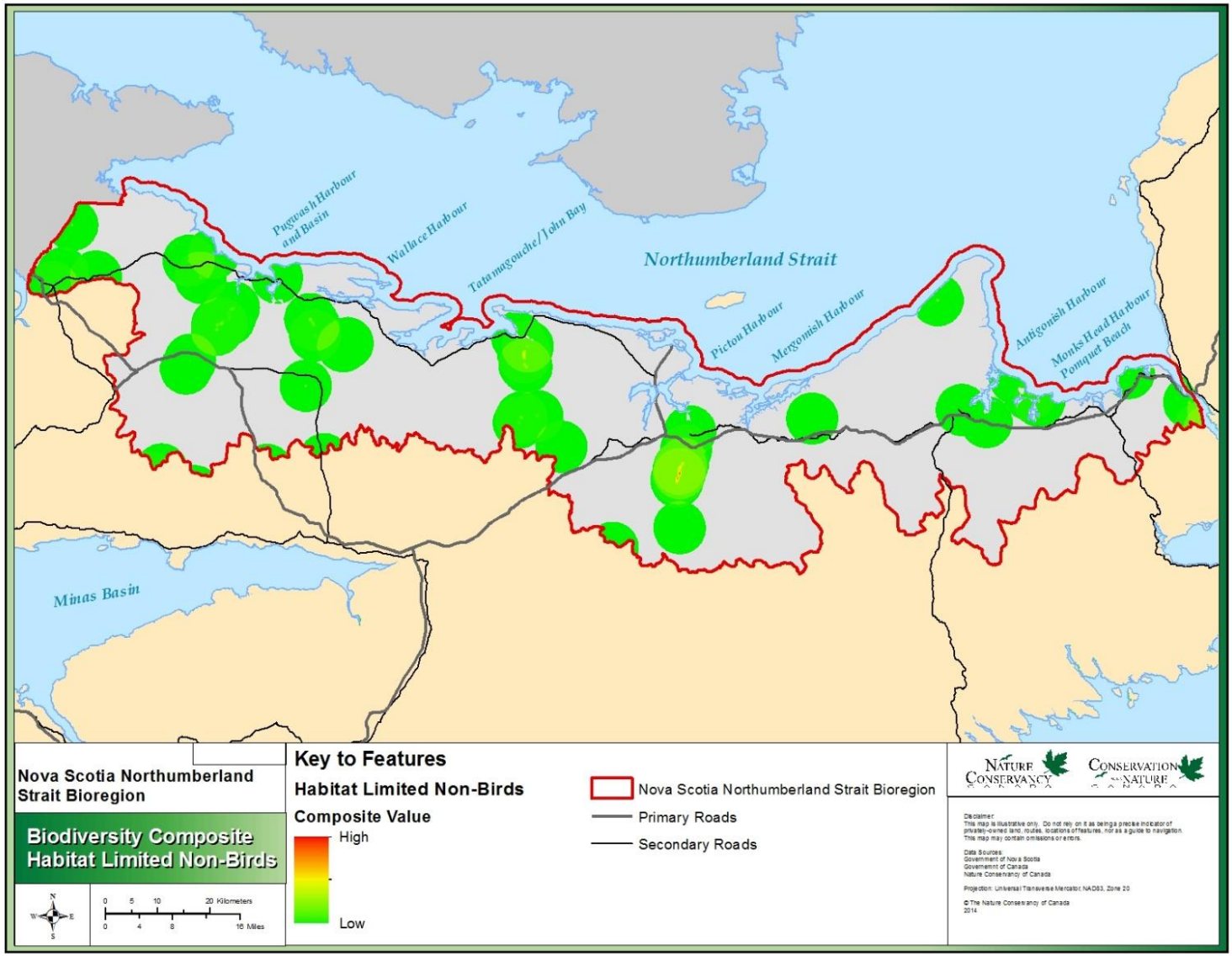


Figure 28. Species composite for rare and at risk non-bird habitat limited priority species[1] in the Nova Scotia Northumberland Strait bioregion.

[1] *This subset, developed through expert review, includes 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. Species that met the criteria are identified in Appendix C.*

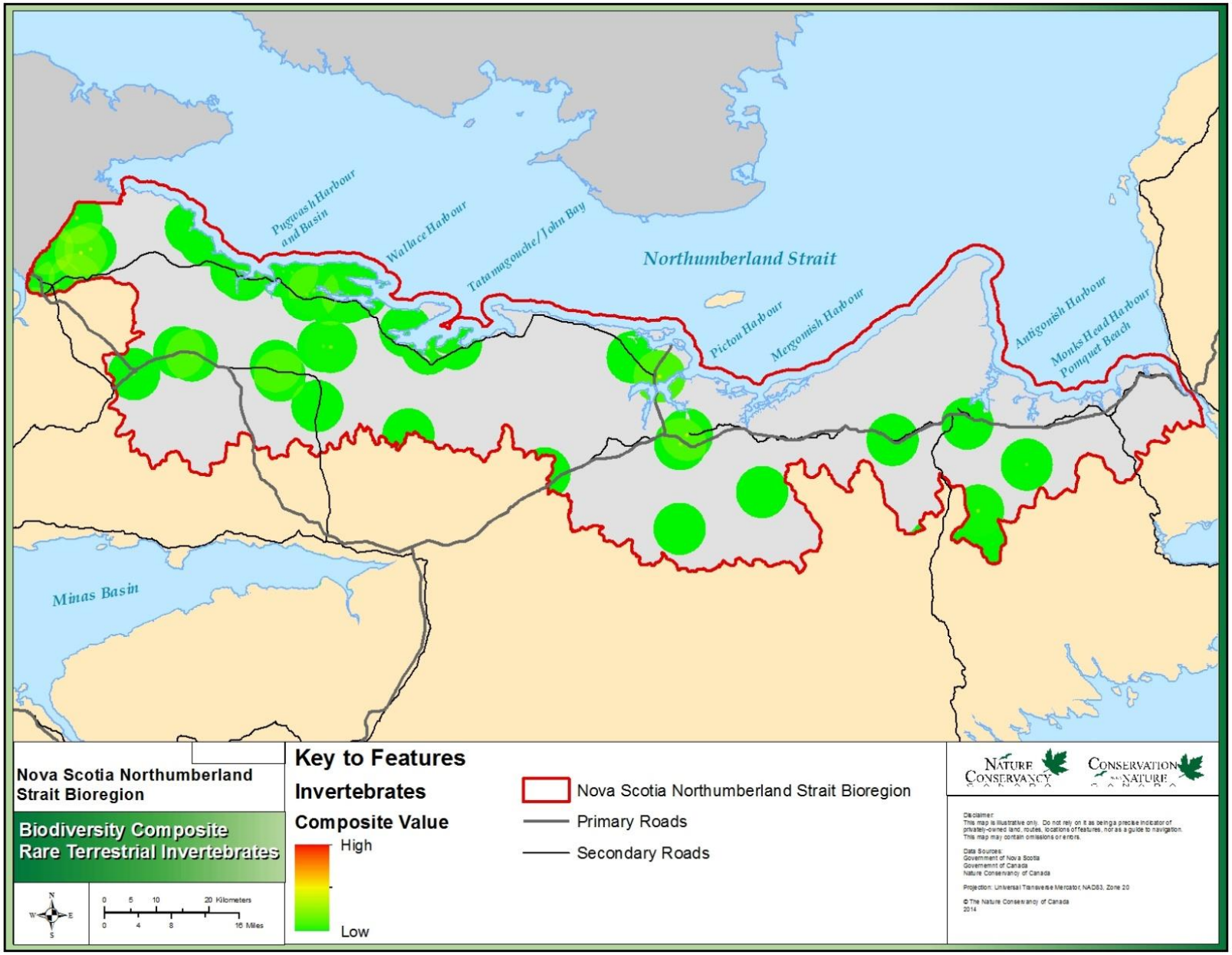


Figure 29. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) terrestrial invertebrate priority species in the Nova Scotia Northumberland Strait bioregion.

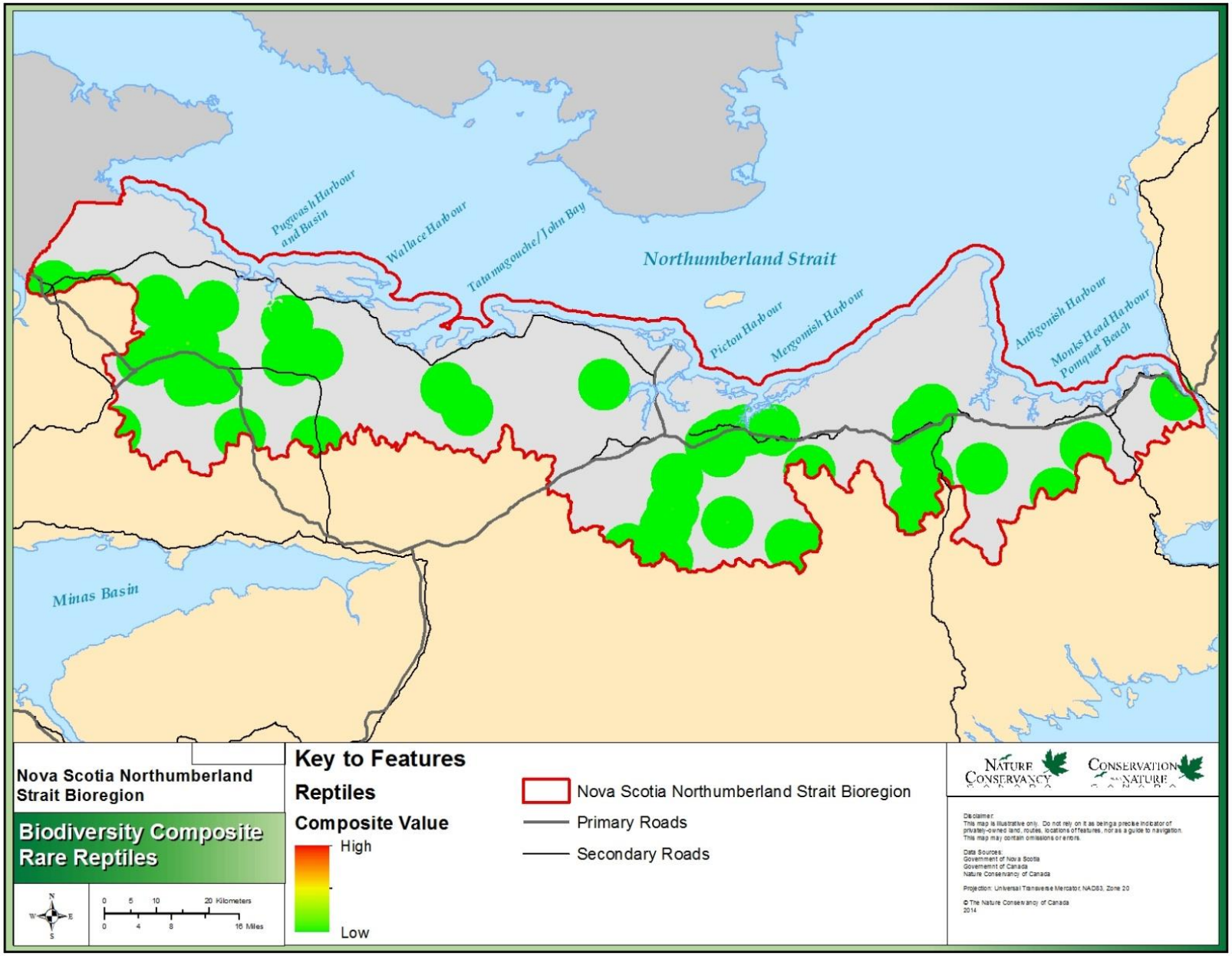


Figure 30. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) reptiles in the Nova Scotia Northumberland Strait bioregion.

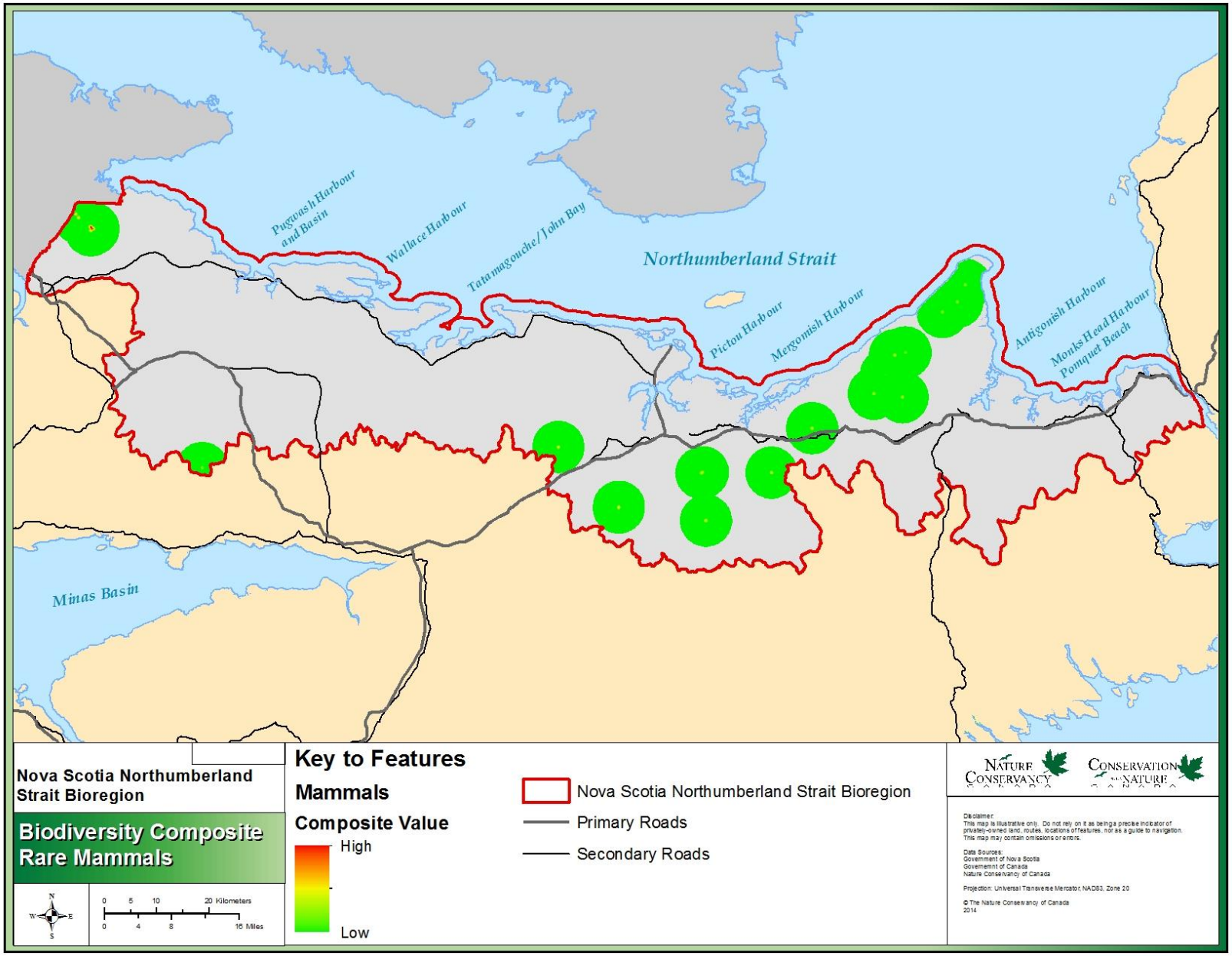


Figure 31. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) mammals in the Nova Scotia Northumberland Strait bioregion.

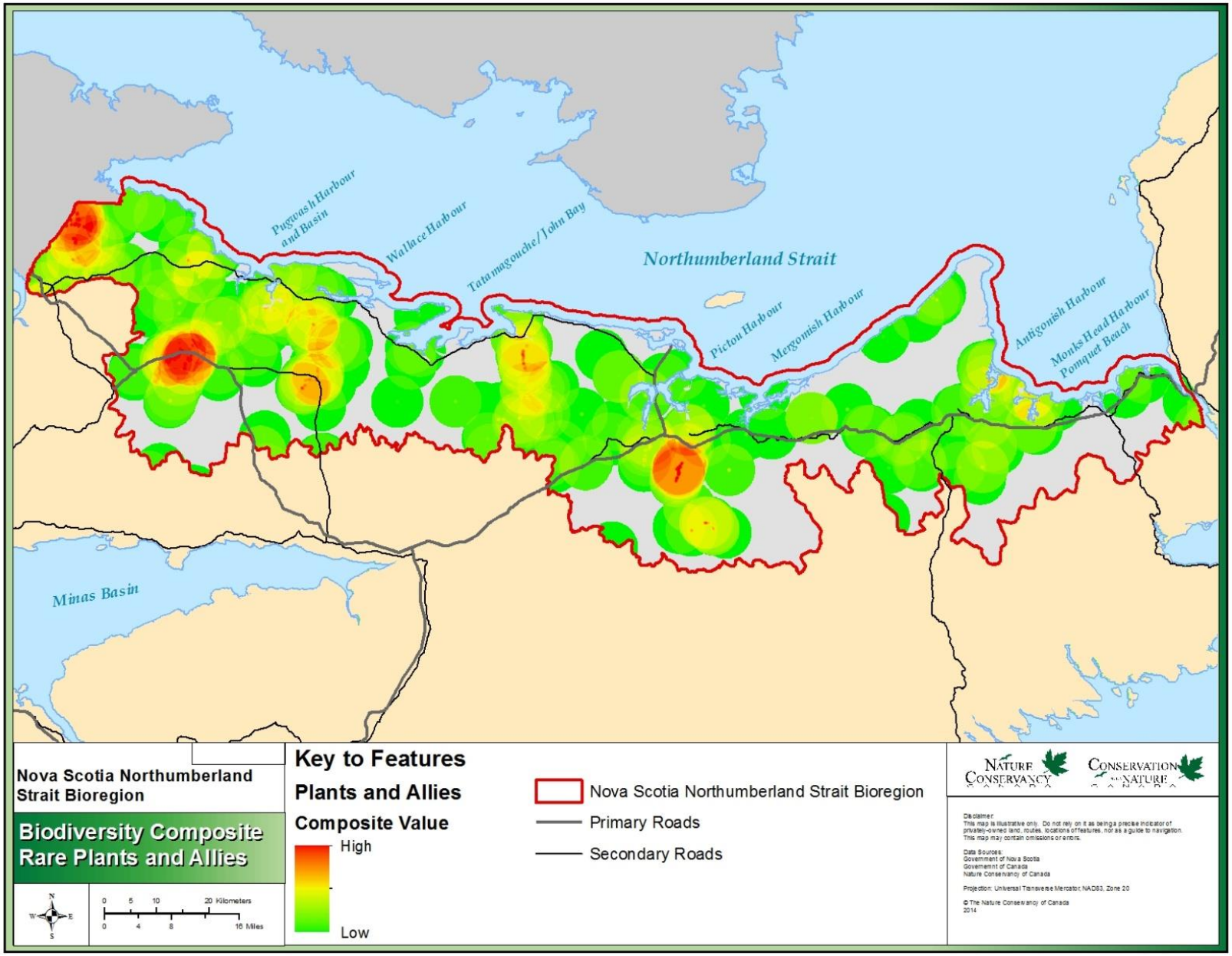


Figure 32. Species composite for rare and at risk (COSEWIC assessed and NS ESA listed) plant and lichen species in the Nova Scotia Northumberland Strait bioregion.

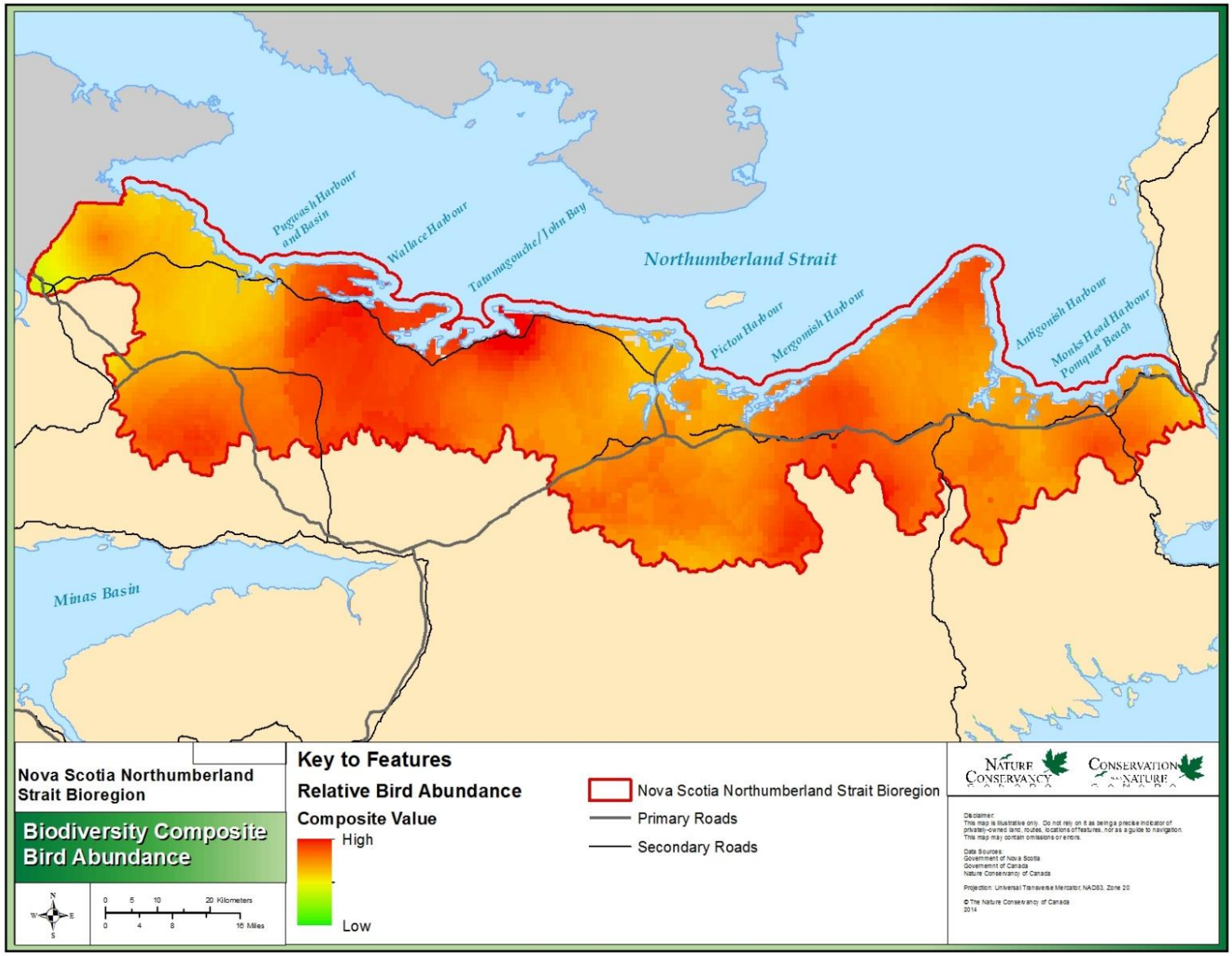


Figure 33. Relative abundance[1] species composite for rare, at risk (COSEWIC assessed and NS ESA listed), and priority bird species in the Nova Scotia Northumberland Strait bioregion.

[1] *Derived from point count data collected for the Maritime Breeding Bird Atlas, used for species with adequate coverage.*

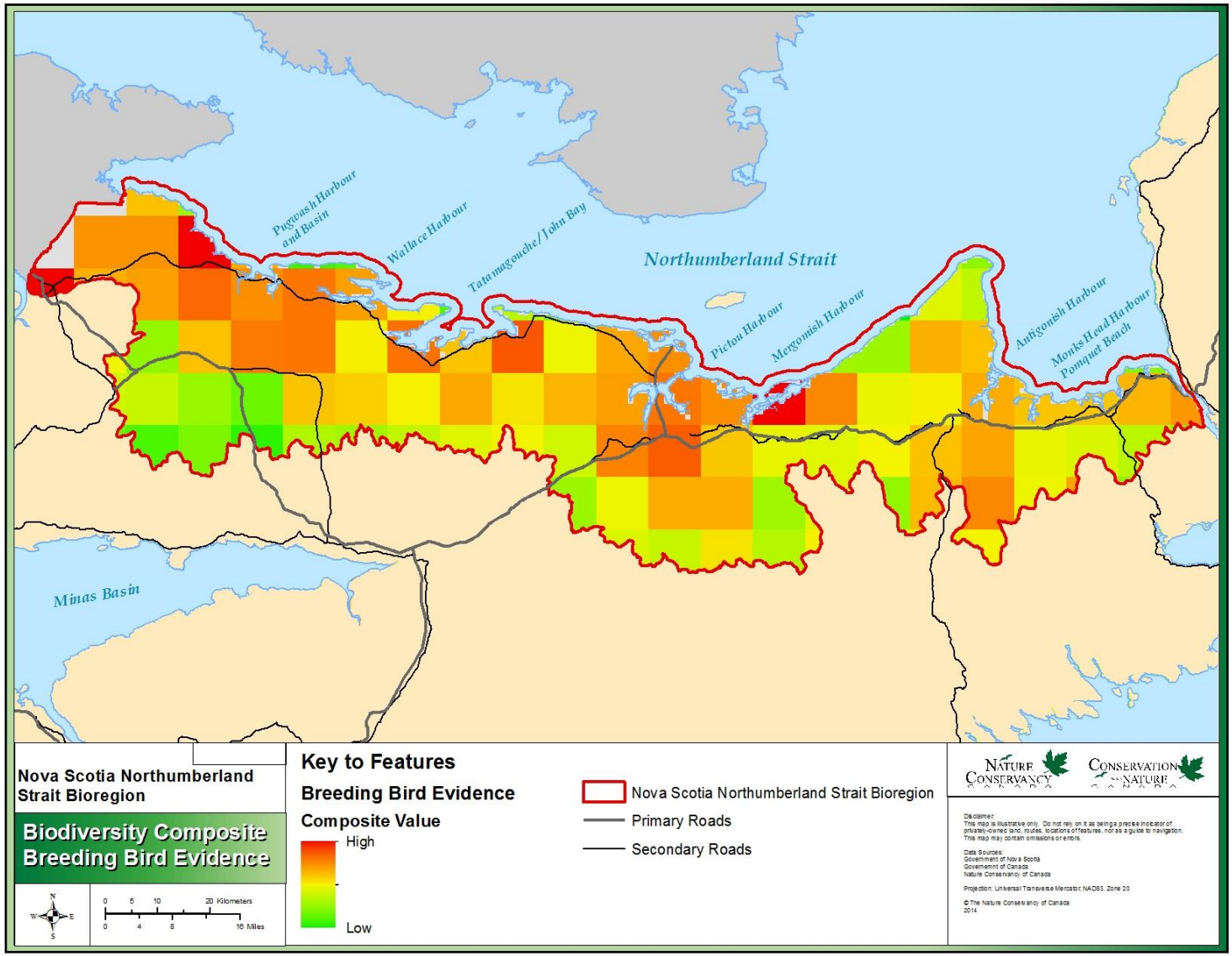


Figure 34. Breeding evidence[1] species composite for rare, at risk (COSEWIC assessed and NS ESA listed), and priority bird species in the Nova - Scotia Northumberland Strait bioregion.

[1] *Derived from data collected for the Maritime Breeding Bird Atlas reported within 10 km by 10 km survey squares, used for those species that were not adequately captured through point count surveys.*

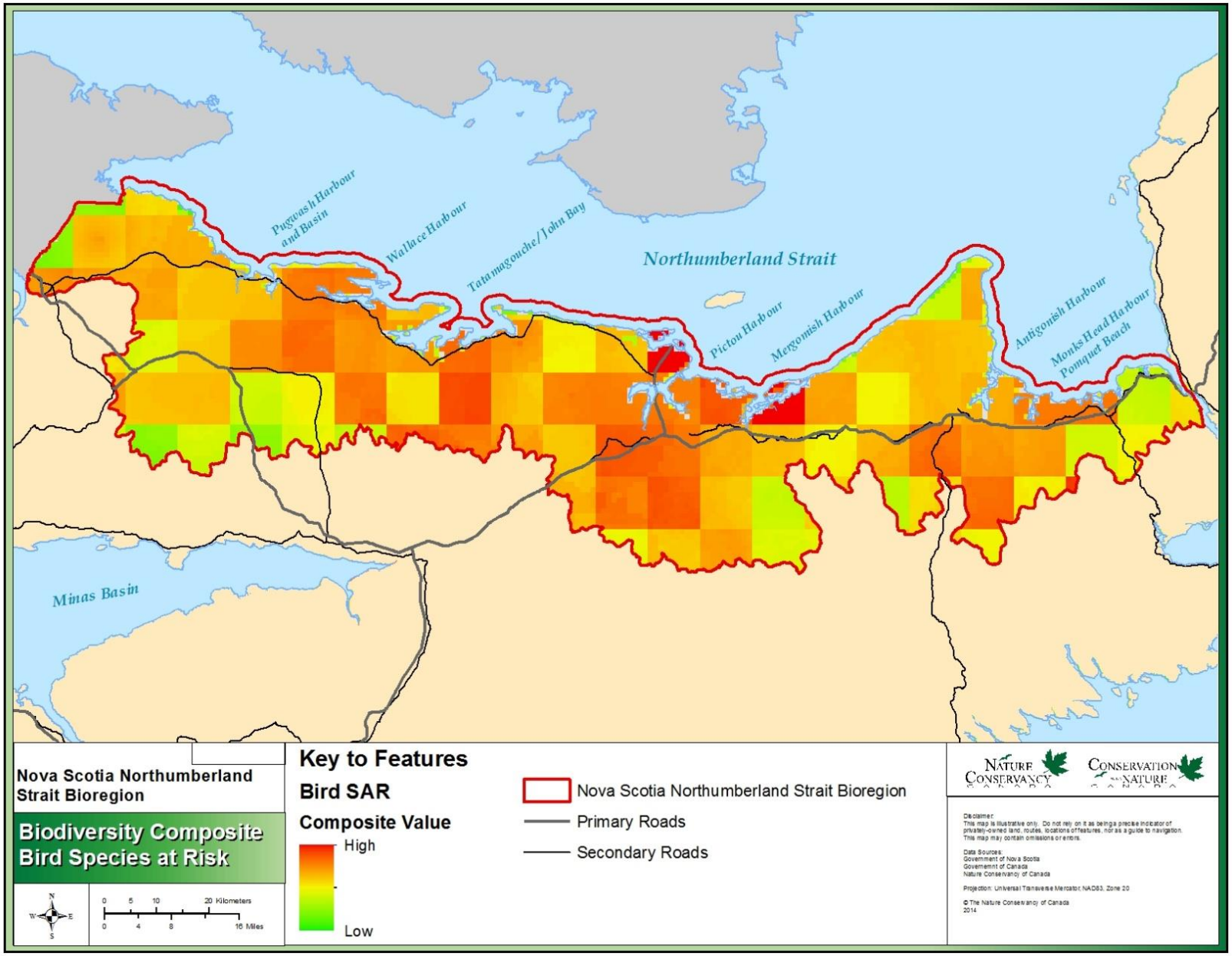


Figure 35. Species composite for bird species at risk (COSEWIC assessed and NS ESA listed) in the Nova Scotia Northumberland Strait bioregion (based on breeding evidence and relative abundance).

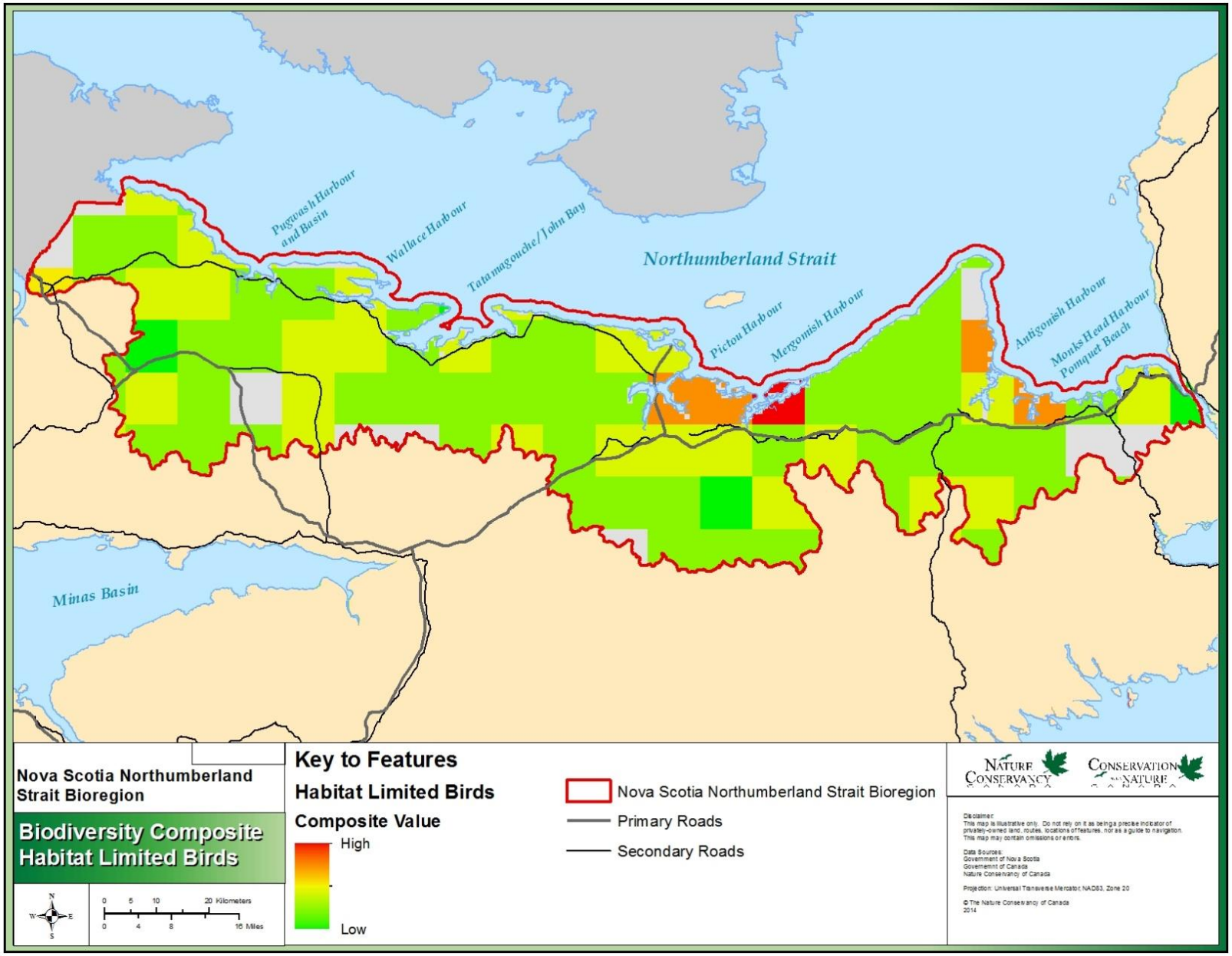


Figure 36. Breeding evidence composite for species at risk, rare and priority habitat limited bird species in the Nova Scotia Northumberland Strait bioregion.

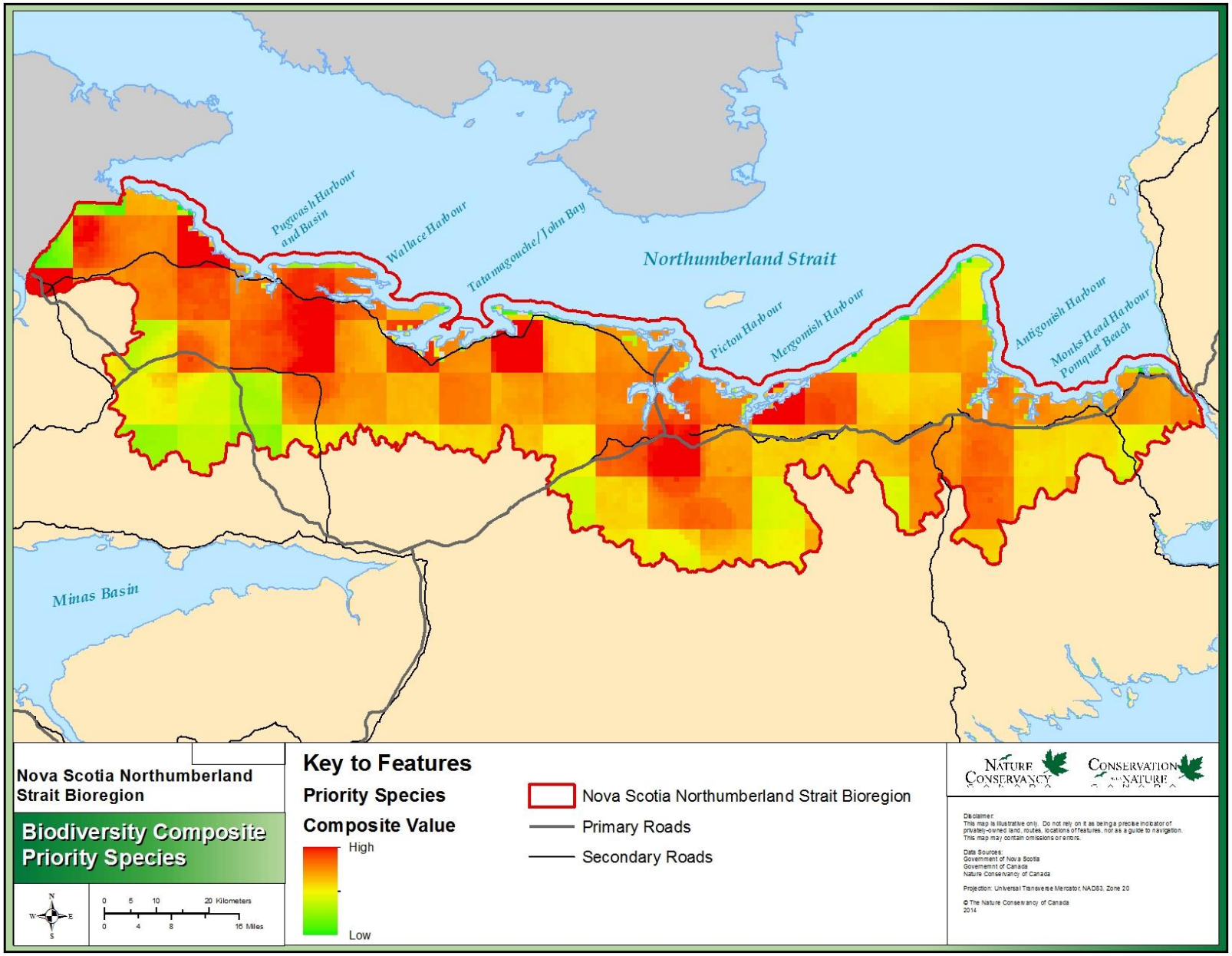


Figure 37. Species composite for all rare, at risk (COSEWIC assessed and NS ESA listed), and priority priority species in the Nova Scotia Northumberland Strait bioregion.

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 Northumberland Strait bioregion, presented in Figure 38. Table 14 provides a summary of the results of the conservation value index analysis.

The Conservation Value Index and species composites are based on our current state of knowledge as it relates to the distribution of priority species and relies on existing species occurrence databases. Sampling effort varies substantially both among and between taxa, and spatially throughout the bioregion. The results of the analyses have not been ground-truthed and are meant to direct more detailed conservation actions, including surveys and site-assessments.

Table 14. Summary results for the conservation value index for the Nova Scotia Northumberland Strait bioregion.

Conservation Value	Value Interval	Area (ha)	% of Bioregion
Very High	≥ 1	148,602	22
High	0.8 to < 1	145,509	21
Moderate	0.6 to < 0.8	195,508	29
Low	0 to < 0.6	188,574	28
Total	**N/A**	**678,193**[1]	**100**

[1] *The discrepancy in size from the bioregion area of 654,032 ha is due to the addition of tidal flats to the area, which were not included in the bioregion area measurement.*

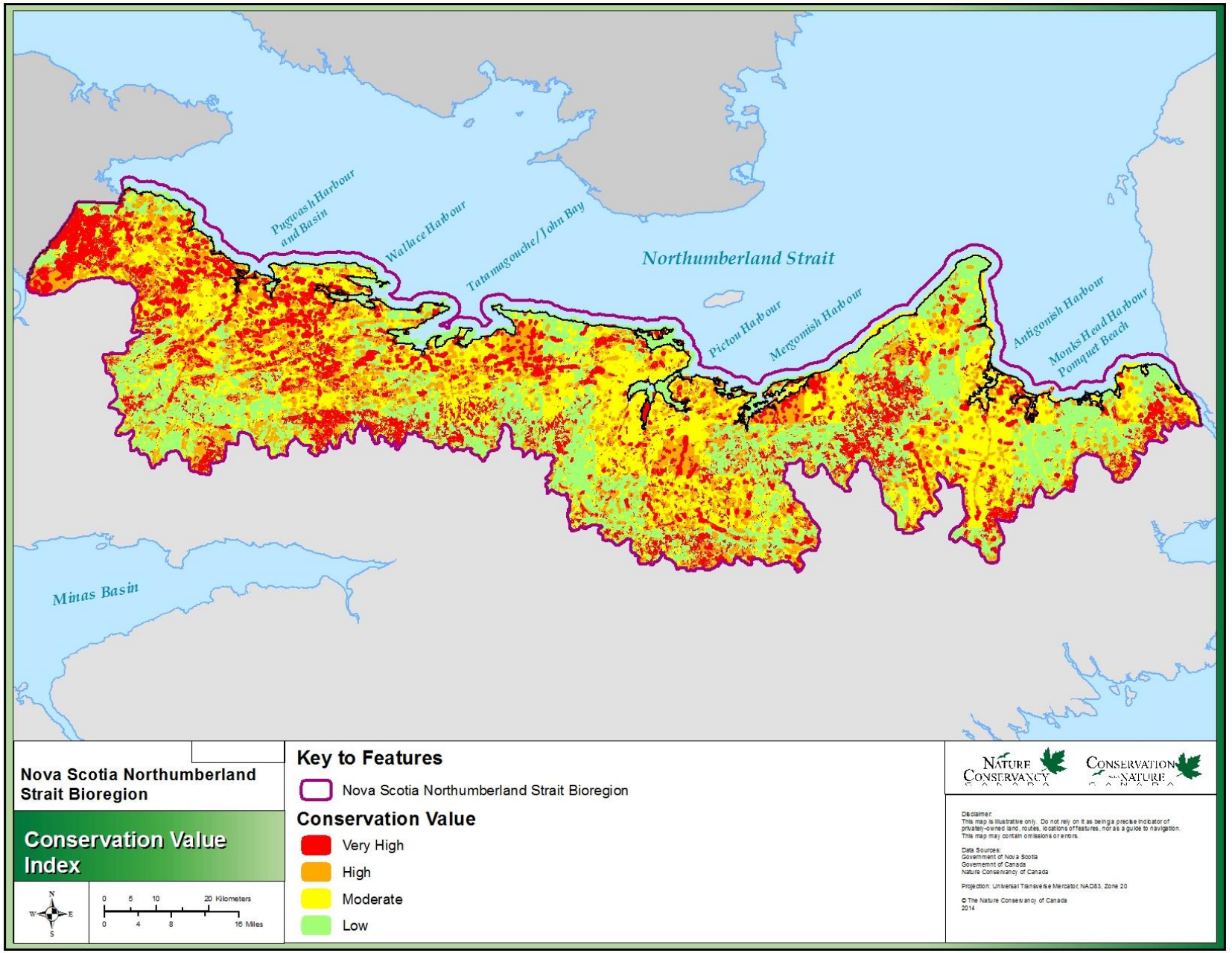


Figure 38. Conservation Value Index for the Nova Scotia Northumberland Strait bioregion.

3. CONSERVATION STRATEGY

This Habitat Conservation Strategy has incorporated the input of many partners and collaborators involved in habitat conservation in Nova Scotia. It is intended to respond to the need to better communicate, coordinate, and inform conservation actions taken by regional and local conservation organizations. In addition to providing decision support for these groups, it is hoped that HCS development will create opportunities to enhance partnerships, recognizing that each organization is guided by its own particular mission, vision, and/or guiding principles.

A. Vision

The Nova Scotia Northumberland Strait bioregion contains climatic and geologic conditions unique within Nova Scotia. The shared Vision for this bioregion is that:

1) It will contain a diverse array of habitats, including rich and productive coastal estuaries, beach and dune systems that seasonally support significant numbers of migratory waterfowl, water birds and shorebirds.
2) Habitat connectivity to and through the Chignecto Isthmus is relatively intact.
3) Habitats along with the area's diverse forests and freshwater aquatic ecosystems are being conserved through a coordinated network of public and private initiatives aimed at maintaining their ecological integrity.
4) Sustainable farming and fishing practices, along with recreational, tourism and other resource based activities continue to provide economic benefits to the region, with the understanding that their very existence depends upon maintaining healthy ecosystems.
5) The conservation, restoration and stewardship of priority habitats and species continues, guided by science and supported by people who are both well-informed and fully engaged in the process.

B. Goals

The Conservation Goals that have been identified to guide the development of the Nova Scotia Northumberland Strait Habitat Conservation Strategy are:

1) Identify key conservation areas that are critical for priority conservation species and habitats.
2) Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3) Maintain healthy, intact, and fully functioning ecosystems by building on existing conservation 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.
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.

C. Actions

i. Identified Knowledge and Action Gaps

While this Habitat Conservation Strategy strives to address and discuss the full range of habitat conservation priorities and threats to biodiversity in the bioregion, it is not within the scope of the strategy to 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 assessments and their threats.

The following knowledge gaps are listed according to the priority habitat types addressed in this report. The research and action gaps below are a brief, summarized compilation of gaps identified in SARA and NS ESA recovery plans, the NS BCR 14 and MBU 12 Bird Conservation Strategy, and through dialogue with partners active in the region.

1. Beaches and Dunes
    - Identify and quantify key ecological attributes (KEAs) that can be used to assess the condition of dunes in the bioregion. Attempt to determine the percent of vegetated vs. non-vegetated dune.
    - Assess the location and extent of beaches and dunes that have reduced ability to migrate landward, due to coastal development, in the face of rising sea level.
    - Determine Piping Plover non-breeding areas, fledgling rate estimates, movement of adults and young between areas, habitat carrying capacity (should unoccupied sites be protected), and the impact of sea level rise on critical habitat.
    - Assess the impact of recreational activities in coastal areas on priority species.

2. Salt Marshes
    - Assess the impact of coastal development on salt marsh.
    - Determine a critical patch size appropriate for the bioregion.
    - Determine the rate at which salt marsh is disappearing as a result of coastal development.
    - Assess the impact of recreational activities in coastal areas on priority species.

3. Tidal Flats
    - Research the range of extent of impact from European Green Crab on Eelgrass in the bioregion.
    - Initiate an Eelgrass mapping and monitoring program to determine rate of loss and highly impacted areas suitable for eelgrass restoration activities.
    - Research the impact of nutrient loading in estuaries.
    - Assess the impact of recreational activities in coastal areas on priority species.
    - Assess the impact of aquaculture on priority species.

4. Acadian Forest Mosaic
    - Determine the extent and define boundaries for Karst and Calcareous forested lands in the bioregion.
    - Assess the age structure of forest to determine where old growth and late successional forest is located through a ground truthing exercise.

- Least-cost analysis or other appropriate corridor modeling of connectivity through the Chignecto Isthmus to identify patches critical to the movement of priority species.
- Determine the locations of bat hibernacula to inform conservation strategies for bats in the bioregion.
- Determine the impacts of forestry on the demography of priority species.
- Assess the impacts of Calcium depletion on priority species.
- Identify core breeding habitat for priority species.
- Improve habitat suitability for mainland moose.
- Complete a genetic profile of NS mainland moose and moose in New Brunswick.
- Define and provide minimum number of snags and living trees needed for priority bird species.
- Further analysis to achieve a more complete understanding of the impacts of forest fragmentation on species composition.

5. Hydro Riparian Systems
    - Active River Area Mapping project – using high resolution DEM or LiDAR data to determine the extent of floodplains and riparian habitat and identify rare floodplain forest communities.
    - Cold water fish refugia mapping.
    - Determine the threats to aquatic connectivity. Assess the degree of impact of aquatic barriers in the bioregion.
    - Assess the impacts of recreational activities in waterbodies and waterways on priority species.

6. Freshwater Wetlands
    - Determine an appropriate minimum patch size for the bioregion.
    - Determine the amount of wetland loss over time.

7. Grasslands
    - Create a detailed agricultural layer that identifies active and follow pasture lands.
    - Determine the location of habitat suitable for grassland bird species.
    - Determine the area of dykeland in the bioregion and assess high risk areas to sea level rise and storm surge.

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 Northumberland Strait bioregion's conservation priority habitats and species. Table 15 identifies which organizations and government agencies are working to conserve priority habitats and species in the 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 I). Actions are not listed in order of importance

Table 15. Conservation actions and associated information for conservation partners in the Nova Scotia Northumberland Strait bioregion.

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[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, Salt Marshes, Tidal Flats	

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

[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, Salt Marshes, Tidal Flats, Freshwater Wetlands, Acadian Forest Mosaic, Hydro-Riparian Systems, Grasslands.*

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
1.1 Site/Area Protection Province of Nova Scotia to designate an additional 12,500 ha across the bioregion as provincial Wilderness Areas or Nature Reserves, as detailed in the 'Parks and Protected Areas Plan'.	NSE	Necessary		All	
1.1 Site/Area Protection Complete a gap analysis for the network of protected areas in the province.	Province of NS	Beneficial		All	
1.1 Site/Area Protection Continue to pursue high priority conservation lands in key focal areas including the Chignecto Isthmus, the Pugwash River Estuary and the floodplain and headwater forests located in Pictou and Cumberland counties. A minimum of 800 ha will be protected during the 5 years of the HCS.	NCC	Necessary	2020		
1.1 Site/Area Protection NCC to acquire a minimum of 500 ha of P1 and P2 lands and a minimum of 200 ha of P3 lands in the Chignecto Isthmus region.	NCC	Necessary; 2		Acadian Forest	
1.1 Site/Area Protection NCC and Province of Nova Scotia to jointly explore options for acquisition and protection of a 3,500 ha block of privately owned industrial freehold lands on Chignecto Isthmus.	NCC	Necessary; 2		Acadian Forest	
1.1 Site/Area Protection NCC to acquire or contribute to permanent conservation of a minimum of 200 ha of P1 and P2 lands containing calcareous (gypsum and limestone) influenced ecosystems.	NCC	Beneficial; 2		Acadian Forest	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
1.1 Site/Area Protection NCC to acquire a minimum of 300 ha of P1 and P2 lands containing intact Acadian forest communities.	NCC	Beneficial		Acadian Forest	
1.1 Site/Area Protection NCC to acquire a minimum of 200 ha at Pugwash River Estuary.	NCC	Beneficial		Salt Marsh, Tidal Flats	
1.1 Site/Area Protection Where feasible, NCC owned lands in the bioregion to be designated under provincial legislation, protecting against future mining related risk.	NCC, NSE	Beneficial		All	Mining
1.2 Resource and Habitat Protection Administer the Atlantic Wetland Care Program with a goal to target 1800 landowners in the Maritimes and encourage 25 of them to take action to protect essential wetland habitat. The program will secure wetland habitat by encouraging landowners to sign conservation and stewardship agreements. Landowners will be asked to maintain existing nest boxes and install up to 100 new ones. There will be educational opportunities for private landowners such as 'Caring for Your Wetland' workshops and other user-friendly educational resources.	Ducks Unlimited Canada	Beneficial	Ongoing	Freshwater Wetlands	
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	Salt Marshes, Tidal Flats, Freshwater Wetlands, Grasslands, Hydro-riparian Systems	
2.1 Site/Area Management Implement management plans for John Lusby Marsh, Chignecto, Wallace Bay National Wildlife Areas and	EC	Necessary	Ongoing	Beaches and Dunes, Salt Marshes, Tidal Flats, Acadian Forest,	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
Migratory Bird Sanctuaries.				Freshwater Wetlands, Hydro-riparian Systems	
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 Site/Area Management Assess air quality and climate change using lichens within permanent sample plots.	Province of NS	Beneficial		Acadian Forest, Freshwater Wetlands, Hydro-riparian Systems	
2.1 Site/Area Management Work collaboratively with partners and neighbours to manage conservation lands in the region including conducting baseline inventories and developing management plans for all NCC sites and monitoring key threats. Where possible, direct action will be taken to mitigate threats posing an imminent impact to priority conservation targets. Monitor effectiveness of active management techniques employed on NCC property.	NCC	Necessary			
2.1 Site/Area Management Ongoing stewardship of the Pugwash Estuary, including water quality assessments and restoration of tributary streams.	Friends of Pugwash Estuary	Beneficial	Ongoing		
2.1 Site/Area Management Conduct annual river restorations in Antigonish County, including clean up and installation of in-stream structures, resulting in the restoration and enhancement of 1 km of stream habitat per year. Develop a remediation strategy for the restoration of	Habitat Unlimited	Beneficial	Ongoing	Hydro-riparian Systems	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
Gaspereaux Lake in Antigonish County, as well as the restoration of a wetland within the Town of Antigonish in partnership with St. Francis Xavier. Develop watershed management plans for four watersheds in Antigonish County. Assist a ten-year study (ending in 2018) on the effects of river restoration on populations of trout.					
2.1 Site/Area Management Continue restoration work on the Waugh's and French Rivers with a focus on enhancing Atlantic Salmon habitat. As of 2014, 60,000 square meters of stream habitat has been restored.	North Colchester River Restoration Association	Beneficial	Ongoing	Hydro-riparian Systems	
2.1 Site/Area Management Continue in-stream and bank restoration on the West Bank River John, Six mile, and Eight Mile Brooks, and Watervale Brook in Pictou County. In 2013, 7620 m^2 of stream habitat were restored.	Pictou County Rivers Association	Beneficial	Ongoing	Hydro-riparian Systems	
2.1 Site/Area Management Continue to improve habitat issues on South River, including bank erosion, increasing sedimentation, loss of riparian habitat, and widening of the channel. In 2013, 3600 m^2 of stream habitat and 600 m^2 of riparian habitat were restored.	Antigonish Rivers Association	Beneficial	Ongoing	Hydro-riparian Systems	
2.1 Site/Area Management Perform restoration work on the Afton River.	Paqtnkek Fisheries	Beneficial	Ongoing	Hydro-riparian Systems	
2.1 Site/Area Management Map calcareous ecosystem distribution in the bioregion.	ACCDC	Beneficial		Acadian Forest	
2.1 Site/Area Management Update NCC prioritization layer using aerial photo analysis and fieldwork in potential calcareous and	NCC	Beneficial		Hydro-riparian Systems, Acadian Forest	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
floodplain priority areas to determine best site for NCC land assembly efforts.					
2.1 Site/Area Management Work with MTRI to develop improved mapping of old forest distribution in the bioregion.	NCC, MTRI	Beneficial		Acadian Forest	
2.1 Site/Area Management Work with partners to determine minimum patch size for forest ecosystems and associated focal species in the bioregion.	NCC	Beneficial		Acadian Forest	
2.1 Site/Area Management Develop mapping products depicting the Active River Area for 1 major river system.	NCC	Beneficial		Hydro-riparian Systems, Acadian Forest, Freshwater Wetlands	
2.1 Site/Area Management Continue to support research and advance knowledge of unique wetland communities and rare plant occurrences in Mussaguash marshes.	NCC	Beneficial		Freshwater Wetlands	
2.2 Invasive/Problematic Species Control Conduct experimental trials to determine best control technique for Glossy Buckthorn and disseminate information to partners.	NCC	Beneficial			Invasive and non-native alien species - Glossy Buckthorn
2.2 Invasive/Problematic Species Control Establish a structure to facilitate collaboration and strategic decision making regarding invasive species control techniques (i.e. Invasive Species Alliance).	NCC	Beneficial	2020		Invasive and non-native alien species
3. Species Management					
3.2 Species Recovery Map Eelgrass distribution in Pugwash estuary every five years to identify trends.	NCC	Beneficial			Invasive and non-native alien species -

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
					European Green Crab
3.2 Species Recovery Continue to work together through the coordination of volunteers and partners in plover monitoring, breeding habitat protection, and stewardship on beaches in northern Nova Scotia, including joint monitoring collaborations, outreach, and volunteer celebration events. A Piping Plover recovery strategy has been developed, with a population objective of 60 pairs for NS and 13 for the gulf region, which includes Cape Breton and the Northumberland Strait region.	BSC, EC	Beneficial		Beaches and Dunes	Recreational Beach Use; Tourism and Recreational Areas
3.2 Species Recovery Conduct Moose population surveys.	NSDNR Wildlife	Necessary			
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 bioregion.	EC, NSDNR, Academic Institutions, NSNT, NCC, MTRI	Necessary	Ongoing	All	
4. Education & Awareness					
4.2 Training Engage partners in the 'Staying Connected' Program and explore possibilities for expanding program model to the bioregion (Chignecto Isthmus).	NCC	Beneficial			Fragmentation
4.3 Awareness & Communications Hold a minimum of five conservation volunteer events and five guided interpretive activities in the	NCC	Beneficial	2020		

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
bioregion.					
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 maintenance or enhancement of biodiversity on farms.	EHJV	Necessary	Ongoing	Freshwater Wetlands, Grasslands	Incompatible agricultural practices
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		

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
5. Law & Policy					
5.1.2 Legislation (National level) Implement the Migratory Bird Convention Act (MBCA), Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA), Species at Risk Act (SARA), Canadian Environmental Protection Act (CEPA), Canada Wildlife Act (CWA), Environmental Enforcement Act (EEA), Canadian Environmental Assessment Act (CEAA), Fisheries Act (water pollution).	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		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 Floodplain Systems	
5.2 Policies & Regulations Conduct an analysis of landscape connectivity options in the Chignecto Isthmus region.	NCC	Necessary		Acadian Forest	Logging and Wood Harvesting; Renewable Energy; Housing, Cottage and Urban Area Development

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
5.2 Policies & Regulations Develop mapping products depicting Active River Area for 1 major river system.	NCC	Beneficial		Rivers, Streams and Riparian Area	Logging and Wood Harvesting; Housing, Cottage and Urban Area Development
5.2 Policies & Regulations Develop mapping of coastal sensitivity to erosion.	NCC	Beneficial		Beaches and Dunes	Shoreline Armouring
5.2 Policies & Regulations Collaborate with the province of Nova Scotia and other stakeholders regarding changes to the *Code of Forest Practice for Crown Land*.	EAC, MTRI	Necessary		Acadian Forest	Logging and Wood Harvesting
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 & Other Incentives					
6.3 Market Forces Continue to assist small woodland owners in Southwest Nova Scotia 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 certified forest products.	MTRI, FNSWO	Beneficial	Ongoing	Acadian Forest Mosaic	Logging and Wood Harvesting

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
6.3 Market Forces Complete report summarizing regulatory regime and economic, social, and political considerations of Green Crab market development.	NCC	Beneficial			Invasive Alien Species - European Green Crab
6.4 Conservation Payments Implement and encourage the use of EC Ecological Gifts (Ecogifts) program.	EC, NCC, NSNT	Necessary	Ongoing	All	
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	Logging and Wood Harvesting
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 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		
7.2 Alliance and Partnership Development Provide EC-CWS input into: Staying Connected Initiative, Western Hemispheric Shorebird Reserve	EC, NCC, MTRI, NSNT, DUC, Province	Beneficial	Ongoing	All	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Conservation Goals	Date for Completion	Priority Habitats[3]	Primary Related Threat(s)
Network, Important Bird Areas.	of NS, BSC, ACCDC, International ENGOs, other government agencies, watershed groups, municipalities,				
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 bioregion.	NCC, MTRI, NSNT, ENGOs	Necessary	Ongoing	All	
7.3 Conservation Finance Continue to engage Open Spaces Institute in conservation work on the Chignecto Isthmus.	NCC - Program Director	Beneficial			

iii. Additional Stewardship, Education, Outreach and Advocacy

The Ecology Action Centre

Demonstrating a "Living Shorelines" Approach to Managing coastal erosion in Nova Scotia. This project will conserve coastal landscapes and improve wildlife habitat along the Bay of Fundy and Northumberland Strait coasts of Nova Scotia. The Ecology Action Centre will identify at least four pilot sites to implement appropriate Living Shoreline methods, including the strategic placement of native plants and other biodegradable materials, to manage erosion. As a result of project activities, at least 2 ha of natural coastal systems will be preserved and enhanced. Two workshops and two site tours will allow community members to see how Living Shorelines can be used to manage coastal erosion. The restoration of the sites will be documented and published as a series of fact sheets and videos to encourage stakeholders to adopt these methods. This project is time sensitive as season-dependent shoreline stabilization work should begin in early summer.

Cumberland Wilderness Society

Continuing to advocate for the protection of 12% of Cumberland County. The focus specifically, is to push for the protection of lands between the Raven Head and Kelley River Wilderness Areas as well as other crown and freehold lands on the Chignecto Isthmus which would help to maintain or increase connectivity between Nova Scotia and New Brunswick.

Ducks Unlimited

The Atlantic Wetland Care Program - Its goal is to target 1800 landowners in the Maritimes (some within the Nova Scotia Northumberland Strait Bioregion) and encourage 25 of them to take action to protect essential wetland habitat. This will result in the improvement of water resources, survival of waterfowl and associated wetland species and foster a stewardship ethic among private landowners. The program will secure wetland habitat by encouraging landowners to sign conservation and stewardship agreements. Landowners will be asked to maintain existing nest boxes and install up to 100 new ones. There will be educational opportunities for private landowners such as 'Caring for Your Wetland' workshops and other user-friendly educational resources.

Nova Scotia Nature Trust

Coastal Conservation Campaign - This campaign is focused on protecting properties of ecological significance representing the diversity of habitats and species important to sustaining the overall integrity of Nova Scotia's coastal areas.

Habitat Unlimited

Maintaining a live learning display aquarium within the People's Place Library in Antigonish. Plans to expand its outreach and education program.

References

i. Publications

Allard, K., A. Hanson, & M. Mahoney. 2014. Important Marine Habitat Areas for Migratory Birds in Eastern Canada. Technical Report Series No. 530, Canadian Wildlife Service, Sackville, New Brunswick.

Anderson, M. G., B. Vickery, M. Gorman, L. Gratton, M. Morrison, J. Maillet, A. Olivero, C. Ferree, D. Morse, G. Kehm, K. Rosalska, S. Khanna, & S. Bernstein. 2006. The Northern Appalachian/Acadian Ecoregion: Ecoregional Assessment, Conservation Status and Resource CD. The Nature Conservancy, Eastern Conservation Science and The Nature Conservancy of Canada: Atlantic and Quebec regions.

ACCDC (Atlantic Canada Conservation Data Centre). 2013. Digital database of rare species locations for Nova Scotia. Atlantic Canada Conservation Data Centre, Sackville, New Brunswisk.

Atlantic Salmon Federation. 2013. Fighting Acid Rain. Accessed February 14, 2013. http://www.asf.ca/fighting-acid-rain.html.

Beazley, K., T. Snaith, F. MacKinnon, & D. Colville. 2004. Road density and potential impacts on wildlife species such as American Moose in mainland Nova Scotia. *Proceedings of the Nova Scotia Institute of Science* 42:339–357.

Belliveau, A. 2012. Invasive Alien Species in Nova Scotia, Identification and Information Guide. Mersey Tobeatic Research Institute, Kempt, Nova Scotia.

Bertness, M. D. 1999. The Ecology of Atlantic Shorelines. Sinauer Associates, Sunderland, Massachusetts.

Betts, M. G. & G. J. Forbes (eds.). 2005. Forest management guidelines to protect native biodiversity in the Greater Fundy Ecosystem. Greater Fundy Ecosystem Research Group, New Brunswick Co-operative Fish and Wildlife Research Unit, University of New Brunswick, Fredericton, New Brunswick.

Bird Studies Canada. (year unknown). Important Bird Area site NS 009 summary, Pomquet Beach Region, Antigonish, Nova Scotia. http://www.bsc-eoc.org/iba/site.jsp?siteID=NS009.

Bird Studies Canada, Environment Canada, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, & Prince Edward Island Department of Agriculture and Forestry. 2012. Maritimes Breeding Bird Atlas Database. Data accessed from the Maritimes Breeding Bird Atlas website and/or Nature Counts, a node of the Avian Knowledge Network, Bird Studies Canada. http://www.naturecounts.ca/.

Blais, J. R. 1983. Trends in the frequency, extent and severity of Spruce Budworm outbreaks in eastern Canada. *Canadian Journal of Forest Research* 13:539-547.

Blaney, S. & D. Mazerolle D. 2007. Nova Scotia Status Report on the Ram's Head Lady Slipper (*Cypripedium arietinum* R. Br.). Atlantic Canada Conservation Data Centre, Sackville, New Brunswick.

Bowron, T., N. Neatt, D. van Proosdij, & J. Lundholm. 2012. Chapter 14: Tidal Marsh Restoration in Atlantic Canada, Pp. 191-210 In *Restoring Tidal Flow to Tidal marshes: A Synthesis of Science and Management*. C. T. Roman & D. M. Burdick (eds). Island Press.

CBCL Limited. 2009. The State of Nova Scotia's Coast Technical Report. Prepared for the Province of Nova Scotia, Halifax.

Cheng R. & P. G. Lee. 2009. Recent (1990-2007) anthropogenic change within the forest landscapes of Nova Scotia. Global Forest Watch Canada, Edmonton, Alberta.

Christian, D. P., W. Hoffman, J. M. Hanowski, G. J. Niemi, & J. Beyea. 1998. Bird and mammal diversity on woody biomass plantations in North America. *Biomass and Bioenergy* 14:395-402.

COSEWIC. 2007. COSEWIC assessment and update status report on the Wood Turtle *Glyptemys insculpta* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

COSEWIC. 2010. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

COSEWIC. 2011. Status appraisal summary on the Barrow's Goldeneye (*Bucephala islandica*), eastern population in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

COSEWIC. 2012. Striped Bass (*Morone saxatilis*) Southern Gulf of St. Lawrence population status change, November 2012. http://www.COSEWIC.gc.ca.

Davis, M., L. Gratton, J. Adams, J. Goltz, C. Stewart, S. Buttrick, N. Zinger, K. Kavanagh, M. Sims & G. Mann. 2013. New England-Acadian forests. World Wildlife Fund. http://worldwildlife.org/ecoregions/na0410.

Davis, D. S. & S. Browne. 1996a. The Natural History of Nova Scotia, Volume One: Topics and Habitats. Nova Scotia Museum, Government of Nova Scotia, Nimbus Publishing, Halifax.

Davis, D. S. & S. Browne. 1996b. The Natural History of Nova Scotia, Volume Two: Theme Regions. Nova Scotia Museum, Government of Nova Scotia, Nimbus Publishing, Halifax.

Department of Fisheries and Oceans (DFO). 2007a. *By the Sea - A Guide to the Coastal Zone of Atlantic Canada.*

Department of Fisheries and Oceans (DFO). 2007b. Northumberland Strait Ecosystems Overview Report. Prepared by AMEC Earth and Environmental, File No. TE 2007.

Department of Fisheries and Oceans (DFO). 2009. Does eelgrass (*Zostera marina*) meet the criteria as an ecologically priority species? Canadian Science Advisory Secretariat Science Advisory Report 2009/018.

Dudley, N. (ed.). 2008. Guidelines for applying protected areas management categories. International Union for Conservation of Nature, Gland, Switzerland.

Eastern Habitat Joint Venture (EHJV). 2007. Five Year Plan for the Implementation of the North American Waterfowl Management Plan in Nova Scotia (Draft).

Environment Canada. 2009. Atlantic Canada Shorebird Surveys Site Catalog. Environment Canada Atlantic region.

Environment Canada. 2012a. Environment Canada Climate Trends and Variation Bulletin, Summer 2012. http://www.ec.gc.ca/adsc-cmda/default.asp?lang=en&n=30EDCA67-1#a1.

Environment Canada. 2012b. Recovery Strategy for the Piping Plover (*Charadrius melodus melodus*) in Canada. *Species at Risk Act* Recovery Strategy Series, Environment Canada, Ottawa.

Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 14 and Marine Biogeographic Units 11 and 12 in Nova Scotia: Atlantic Northern Forest, Scotian Shelf and Bay of Fundy, and Gulf of St. Lawrence. Canadian Wildlife Service, Environment Canada, Sackville, New Brunswick.

Environment Canada. 2014a. Management Plan for the Chignecto National Wildlife Area. Environment Canada, Canadian Wildlife Service Atlantic Region.

Environment Canada. 2014b. Management Plan for the John Lusby Marsh National Wildlife Area. Environment Canada, Canadian Wildlife Service Atlantic Region.

Environment Canada. 2014c. Management Plan for the Wallace Bay National Wildlife Area. Environment Canada, Canadian Wildlife Service Atlantic Region.

Environment Canada, Ontario Ministry of Natural Resources, & Ontario Ministry of Environment (EC, OMNR & OME). 1998. A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern. Public Works and Government Services Canada, Toronto, Ontario.

Environment Canada & Parks Canada Agency. 2010. Recovery Strategy and Management Plan for Multiple Species of Atlantic Coastal Plain Flora in Canada. *Species at Risk Act* Recovery Strategy Series, Ottawa.

Erdle, T. A. & M. Sullivan. 1998. Forest management design for contemporary forestry. *Forest Chronicles* 74:83-90.

Erskine, A. J. 1992. Atlas of Breeding Birds in the Maritime Provinces. Nova Scotia Museum Program of the Department of Education, Province of Nova Scotia.

Forman, R. T. T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, Cambridge, United Kingdom.

Government of Nova Scotia. 2011. Nova Scotia Wetland Conservation Policy. http://www.gov.ns.ca/nse/wetland/docs/Nova.Scotia.Wetland.Conservation.Policy.pdf.

Government of Nova Scotia. 2013. Our Parks and Protected Areas: A Plan for Nova Scotia. http://www.gov.ns.ca/parksandprotectedareas/pdf/Parks-Protected-Plan.pdf.

Greenburg, D. A., W. Blanchard, B. Smith, & E. Barrow. 2012. Climate change, mean sea level and high tides in the Bay of Fundy. *Atmosphere-Ocean* 50:261-276.

Gregory, S. V., F. J. Swanson, W. A. McKee, & K. W. Cummins. 1991. An ecosystem perspective of riparian zones. *Bioscience* 41:540-551.

Gulf of Maine Council (GOMC) on the Marine Environment. 2007. Priority habitats and threats: Eelgrass beds. Gulf of Maine Council on the Marine Environment.

Hanson, A. & L. Calkins. 1996. Wetlands of the Maritime Provinces: Revised Documentation for the Wetlands Inventory. CWS Technical Report No. 267. Canadian Wildlife Service - Environment Canada, Sackville, New Brunswick, Canada.

Hanson, A. 2001. Modelling the spatial and temporal variation in density of breeding Black Ducks at landscape and regional levels. Ph.D. Thesis, University of Western Ontario, London, Ontario.

Hanson, A. 2004a. Breeding bird use of salt marsh habitat in the Maritime Provinces. CWS Technical Report No. 414. Canadian Wildlife Service - Environment Canada, Sackville, New Brunswick, Canada.

Hanson, A. (ed). 2004b. Status and conservation of eelgrass (*Zostera marina*) in Eastern Canada. Technical Report Series No. 412. Canadian Wildlife Service, Atlantic Region.

Hill, N., L. Beveridge, A. Flynn, & D. J. Garbary. 2010. *Rosa rugosa* as an invader of coastal sand dunes of Cape Breton Island and mainland of Nova Scotia. *Canadian Field-Naturalist* 124(2):151–158.

IBA Canada. 2012. Important Bird Areas in Canada. Bird Studies Canada and Nature Canada, Ottawa. Accessed January, 2014. http://www.ibacanada.ca.

IUCN-CMP. 2006a. Unified Classification of Direct Threats, Version 1.0. http://www.iucn.org/themes/ssc/sis/classification.htm.

IUCN-CMP. 2006b. Unified Classification of Conservation Actions, Version 2.0. http://www.iucn.org/themes/ssc/sis/classification.htm.

Kennedy, J. A., E. A. Krebs, & A. F. Camfield. 2012. A Manual for Completing All-bird Conservation Plans in Canada, April 2012 version. Canadian Wildlife Service, Environment Canada, Ottawa.

Keys, K., P. Neily, E. Quigley, & B. Stewart. 2010. Forest Ecosystem Classification for Nova Scotia, Part III: Ecosites. Nova Scotia Department of Natural Resources, Renewable Resources Branch. http://novascotia.ca/natr/library/forestry/reports/Ecosites.pdf.

Lemieux, M. J. 2010. A Management Plan for Native Occurrences of Eastern Cedar (*Thuja occidentalis*) in Nova Scotia, Nova Scotia Department of Natural Resources. http://www.gov.ns.ca/natr/wildlife/biodiversity/pdf/Management_Plan_EWC_NS_July_2010_MJL.pdf.

Loo, J. & N. Ives. 2003. The Acadian Forest: Historical condition and human impacts. *The Forestry Chronicle* 79:462-474.

Low, G. 2003. Landscape-Scale Conservation: A Practitioner's Guide. The Nature Conservancy.

Lynds, A. & J. Leduc. 1995. Old forests of Nova Scotia. Nova Scotia Department of Natural Resources Occasional Papers No.1.

MacDonald, H. L. 2013. The effects of the fish ladder on Waughs River, Nova Scotia. Saint Francis Xavier University, Abstract.

http://people.stfx.ca/btaylor/WebPage/Waughs/The%20Effects%20of%20the%20Fish%20Ladder%20on%20Waughs%20River.pdf.

MacKinnon, C. M. & A. C. Kennedy. 2008. Canada Lynx, *Lynx canadensis*, use of the Chignecto Isthmus and the possibility of gene flow between populations in New Brunswick and Nova Scotia. *Canadian Field Naturalist* 122(2):166-168.

MacLean, D. A. 1980. Vulnerability of spruce-fir stands during uncontrolled Spruce Budworm outbreaks. *Forestry Chronicle* 56:213-221.

MacMillan, J. L. & R. Madden. 2007. Angler effort and harvest of sea-run brook trout from a specially regulated estuary, Nova Scotia, Canada. Proceedings of Wild Trout 1X. Sustaining wild trout in a changing world. In press. Inland Fisheries Division, Nova Scotia Department of Fisheries and Aquaculture, Pictou, Nova Scotia.

Maillet, J. & M. Morrison. 2006. *New Brunswick Biodiversity Status Report: Conservation Blueprint for the Northern Appalachian - Acadian Ecoregion*. Nature Conservancy of Canada - Atlantic Region, Fredericton, New Brunswick, Canada.

Mal, T. K. & L. Narine. 2004. The biology of Canadian weeds. 129: *Phragmites australis* (Cav.) Trin. Ex Steud. *Canadian Journal of Plant Science* 84:365-396.

McAlpine, D. & I. Smith. 2010. Assessment of species diversity in the Atlantic maritime ecozone. National Research Council of Canada Press, Ottawa.

Mersey Tobeatic Research Institute (MTRI). 2012. Invasive Alien Species in Nova Scotia: Identification and Information Guide. Kempt, Nova Scotia.

Mosseler, A., I. D. Thompson, B.A. Pendrel. 2003. Overview of old-growth forests in Canada from a science perspective. *Environmental Reviews* 11:S1-S7.

Natural Resources Canada. 2008. Factsheet: *Understanding Nova Scotia's Coastlines*. http://www.nrcan.gc.ca/earth-sciences/about/organization/organization-structure/geological-survey-of-canada/7844.

Neckles, H, A. Hanson, P. Colarusso, B. Buchsbaum, & F. Short. 2009. Status, Trends, and Conservation of Eelgrass in Eastern Canada and the Northeastern United States. Proceedings of February 24-25, 2009 Workshop. Gulf of Maine Council on the Marine Environment, Portland, Maine.

Neily, P. D., E. Quigley, L. Benjamin, B. Stewart, & T. Duke. 2003. Ecological Land Classification for Nova Scotia: Volume 1 - Mapping Nova Scotia's Terrestrial Ecosystems. Nova Scotia Department of Natural Resources, Renewable Resources Branch. Report DNR 2003 -2.

Neily, P.D., E. Quigley & B. Stewart. 2008. Mapping Nova Scotia's Natural Disturbance Regimes. Nova Scotia Department of Natural Resources, Renewable Resources Branch. Report FOR 2008-5.

Newell, R. E. 2005. Provincial (Nova Scotia) Status Report on Northern White Cedar *Thuja occidentalis*, prepared for the Nova Scotia Department of Natural Resources.

North American Bird Conservation Initiative (NABCI). 2012. The State of Canada's Birds 2012. Environment Canada, Ottawa.

Nova Scotia Agricultural Land Review Committee (NSALRC). 2010. Preservation of Agricultural Land in Nova Scotia. A report prepared for the Nova Scotia Department of Agriculture.

Nova Scotia Department of Agriculture. 2010. Preservation of Agricultural Land in Nova Scotia Appendix F, Nova Scotia Land Use Committee Profiles of Agricultural Land and Resources. http://www.gov.ns.ca/agri/elibrary/nsalrc/AppendixF-AgriculturalProfiles-NS.pdf.

Nova Scotia Department of Energy. 2010. Renewable Electricity Plan, April 2010. www.gov.ns.ca/energy.

Nova Scotia Department of Environment and Labour. 2002. Natural Landscapes of Nova Scotia Summary Report. Nova Scotia Department of Environment and Labour, Protected Areas Branch.

Nova Scotia Department of Natural Resources (NSDNR). 2000. Nova Scotia forest inventory – based on forest inventory permanent sample plots measured between 1994 and 1998. Renewable Resources Branch Report FOR 2000-1.

Nova Scotia Department of Natural Resources (NSDNR). 2007. Recovery Plan for Moose (*Alces alces americana*) in Mainland Nova Scotia. Nova Scotia Department of Natural Resources, Wildlife Division.

Nova Scotia Department of Natural Resources (NSDNR). 2013. Submerged Crown Land. Last Updated July 11, 2013. http://novascotia.ca/natr/land/submerged-land.asp.

Nova Scotia Environment. 2011. Nova Scotia Wetlands Conservation Policy. Nova Scotia Environment, Protected Areas and Wetlands Branch.

Nova Scotia Environment (NSE). 2012a. About Protected Areas. Last updated May 16, 2013. http://www.gov.ns.ca/nse/protectedareas/about.asp.

Nova Scotia Environment (NSE). 2012b. Historic Wetland Loss in Nova Scotia. Last updated May 23, 2013. http://www.gov.ns.ca/nse/wetland/historic-wetland-loss-ns.asp.

Nussey, P. 2010. Potential for the Conservation of an Ecological Corridor Across the Chignecto Isthmus: a science based approach for landscape level conservation. Master of Environmental Management Final Report. University of New Brunswick, Fredericton, New Brunswick, Canada.

Olsen, L., J. Ollerhead, & A. Hanson. 2005. Relationships between halophytic vascular plant species' zonation and elevation in salt marshes of the Bay of Fundy and Northumberland Strait, New Brunswick, Canada. Proceedings of the 12th Canadian Coastal Conference, November 6-9, 2005. Dartmouth, Nova Scotia, Canada (CD).

Parker, G. 2001. Status Report on the Canada Lynx in Nova Scotia, Loup curvier *Lynx canadensis* (Kerr 1792). Report submitted to the Nova Scotia Species at Risk Working Group.

Parker, G. 2003. Status Report on The Eastern Moose (*Alces alces Americana* Clinton) in Mainland Nova Scotia. Nova Scotia Department of Natural Resources, Nova Scotia.

Pictou County GenWeb (2000). History of Pictou County, Nova Scotia. Accessed February 10, 2014. http://www.rootsweb.ancestry.com/~nspictou/elect_text/hist_pictou_1.htm.

Province of Nova Scotia. 2009. Wildlife habitat and watercourse protection regulations. http://www.gov.ns.ca/just/regulations/regs/fowhwp.htm.

Province of Nova Scotia. 2012. On Nova Scotia Farms: A Teacher's Guide to Nova Scotia Agriculture. Agricultural Education Office of the Nova Scotia Department of Agriculture.

Province of Nova Scotia. 2013. "Our Parks and Protected Areas a plan for Nova Scotia". http://www.novascotia.ca/parksandprotectedareas/pdf/Parks-Protected-Areas-Proposed-Plan.pdf.

Province of Nova Scotia Draft Coastal Strategy. 2011. http://www.gov.ns.ca/coast/documents/draft-coastal-strategy2011oct.pdf.

Pulsifer, M. & T. Nette. 1995. History, status and present distribution of Moose in Nova Scotia. *Alces* 31:209-219.

Redfield, A. C. 1972. Development of a New England salt marsh. *Ecological Monographs* 42:201-237.

Reed, A. & A. D. Smith. 1972. Man and waterfowl in tidal shorelines of Eastern Canada. Pages 151-155 in Proceedings of Coastal Zone Canada. Dartmouth, Nova Scotia.

Richards, W. & R. Daigle. 2011. Scenarios and Guidelines for Adaptation to Climate Change and Sea Level Rise – NS and PEI Municipalities. Climate Change Dictorate, Nova Scotia Department of Environment.

Seymour, N. R., A. G. Miller, & D. J. Garbary. 2002. Decline of Canada geese (*Branta canadensis*) and common goldeneye (*Bucephala clangula*) associated with a collapse of eelgrass (*Zostera marina*) in a Nova Scotia estuary. *Helgoland Marine Research* 56(3):198-202.

Shaw, J., R. B. Taylor, D. L. Forbes, M. -H Ruz, & S. Solomon. 1998. Sensitivity of the coastline of Canada to sea-level rise. *Geological Survey of Canada Bulletin* 505.

Staicer, C. A. (year unknown). Bird species associated with old-growth forest in southwestern Nova Scotia. Abstract prepared for: Old growth forests in Canada - A science perspective. Canadian Forest Service symposium, Sault Ste. Marie, Ontario.

Statistics Canada. 2012a. Antigonish, Nova Scotia (Code 1214) and Nova Scotia (Code 12) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E.

Statistics Canada. 2012b. Colchester, Nova Scotia (Code 1210) and Nova Scotia (Code 12) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E.

Statistics Canada. 2012c. Cumberland, Nova Scotia (Code 1211) and Nova Scotia (Code 12) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E.

Statistics Canada. 2012d. Pictou, Nova Scotia (Code 1212) and Nova Scotia (Code 12) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E.

Stewart, B. J., P. D. Neily, E. J. Quigley, A. P. Duke, & L. K. Benjamin. 2003. Selected Nova Scotia old-growth forests: Age, ecology, structure, scoring. *The Forestry Chronicle* 79:632-644.

Thurston, H. 2011. The Atlantic Coast: A Natural History, Greystone Books, co-published with David Suzuki Foundation, pp 77- 84, 206-229.

Tufts, R. W. 1962, 1963. *The Birds of Nova Scotia*. The Nova Scotia Museum.

Underwood, J. K., J. G. Ogden, J. J. Kerekes, & H. H. Vaughan. 1987. Acidification of Nova Scotia Lakes. *Water, Air and Soil Pollution* 32.

United States Climate Change Science Program (US CCSP). 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. J. G. Titus (coordinating lead author). A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research.

Watt, C., D. J. Garbary, & C. Longtin. 2011. Population sutucture of the ribbed mussel (*Geukensia demissa*) in salt marshes in the southern Gulf of St. Lawrence, Canada. *Helgoland Marine Research* 65(3):275-283.

Woolmer, G., S. C. Trombulak, J. C. Ray, P. J. Doran, M. G. Anderson, R. F. Baldwin, A. Morgan, & E. W. Sanderson. 2008. Rescaling the Human Footprint: A tool for conservation planning at an ecoregional scale. *Landscape and Urban Planning* 87:42-53.

ii. Unpublished Data Sources

Statistics Canada, 2011 Agriculture Census Data for Antigonish, Pictou, Colchester and Cumberland counties from sources. Provided by Adam Wile, Agricultural Transition Officer, Eastern and C.B. Nova Scotia, Nova Scotia Department of Agriculture, 190 Beechill Road, Antigonish, N.S. Phone 902-863-2087.

Bird Studies Canada, unpublished summary tables, Piping Plover surveys and critical habitats in Nova Scotia, 2006-2012. Provided by Sue Abbot, Program Coordinator, 45 Alderney Drive, 16th Floor, Datrmouth, N.S.

Canadian Wildlife Service, Atlantic Region, unpublished Fall/Winter Waterfowl Surveys along the Northumberland Strait of Nova Scotia, 2002-2007, 2010. Provided by Andrew Hicks, Wildlife Technician, Canadian Wildlife Service, 17 Waterfowl Lane, Sackville N.B. Phone 506-364-5138.

Canadian Wildlife Service, Atlantic Region, unpublished Shorebird Survey Data for Northumberland Strait Region of Nova Scotia, 1974 –present. Provided by J. Paquet, Shorebird Biologist Canadian Wildlife Service, 17 Waterfowl Lane, Sackville N.B. Phone 506-364-5044.

Wikepedia, Demographics of Nova Scotia. http://en.wikipedia.org/wiki/Demographics_of_Nova_Scotia.

iii. Personal Communications

Basquille, Sean, Provincial Habitat Biologist, Department of Natural Resources, Wildlife Division, Kentville, N.S. Phone 902-679-6148.

Blaney, Sean, Botanist and Assistant Director, Atlantic Canada Conservation Data Centre, Sackville, N.B. Phone 506-364-2658.

Finley, Peter, Mystic Coast Realty, Pugwash, N.S. Phone 902-242-2552.

George, Kim, Regional Biologist, Department of Natural Resources, Truro, N.S. Phone 902-893-5630.

Hall, Ross, Retired Regional Biologist Department of Natural Resources, Truro, N.S. Volunteer Maritime Breeding Bird Atlas coordinator, Cobequid Naturalists Club, Bible Hill, N.S. Phone 902-893-9665.

MacKinnon, Dave, Systems Planning Coordinator, Nova Scotia Environment, Halifax, N.S.

Milton, Randy, Manager Wildlife Resources, Department of Natural Resources, Kentville, N.S. Phone 902-679-6091.

Neily, Peter, Senior Forester, Department of Natural Resources, Truro, N.S. Phone 902-893-5692.

Paquet, Julie, Sackville, Canadian Wildlife Service, 17 Waterfowl Lane, Sackville, NB. Phone 506-364-5041.

Pollard, Bruce, Wildlife Biologist, Gamebird Management, Canadian Wildlife Service, 17 Waterfowl Lane, Sackville, N.B. Phone 506-364-5041.

Pulsifer, Mark, Regional Biologist Department of Natural Resources, Antigonish, N.S. Phone 902-863-7523.

Appendices

Appendix A. List of Abbreviations

Acronyms	Title
ACCDC	Atlantic Canada Conservation Data Centre
AOI	Area of Interest
BCR	Bird Conservation Region
BSC	Bird Studies Canada
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DUC	Ducks Unlimited Canada
EC	Environment Canada
EHJV	Eastern Habitat Joint Venture
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
MBBA	Maritime Breeding Bird Atlas
MBS	Migratory Bird Sanctuary
MBU	Marine Biogeographic Unit
MTRI	Mersey Tobeatic Research Institute
NAAP	Northern Appalachian - Acadian Ecoregional Plan
NAWCA	North American Waterfowl Conservation Act
NAWMP	North American Waterfowl Management Plan
NCC	Nature Conservancy of Canada
NS	Nova Scotia
NSDNR	Nova Scotia Department of Natural Resources
NSE	Nova Scotia Environment
NS ESA	Nova Scotia Endangered Species Act
NSNT	Nova Scotia Nature Trust
NWA	National Wildlife Area
OHV	Off-Highway Vehicle
PC	Parks Canada
SAR	Species at Risk
SNBR	Southwest Nova Biosphere Reserve
UNESCO	United Nations Educational, Scientific, and Cultural Organization

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 C: Significant Species—Conservation Ranks and Data Sources

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 C: Significant Species—Conservation Ranks and Data Sources

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 Data Sources

This appendix provides a list of priority species for the Nova Scotia Northumberland Strait 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.

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Invertebrates													
Acadian Hairstreak	*Satyrium acadica*				G5	S1	5			x			
Bronze Copper	*Lycaena hyllus*				G5	S1	4			x			
Brook Floater	*Alasmidonta varicosa*	SC	SC	TH	G3	S1S2	3			x			
Brook Snaketail	*Ophiogomphus aspersus*				G4	S1	2			x			
Common Roadside Skipper	*Amblyscirtes vialis*				G5	S2	4			x			
Creeper	*Strophitus undulatus*				G5	S1	2			x			
Delicate Emerald	*Somatochlora franklini*				G5	S1	3			x			
Eastern Lampmussel	*Lampsilis radiata*				G5	S2	3			x			

[1] *Committee on the Status of Endangered Wildlife in Canada*
[2] Species at Risk Act *(2002)*
[3] Nova Scotia Endangered Species Act *(1999)*
[4] *Priority bird species in Bird Conservation Region 14, and Marine Biogeographic Units 12 in Nova Scotia (Environment Canada 2013).*

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Ebony Boghaunter	*Williamsonia fletcheri*				G4	S1	2			x			
Harpoon Clubtail	*Gomphus descriptus*				G4	S2	3			x			
Hoary Comma	*Polygonia gracilis*				G5	S1	3			x			
Jutta Arctic	*Oeneis jutta*				G5	S1	2			x			
Juvenal's Duskywing	*Erynnis juvenalis*				G5	S2S3	4			x			
Kennedy's Emerald	*Somatochlora kennedyi*				G5	S1S2	2			x			
Macropis Cuckoo Bee	*Epeoloides pilosulus*	EN		EN	G1	S1	?						
Maine Snaketail	*Ophiogomphus mainensis*				G4	S1	2			x			
Maritime Copper (Salt Marsh Copper)	*Lycaena dospassosi*				G3G4	S2	?			x			
Milbert's Tortoiseshell	*Aglais milberti*				G5	S2	4			x			
Monarch	*Danaus plexippus*	SC	SC		G5	S2B	3			x			
Mustard White	*Pieris oleracea*				G4G5	S2	3			x			
Northern Cloudywing	*Thorybes pylades*				G5	S2	3			x			
Prince Baskettail	*Epitheca princeps*				G5	S2	3			x			
Taiga Bluet	*Coenagrion resolutum*				G5	S1	2			x			
Tidewater Mucket	*Leptodea ochracea*				G3G4	S1	3			x			
Triangle Floater	*Alasmidonta undulata*				G4	S2S3	4			x			
Williamson's Emerald	*Somatochlora williamsoni*				G5	S1	2			x			
Fish													
American Eel	*Anguilla Rostrata*	TH			G4	S5							
Atlantic Salmon (Gaspe-SG of SL pop)	*Salmo salar*	SC	EN		G5	S2	2			x			
Striped Bass (SG of SL pop)	*Morone saxatilis*	SC			G5	S1	1			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Birds													
American Bittern	*Botaurus lentiginosus*				G4	S3S4B	3	x					x
American Black Duck	*Anas rubripes*				G5	S5	4	x					x
American Coot	*Fulica americana*				G5	S1B	5						x
American Golden Plover	*Pluvialis dominica*				G5	S3M	3	x					
American Red Start	*Setophaga ruticilla*				G5	S5B	4	x				x	
American Three-toed Woodpecker	*Picoides dorsalis*				G5	S1S2	5						x
American Woodcock	*Scolopax minor*				G5	S4S5B	4	x					x
Bald Eagle	*Haliaeetus leucocephalus*				G5	S4	4	x					x
Baltimore Oriole	*Icterus galbula*				G5	S2S3B	2						x
Bank Swallow	*Riparia riparia*	TH			G5	S3B	2	x				x	
Barn Swallow	*Hirundo rustica*	TH		EN	G5	S3B	3	x					x
Barrow's Goldeneye - Eastern pop.	*Bucephala islandica (Eastern pop.)*	SC	SC		G5	S1N	1	x					
Bay-breasted Warbler	*Setophaga castanea*				G5	S3S4B	3	x				x	
Belted Kingfisher	*Megaceryle alcyon*				G5	S5B	4	x				x	
Bicknell's Thrush	*Catharus bicknelli*	TH	TH		G4	S2S3B	1	x					
Black and White Warbler	*Mniotilta varia*				G5	S4S5B	4	x				x	
Black-bellied Plover	*Pluvialis squatarola*				G5	S4M	4	x					
Black-billed Cuckoo	*Coccyzus erythropthalmus*				G5	S3?B	2	x					x
Blackburnian Warbler	*Setophaga fusca*				G5	S4B	4	x				x	
Black-crowned Night-heron	*Nycticorax nycticorax*				G5	S1B	2						
Black Scoter	*Melanitta americana*				G5	S5N	4	x					x

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Black Tern	*Chlidonias niger*				G4	S1B	2						x
Black-Throated Green Warbler	*Dendroica virens*				G5	S4S5B	4	x				x	
Blue Headed Verio	*Vireo solitarius*				G5	S5B	4	x				x	
Bobolink	*Dolichonyx ory*	TH		VU	G5	S3S4B	3	x					x
Bonapart's Gull	*Chroicocephalus philadelphia*				G5	S5M	4	x					
Boreal Chickadee	*Poecile hudsonica*				G5	S3	3	x				x	
Boreal Owl	*Aegolius funereus*				G5	S1B	5						x
Brown Thrasher	*Toxostoma rufum*				G5	S1?B	5						x
Brown-headed Cowbird	*Molothrus ater*				G5	S2S3B	4					x	
Canada Goose	*Branta canadensis*				G5	SNABS4N	4	x					x
Canada Warbler	*Wilsonia canadensis*	TH	TH	EN	G5	S3B	1	x				x	
Cape May Warbler	*Dendroica tigrina*				G5	S3?B	3	x					x
Chimney Swift	*Chaetura pelagica*	TH	TH	EN	G5	S2S3B	1	x					x
Common Eider	*Somateria mollissima*				G5	S4	4	x	x				x
Common Loon	*Gavia immer*				G5	S3BS4N	2	x				x	
Common Goldeneye	*Bucephala clangula*				G5	S2BS5N	4	x					x
Common Moorhen	*Gallinula chloropus*				G5	S1B	5						x
Common Nighthawk	*Chordeiles minor*	TH	TH	TH	G5	S3B	1	x					x
Common Tern	*Sterna hirundo*				G5	S3B	3	x					x
Dunlin	*Calidris alpina*				G5	S4M	4	x					
Dovekie	*Alle alle*				G5	S5N	4	x					
Eastern Kingbird	*Tyrannus tyrannus*				G5	S3S4B	3	x					x

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Eastern Wood-Pewee	*Contopus virens*	SC		VU	G5	S3S4B	3	x				x	
Evening Grosbeak	*Coccothraustes vespertinus*				G5	S4BS5N	4	x				x	
Gadwall	*Anas strepera*				G5	S2B	2						x
Gray Catbird	*Dumetella carolinensis*				G5	S3B	2	x				x	
Gray Jay	*Perisoreus canadensis*				G5	S3S4	3	x					x
Great Cormorant	*Phalacrocorax carbo*				G5	S3	3	x					x
Great Crested Flycatcher	*Myiarchus crinitus*				G5	S2B	2						x
Green-winged Teal	*Anas crecca*				G5	S4S5B	4	x					x
Hudsonian Godwit	*Limosa haemastica*				G4	S3M	3	x					
Indigo Bunting	*Passerina cyanea*				G5	S1S2B	5						x
Killdeer	*Charadrius vociferus*				G5	S3S4B	3	x					x
Least Sandpiper	*Calidris minutilla*				G5	S1BS5M	4	x					x
Lesser Yellowlegs	*Tringa flavipes*				G5	S5M	4	x					
Long-eared Owl	*Asio otus*				G5	S2	2						x
Long-tailed Duck	*Clangula hyemalis*				G5	S4N	4	x					
Magnolia Warbler	*Setophaga magnolia*				G5	S5B	4	x				x	
Mallard	*Anas platyrhynchos*				G5	S5	4	x					x
Marsh Wren	*Cistothorus palustris*				G5	S1B	5						x
Mourning Warbler	*Geothlypis philadelphia*				G5	S4B	4	x				x	
Nelson' Sparrow	*Ammodramus nelsoni*				G5	S4B	4	x					x
Northern Goshawk	*Accipiter gentilis*				G5	S3S4	4						
Northern Parula	*Setophaga americana*				G5	S5B	4	x				x	

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Northern Pintail	*Anas acuta*				G5	S2B	2						x
Northern Shoveler	*Anas clypeata*				G5	S2B	2						x
Olive-sided Flycatcher	*Contopus cooperi*	TH	TH	TH	G4	S3B	1	x				x	
Peregrine Falcon	*Falco peregrinus*	SC	SC	VU	G4T4	S1B	3	x	x				x
Philadelphia Vireo	*Vireo philadelphicus*				G5	S2?B	5						x
Pied- billed Grebe	*Podilymbus podiceps*				G5	S3B	3	x					x
Pine Grosbeak	*Pinicola enucleator*				G5	S3?BS5N	2	x				x	
Piping Plover melodus ssp	*Charadrius melodus melodus*	EN	EN	EN	G3TNR	S1B	1	x	x		x		x
Purple Finch	*Haemorhous purpureus*				G5	S4S5	4	x				x	
Purple Martin	*Progne subis*				G5	S1B	2						x
Purple Sandpiper	*Calidris maritima*				G5	S3N	3	x					
Red Knot	*Calidris canutus rufa*	EN	EN	EN	G4T1	S2S3M	1	x					
Ring-billed Gull	*Larus delawarensis*				G5	S1?BS5N	4						x
Ring-Necked Duck	*Aythya collaris*				G5	S5B	4	x					x
Ruffed Grouse	*Bonasa umbellus*				G5	S4S5	4	x				x	
Rusty Blackbird	*Euphagus carolinus*	SC	SC	EN	G4	S2S3B	2	x				x	
Sanderling	*Calidris alba*				G5	S4MS2N	4	x					
Savannah Sparrow	*Passerculus sandwichensis*	SC	SC		G5T2	S1B	4	x	x			x	
Scarlet Tanager	*Piranga olivacea*				G5	S2B	5						x
Semipalmated Plover	*Charadrius semipalmatus*				G5	S1S2BS5M	4						x
Semipalmated Sandpiper	*Calidris pusilla*				G5	S3M	3	x					
Short-eared Owl	*Asio flammeus*	SC	SC		G5	S1S2	2	x					x

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Solitary Sandpiper	*Tringa solitaria*				G5	S1?BS4	4	x				x	
Sora	*Porzana carolina*				G5	S4S5B	4	x					x
Spotted Sandpiper	*Actitis macularius*				G5	S3S4B	3	x				x	
Spruce Grouse	*Falcipennis canadensis*				G5	S5	4	x					x
Surf Scoter	*Melanitta perspicillata*				G5	S5N	4	x					
Tree Swallow	*Tachycineta bicolor*				G5	S4B	3	x				x	
Veery	*Catharus fuscescens*				G5	S4B	4	x				x	
Vesper Sparrow	*Pooecetes gramineus*				G5	S2S3B	2					x	
Virginia Rail	*Rallus limicola*				G5	S2B	5	x					x
Warbling Vireo	*Vireo gilvus*				G5	S1?B	5						x
Whimbrel	*Numenius phaeopus*				G5TNR	S3M	3	x					
Whip-Poor-Will	*Caprimulgus vociferus*	TH	TH	TH	G5	S1?B	1	x					x
White-Throated Sparrow	*Zonotrichia albicollis*				G5	S5B	4	x				x	
Willet	*Tringa semipalmata*				G5	S2S3B	2	x				x	
Wilson's Snipe	*Gallinago delicata*				G5	S3S4B	3	x				x	
Wood Thrush	*Hylocichia mustelina*	TH			G5	S1B	5						x
Reptiles													
Snapping Turtle	*Chelydra serpentina*	SC	SC	VU	G5	S5	4						
Wood Turtle	*Glyptemis insculpta*	TH	TH	TH	G4	S3	3			x			
Mammals													
Little Brown Myotis	*Myotis lucifugus*	EN		EN	G3	S1	3			x			
Moose	*Alces americanus*			EN	G5	S1	1			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Canada Lynx	*Lynx canadensis*			EN	G5	S1	1						
Northern Myotis	*Myotis septentrionalis*	EN		EN	G1G3	S1	3						
Tri-colored Bat	*Perimyotis subflavus*	EN		EN	G3	S1	3						
Lichen													
Beaded Jellyskin Lichen	*Leptogium teretiusculum*				G4G5	S2S3	3			x			
Blue Felt Lichen	*Degelia plumbea*	SC		VU	GNR	S2	4		x				
Vole Ears	*Erioderma mollissimum*	EN	EN	EN	G4G5	S1S2	2		x				
Non-Vascular Plants													
Aloe-Like Rigid Screw Moss	*Aloina rigida*				G3G5	S1	2			x			
Vascular Plants													
American False Pennyroyal	*Hedeoma pulegioides*				G5	S2S3	3			x			
American Waterwort	*Elatine americana*				G4	S1				x			
Bastard's Toadflax	*Comandra umbellata*				G5	S2S3	2			x			
Bearded Sedge	*Carex comosa*				G5	S2S3	3			x			
Bebb's Sedge	*Carex bebbii*				G5	S2	2			x			
Black Ash	*Fraxinus nigra*			TH	G5	S2S3	3			x			
Blood Milkwort	*Polygala sanguinea*				G5	S2S3	3			x			
Blue Cohosh	*Caulophyllum thalictroides*				G4G5	S2	2		x	x			
Blunt-leaved Pondweed	*Potamogeton obtusifolius*				G5	S2S3	3			x			
Bog Willow	*Salix pedicellaris*				G5	S2	3		x	x			
Boreal Aster	*Symphyotrichum boreale*				G5	S2?	3			x			
Broad-Glumed Brome	*Bromus latiglumis*				G5	S1	2			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Buttonbush Dodder	*Cuscuta cephalanthi*				G5	S1	2			x			
Canada Anemone	*Anemone canadensis*				G5	S2	2		x	x			
Canada Lily	*Lilium canadense*				G5	S2S3	3			x			
Canada Tick-trefoil	*Desmodium canadense*				G5	S1	2		x	x			
Chinese Hemlock-parsley	*Conioselinum chinense*				G5	S2	3			x			
Clammy Hedge-Hyssop	*Gratiola neglecta*				G5	S1S2	3			x			
Clustered Sanicle	*Sanicula odorata*				G5	S1	2			x			
Creeping Sedge	*Carex chordorrhiza*				G5	S1	2			x			
Cut-Leaved Coneflower	*Rudbeckia laciniata var. gaspereauensis*				G5TNR	S2	3			x			
Disguised St John's-wort	*Hypericum dissimulatum*				G5	S2S3	3			x			
Drummond's Rockcress	*Arabis drummondii*				G5	S2	3			x			
Dudley's Rush	*Juncus dudleyi*				G5	S2?	3			x			
Dwarf Clearweed	*Pilea pumila*				G5	S1	2			x			
Eastern Baccharis	*Baccharis halimifolia*	TH		TH	G5	S1	2		x	x			
Eastern Lilaeopsis	*Lilaeopsis chinensis*	SC	SC	VU	G5	S2	3		x	x			
Eastern White Cedar	*Thuja occidentalis*			VU	G5	S1S2	1			x			
Estuarine Sedge	*Carex vacillans*				GNR	S1S3	5			x			
Estuary Beggarticks	*Bidens hyperborea*				G4	S1	2			x			
False Mermaidweed	*Floerkea proserpinacoides*				G5	S2	3			x			
Farwell's Water Milfoil	*Myriophyllum farwellii*				G5	S2	3			x			
Fernald's Serviceberry	*Amelanchier fernaldii*				G2G4Q	S2?	5			x			
Flat-stemmed Pondweed	*Potamogeton zosteriformis*				G5	S2S3	3			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Foxtail Sedge	*Carex alopecoidea*				G5	S1	2			x			
Frankton's Saltbush	*Atriplex franktonii*				G2G4	S3S4				x			
Fringed Blue Aster	*Symphyotrichum ciliolatum*				G5	S2S3	3			x			
Golden Alexanders	*Zizia aurea*				G5	S1	2			x			
Greene's Rush	*Juncus greenei*				G5	S1S2	2		x	x			
Halberd-leaved Tearthumb	*Polygonum arifolium*				G5	S2	3			x			
Hayden's Sedge	*Carex haydenii*				G5	S1	2			x			
Heart-leaved Foamflower	*Tiarella cordifolia*				G5	S2	3			x			
Hop Flatsedge	*Cyperus lupulinus ssp. macilentus*				G5T5?	S1	2			x			
Horned Sea-blite	*Suaeda calceoliformis*				G5	S2S3	4			x			
Houghton's Sedge	*Carex houghtoniana*				G5	S2?	3			x			
Inflated Narrow-leaved Sedge	*Carex grisea*				G5?	S1				x			
Kalm's Hawkweed	*Hieracium kalmii*				G5	S2?	5			x			
Large Round-Leaved Orchid	*Platanthera macrophylla*				G5T4	S2	3		x	x			
Large St John's-wort	*Hypericum majus*				G5	S1	2			x			
Least Moonwort	*Botrychium simplex*				G5	S2S3	3			x			
Lesser Brown Sedge	*Carex adusta*				G5	S2S3	3			x			
Lesser Pyrola	*Pyrola minor*				G5	S2	3			x			
Livid Sedge	*Carex livida var. radicaulis*				G5T5	S1	2			x			
Maritime Saltbush	*Atriplex acadiensis*				G4?	S1?				x			
Marsh Grass-of-Parnassus	*Parnassia palustris var. parviflora*				G5T4	S2	2			x			
Moor Rush	*Juncus stygius ssp. americanus*				G5T5	S1S2	3			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Narrow-leaved Evening Primrose	*Oenothera fruticosa ssp. glauca*				G5	S2	5			x			
Narrow-leaved Panic Grass	*Dichanthelium linearifolium*				G5	S2?	3			x			
Northern Adder's-tongue	*Ophioglossum pusillum*				G5	S2S3	3			x			
Northern Bedstraw	*Galium boreale*				G5	S2	2			x			
Northern Bog Violet	*Viola nephrophylla*				G5	S2	3			x			
Orange-fruited Tinker's Weed	*Triosteum aurantiacum*				G5	S2?	3			x			
Ovate Spikerush	*Eleocharis ovata*				G5	S2?	3			x			
Pale Jewelweed	*Impatiens pallida*				G5	S2	3			x			
Pale-Spiked Lobelia	*Lobelia spicata*				G5	S1	2			x			
Parlin's Pussytoes	*Antennaria parlinii*				G5?	S1	2			x			
Pennsylvania Buttercup	*Ranunculus pensylvanicus*				G5	S1	2			x			
Pennsylvania Sedge	*Carex pensylvanica*				G5	S1S2	5			x			
Philadelphia Fleabane	*Erigeron philadelphicus*				G5	S2	3			x			
Porcupine Sedge	*Carex hystericina*				G5	S2	2			x			
Prickly Hornwort	*Ceratophyllum echinatum*				G4?	S2?	2			x			
Pubescent Sedge	*Carex hirtifolia*				G5	S2S3	3			x			
Purple-veined Willowherb	*Epilobium coloratum*				G5	S2?	3			x			
Quebec Hawthorn	*Crataegus submollis*				G5	S1?	5			x			
Ram's-Head Lady's-Slipper	*Cypripedium arietinum*			EN	G3	S1	2		x	x			
Red Ash	*Fraxinus pennsylvanica*				G5	S1	2			x			
Red Pigweed	*Chenopodium rubrum*				G5	S1?	2		x	x			
Robinson's Hawkweed	*Hieracium robinsonii*				G2G3	S2	3		x	x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Robinson's Hawthorn	*Crataegus robinsonii*				G2G4Q	S1?	5			x			
Roland's Sea-Blite	*Suaeda rolandii*				G1G2	S1?	2			x			
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*				G5T5	S1S2	2		x	x			
Rugel's Plantain	*Plantago rugelii*				G5	S2	5			x			
Seaside Brookweed	*Samolus valerandi ssp. parviflorus*				G5T5	S2	3		x	x			
Shining Ladies'-Tresses	*Spiranthes lucida*				G5	S2	2		x	x			
Short-awned Foxtail	*Alopecurus aequalis*				G5	S2S3	3			x			
Showy Lady's-Slipper	*Cypripedium reginae*				G4	S2	2			x			
Slender Cottongrass	*Eriophorum gracile*				G5	S2	3			x			
Slim-stemmed Reed Grass	*Calamagrostis stricta*				G5T5	S1S2	3		x	x			
Smooth Sweet Cicely	*Osmorhiza longistylis*				G5	S2	2			x			
Spreading Wild Rye	*Elymus hystrix var. bigeloviana*				G5T5?	S1	2			x			
Stalked Bulrush	*Scirpus pedicellatus*				G4	S1	5			x			
Sturdy Bulrush	*Schoenoplectus robustus*				G5	S1?	5			x			
Tender Sedge	*Carex tenera*				G5	S1S2	3			x			
Tinged Sedge	*Carex tincta*				G4G5	S1	2			x			
Triangle Moonwort	*Botrychium lanceolatum var. angustisegmentum*				G5TNR?	S2S3	3			x			
Triangular-valve Dock	*Rumex salicifolius var. mexicanus*				G5T5	S2	3			x			
Tubercled Orchid	*Platanthera flava*				G4T4?Q	S2	3		x	x			
Tuckerman's Panic Grass	*Panicum tuckermanii*				G5	S2S3	3			x			
Tuckerman's Sedge	*Carex tuckermanii*				G4	S1	2			x			

Common Name	*Scientific Name*	Conservation Status						Data Source					
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	NSDNR General Status	CWS Priority Bird Species[4]	Habitat Limited Species	ACCDC Occurrence Records	CWS Critical Habitat Mapping	MBBA Relative Abundance	MBBA Breeding Evidence
Vasey's Rush	*Juncus vaseyi*				G5?	S1	2			x			
Virginia Anemone	*Anemone virginiana*				G5	S2	3			x			
White Adder's-Mouth	*Malaxis brachypoda*				G4Q	S1	2			x			
White Sea-blite	*Suaeda maritima ssp. richii*				G5T3	S1	4			x			
White Snakeroot	*Ageratina altissima*				G5	S1	2			x			
Whorled Water Milfoil	*Myriophyllum verticillatum*				G5	S2	3			x			
Wiegand's Wild Rye	*Elymus wiegandii*				G4G5	S1	2			x			
Wild Celery	*Vallisneria americana*				G5	S2	7			x			
Wood Anemone	*Anemone quinquefolia*				G5	S2	3		x	x			
Woolly Beach-heath	*Hudsonia tomentosa*				G5	S1	2			x			
Woolly Panic Grass	*Dichanthelium acuminatum var. lindheimeri*				G5T5	S1?	4			x			
Woolly Sedge	*Carex pellita*				G5	S1	2			x			
Yellow Lady's-slipper	*Cypripedium parviflorum*				G5T5	S2	3		x	x			
Yellow Marsh Marigold	*Caltha palustris*				G5	S2	3			x			
Yellow Spikerush	*Eleocharis olivacea*				G5	S2S3	3			x			

Appendix D. Priority species—Habitat Associations

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Invertebrates																
Acadian Hairstreak	*Satyrium acadica*								x	x			x	x	9, 19	palustrine, old field, mixed woodland
Bronze Copper	*Lycaena hyllus*		x					x	x						9, 19	coastal and freshwater wetlands, terrestrial
Brook Floater	*Alasmidonta varicosa*					x	x								9	freshwater slow moving riverine habitats
Brook Snaketail	*Ophiogomphus aspersus*				x	x									9	clear water streams
Common Roadside Skipper	*Amblyscirtes vialis*						x					x	x		9	forest and roadside edges, streamsides
Creeper	*Strophitus undulatus*					x									9	freshwater,lacustrine, riverine
Delicate Emerald	*Somatochlora franklini*								x						9	bogs and fens and seepages
Eastern Lampmussel	*Lampsilis radiata*					x									9	low gradient shallow riverine habitats
Ebony Boghaunter	*Williamsonia fletcheri*								x						9	palustrine bogs and fens
Harpoon Clubtail	*Gomphus descriptus*					x							x		18	clear cold running streams, mixed forest
Hoary Comma	*Polygonia gracilis*				x						x		x		9,19	riparian, boreal and mixed forest
Jutta Arctic	*Oeneis jutta*								x		x				9	black spruce bogs, conifers
Juvenal's Duskywing	*Erynnis juvenalis*											x			9, 19	hardwood forests especially oak
Kennedy's Emerald	*Somatochlora kennedyi*							x	x						?	sedge meadows
Macropis Cuckoo Bee	*Epeoloides pilosulus*												x	x	20	host and plant specific; sandy sunny slopes
Maine Snaketail	*Ophiogomphus mainensis*					x									9	clear flowing streams
Maritime Copper (Salt Marsh Copper)	*Lycaena dospassosi*		x												19	herbaceous estuarine habitats

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Milbert's Tortoiseshell	*Aglais milberti*												x	x	19	mixed forest and roadside edges, old field
Monarch	*Danaus plexippus*												x	x	9, 19	wide range of terrestrial habitats
Mustard White	*Pieris oleracea*								x	x		x	x		9,19	bog and fens, mixed woodlands, moist hardwoods
Northern Cloudywing	*Thorybes pylades*				x					x				x	9	forested wetlands, old fields
Prince Baskettail	*Epitheca princeps*					x	x								20	lakes, ponds, slow moving streams
Taiga Bluet	*Coenagrion resolutum*							x	x						20	ponds, marshes and sphagnum pools
Tidewater Mucket	*Leptodea ochracea*					x									9	low gradient shallow riverine habitats
Triangle Floater	*Alasmidonta undulata*														9	low gradient shallow riverine habitats
Williamson's Emerald	*Somatochlora williamsoni*					x	x		x						21	slow moving streams, ponds and lakes
Fish																
American Eel	*Anguilla Rostrata*			x		x	x								15	catadromous
Atlantic Salmon	*Salmo salar*					x									5	anandromous
Striped Bass	*Morone saxatilis*			x		x									6	tidal rivers and estuaries
Birds																
American Bittern	*Botaurus lentiginosus*							x		x				x	1,2	wetlands
American Black Duck	*Anas rubripes*		x	x	x	x	x	x		x					2,9	coastal and freshwater wetlands and ponds
American Coot	*Fulica americana*							x							2	Freshwater marshes
American Golden Plover	*Pluvialis dominica*	x		x											1,9	beaches, tidal flats
American Red Start	*Setophaga ruticilla*											x	x		2,9	mixed young forests
American Three-toed	*Picoides dorsalis*									x	x				2,9	conifers and treed swamps

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Woodpecker																
American Woodcock	*Scolopax minor*									x		x	x		2,9	alder swamps; young deciduous forests
Bald Eagle	*Haliaeetus leucocephalus*			x	x	x	x								2,9	rivers and coastal habitats
Baltimore Oriole	*Icterus galbula*				x							x			2	Deciduous and urban forests
Bank Swallow	*Riparia riparia*	x					x								1	eroding shorelines and cliffs with sandy soil
Barn Swallow	*Hirundo rustica*				x		x							x	1,2	open areas near water
Barrow's Goldeneye - Eastern pop.	*Bucephala islandica (Eastern pop.)*			x											7	tidal rivers and bays
Bay-breasted Warbler	*Setophaga castanea*										x	x	x			old mixed wood forest
Belted Kingfisher	*Megaceryle alcyon*		x	x	x	x	x	x							2,9	coastal and freshwater wetlands and ponds
Bicknell's Thrush	*Catharus bicknelli*										x				8	high elevation coniferous forest
Black and White Warbler	*Mniotilta varia*												x		1	young moist forest
Blackburnian Warbler	*Setophaga fusca*										x	x	x		1,9	old mixed wood forest
Black Tern	*Chlidonias niger*							x							2	Freshwater marshes
Black-bellied Plover	*Pluvialis squatarola*	x	x	x										x	9	coastal wetlands, pastures
Black-billed Cuckoo	*Coccyzus erythropthalmus*											x			2	deciduous forests
Black-crowned Night-heron	*Nycticorax nycticorax*		x					x							2	Freshwater marshes
Black Scoter	*Melanitta americana*			x		x		x							9	coastal habitats during migration, occasionally in freshwater
Black-Throated Green	*Dendroica virens*												x		2,9	more mature mixed forests

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Warbler																
Blue Headed Verio	*Vireo solitarius*												x		2,9	mixed forest edges
Bobolink	*Dolichonyx ory*													x	2	Cropland/hedgerow, Grassland/herbaceous
Bonapart's Gull	*Chroicocephalus philadelphia*	x	x	x											9	coastal areas during migration
Boreal Chickadee	*Poecile hudsonica*										x				2	conifer dominated forests
Boreal Owl	*Aegolius funereus*										x		x		10,2	dense mixed forest
Brown Thrasher	*Toxostoma rufum*														2	dense shrub and mixed forest edges
Brown-headed Cowbird	*Molothrus ater*												x	x	2	pastures and fields
Canada Goose	*Branta canadensis*		x	x		x	x	x						x	2,9	coastal and freshwater wetlands and ponds
Canada Warbler	*Wilsonia canadensis*												x		2	mixed species forests with understory
Cape May Warbler	*Dendroica tigrina*										x		x		2	mature forests preferred
Chimney Swift	*Chaetura pelagica*												x		2	mature pine and poplar
Common Eider	*Somateria mollissima*														2,9	open ocean and coastal islands
Common Loon	*Gavia immer*			x		x	x								9, 11	lakes for breeding, coast for winter
Common Goldeneye	*Bucephala clangula*			x											2	tidal rivers
Common Moorhen	*Gallinula chloropus*							x							2	Freshwater marshes
Common Nighthawk	*Chordeiles minor*										x		x	x	2	pine barrens, clear cuts, burned over areas
Common Tern	*Sterna hirundo*	x	x	x											9	coastal habitats
Dunlin	*Calidris alpina*	x		x	x		x	x							9	coastal and freshwater wetlands and shorelines
Dovekie	*Alle alle*														2	Pelagic or near shore habitat, talus slopes

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Eastern Kingbird	*Tyrannus tyrannus*									x	x		x		2,9,11	shrub forests near water
Eastern Wood-Pewee	*Contopus virens*											x	x		2, 9	mature open forests
Evening Grosbeak	*Coccothraustes vespertinus*										x		x		2,9	southern boreal forests
Gadwall	*Anas strepera*							x							2	freshwater marshes
Gray Catbird	*Dumetella carolinensis*												x		2,9	dense undergrowth and second growth forests, hedge rows
Gray Jay	*Perisoreus canadensis*										x		x		2,9	conifer and mixed conifer forests
Great Cormorant	*Phalacrocorax carbo*			x		x									2,9	coastal rivers and estuaries
Great Crested Flycatcher	*Myiarchus crinitus*											x			2	mature deciduous forest
Green-winged Teal	*Anas crecca*		x	x	x	x	x	x							2,9	coastal and freshwater wetlands and ponds
Hudsonian Godwit	*Limosa haemastica*		x	x	x			x							9	coastal and freshwater habitats
Indigo Bunting	*Passerina cyanea*												x		2	mixed forest edges
Killdeer	*Charadrius vociferus*	x						x						x	2,9	breeds on land with cobble stone
Least Bittern	*Ixobrychus exilis*							x							2,9	dense cattail marshes
Least Sandpiper	*Calidris minutilla*	x	x	x			x	x	x						2	coastal and freshwater wetlands
Lesser Yellowlegs	*Tringa flavipes*			x		x	x	x							9	coastal wetlands, non-breeding freshwater marshes and mudflats
Long-eared Owl	*Asio otus*												x		2	mixed forests
Long-tailed Duck	*Clangula hyemalis*			x		x									9	marine habitats: bays, estuaries and tidal rivers
Magnolia Warbler	*Setophaga magnolia*										x		x		2,9	eastern boreal forest
Mallard	*Anas platyrhynchos*				x	x	x	x							2,9	freshwater marshes and beaver ponds

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Marsh Wren	*Cistothorus palustris*							x							2	freswater marshes
Mourning Warbler	*Geothlypis philadelphia*						x			x		x			2,9	early second growth forests, wetland edges
Nelson' Sparrow	*Ammodramus nelsoni*		x											x	2,9	saltmarsh and grasslands
Northern Goshawk	*Accipiter gentilis*											x	x		2,9	more abundant in larger forest tracts
Northern Parula	*Setophaga americana*				x					x		x	x		2,9	mature deciduous and floodplain forests, mixed mature forests, forested wetlands
Northern Pintail	*Anas acuta*							x							2	freshwater marshes
Northern Shoveler	*Anas clypeata*							x							2	Freshwater marshes
Olive-sided Flycatcher	*Contopus cooperi*											x	x		2	cut over forest edges, open areas in forests
Peregrine Falcon	*Falco peregrinus*	x	x	x	x	x	x							x	2,9	coastal, freshwater wetlans, open areas
Philadelphia Vireo	*Vireo philadelphicus*											x	x		2	broadleaf and mixed forest
Pied- billed Grebe	*Podilymbus podiceps*							x							2,9	freshwater marshes
Pine Grosbeak	*Pinicola enucleator*										x		x		2,9	breeding habitat is mature boreal forests; winters in mixed woodlands
Piping Plover melodus ssp	*Charadrius melodus melodus*	x													12,13	beaches and cobble dunes
Purple Finch	*Haemorhous purpureus*												x		2,9	open mixed woodlands and edges
Purple Martin	*Progne subis*				x		x	x						x	2	open areas near water
Purple Sandpiper	*Calidris maritima*	x		x											9	coastal areas and rocky shorelines
Red Knot	*Calidris canutus rufa*	x	x	x											9, 11	coastal habitats
Ring-billed Gull	*Larus delawarensis*	x		x		x								x	9	coastal, freshwater and urban areas
Ring-Necked Duck	*Aythya collaris*					x	x	x							2,9	freshwater marshes and beaver ponds
Ruffed Grouse	*Bonasa umbellus*											x	x		2,9	mixed forest and edges

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Rusty Black Bird	*Euphagus carolinus*				x		x		x	x		x		x	2	Bog/fen shrubland, riparian shrub wetland, conifer, grasslands, headgerows
Sanderling	*Calidris alba*	x		x		x									9	tidal wetlands
Savannah Sparrow	*Passerculus sandwichensis*	x	x					x	x					x	2,9	herbaceous areas, emergent wetalnds, salt marshes and dunes
Short-eared Owl	*Asio flammeus*								x					x	2	wetland, grassland
Scarlet Tanager	*Piranga olivacea*											x			2	broadleaf forest
Semipalmated Plover	*Charadrius semipalmatus*	x		x											9	coastal areas
Semipalmated Sandpiper	*Calidris pusilla*	x		x											9	mainly found on coastal habitats
Solitary Sandpiper	*Tringa solitaria*	x	x						x	x					2	forested wetlands and coastal areas
Sora	*Porzana carolina*							x							2,9	freshwater marshes
Spotted Sandpiper	*Actitis macularius*	x				x	x								2,9	freshwater habitats and some coastal areas
Spruce Grouse	*Falcipennis canadensis*									x	x				2,9	conifer forests and forested swams
Tree Swallow	*Tachycineta bicolor*				x	x	x	x						x	2,9	open areas near wetlands
Veery	*Catharus fuscescens*				x							x			2,9	deciduous dominated forests
Vesper Sparrow	*Pooecetes gramineus*													x	2, 9	fields and low shrub areas
Virginia Rail	*Rallus limicola*							x							2	Freshwater marshes
Warbling Vireo	*Vireo gilvus*											x			2	broadleaf forest
Whimbrel	*Numenius phaeopus*	x	x	x	x				x					x	2,9	coastal and freshwater habitats; fields and pastures
Whip-Poor-Will	*Caprimulgus vociferus*											x			2	broadleaf forest
White-Throated	*Zonotrichia albicollis*										x		x		2,9	conifer dominated mixed disturbed forests

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest					
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood	Grasslands/agro-ecosystems	Data Source	Habitat Notes
Sparrow																
Willet	*Tringa semipalmata*	x	x	x											2	coastal areas
Wilson's Snipe	*Gallinago delicata*				x	x	x	x							2,9	freshwater wetlands with emergent cover
Wood Thrush	*Hylocichia mustelina*				x					x		x	x		2	Forested wetland, hardwood, mixed forest
Reptiles																
Snapping Turtle	*Chelydra serpentina*				x	x	x	x	x	x					9	freshwater habitats
Wood Turtle	*Glyptemis insculpta*				x	x			x	x				x	4	permenant rivers and streams & open grasslands
Mammals																
Little Brown Myotis	*Myotis lucifugus*					x	x	x	x	x	x	x	x	x	9	forested, open and urban habitats
Moose	*Alces americanus*					x	x	x	x	x	x	x	x		16	forested and freshwater wetland habitats
Canada Lynx	*Lynx canadensis*										x				17	old conifer forests
Northern Myotis	*Myotis septentrionalis*										x	x	x		9	terrestrial forested
Tri-colored Bat	*Perimyotis subflavus*							x					x		9	large trees on forest and wetland edges
Lichen																
Beaded Jellyskin Lichen	*Leptogium teretiusculum*															
Blue Felt Lichen	*Degelia plumbea*											x			23	mature hardwood
Vole Ears	*Erioderma mollissimum*										x				22	moist conifer forest
Non-Vascular Plants																
Aloe-Like Rigid Screw Moss	*Aloina rigida*												x		9	dry, calcareous soils
Vascular Plants																

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
American False Pennyroyal	*Hedeoma pulegioides*													x	9	stony soil and pastures
American Waterwort	*Elatine americana*				x		x								9	shorelines of lakes and ditches
Bastard's Toadflax	*Comandra umbellata*	x									x				25	damp sandy soil, dune headlands
Bearded Sedge	*Carex comosa*								x	x					25	bogs, wooded swamp
Bebb's Sedge	*Carex bebbii*							x							25	marshy pasture and hillside seeps, gypsum quarries
Black Ash	*Fraxinus nigra*									x					25	poorly drained wooded swamps
Blood Milkwort	*Polygala sanguinea*												x	x	25	acid fields, open woods
Blue Cohosh	*Caulophyllum thalictroides*				x							x			25	associated with sugar maples on or near intervales
Blunt-leaved Pondweed	*Potamogeton obtusifolius*					x	x								25	muck edges of ponds, lakes and slow streams
Bog Willow	*Salix pedicellaris*									x					25	swampy thickets, heavy soils, poorly drained areas
Boreal Aster	*Symphyotrichum boreale*					x			x						25	along brooks and bog edges
Broad-Glumed Brome	*Bromus latiglumis*												x		26	moist woodland
Buttonbush Dodder	*Cuscuta cephalanthi*					x		x							27	stream sides and meadows, with host plants
Canada Anemone	*Anemone canadensis*						x								25	wet meadow at edge of shorline
Canada Lily	*Lilium canadense*									x			x		9	swamps, mosit wood edges, acid soils
Canada Tick-trefoil	*Desmodium canadense*												x		28	wood edges
Chinese Hemlock-parsley	*Conioselinum chinense*									x	x				25	swamps, moist coniferous woods, seeps

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Clammy Hedge-Hyssop	*Gratiola neglecta*				x										26	floodplain forests, woodland seeps
Clustered Sanicle	*Sanicula odorata*				x							x			29	rich hardwood forests both riparian and upland
Creeping Sedge	*Carex chordorrhiza*								x						9	bog and fen habitats
Cut-Leaved Coneflower	*Rudbeckia laciniata var. gaspereauensis*				x					x					25	swamps, swales and gulleys
Disguised St John's-wort	*Hypericum dissimulatum*					x	x			x					25	swamps, lake beaches
Drummond's Rockcress	*Arabis drummondii*									x				x	25	steep slopes and richer lower slopes
Dudley's Rush	*Juncus dudleyi*							x							25	swale
Dwarf Clearweed	*Pilea pumila*					x	x								29	anthropogenic disturbed habitats, riparian
Eastern Baccharis	*Baccharis halimifolia*		x					x							29	brackish or salt marshes and flats, coastal beaches (sea beaches), marshes
Eastern Lilaeopsis	*Lilaeopsis chinensis*			x											25	tidal rivers and estuaries
Eastern White Cedar	*Thuja occidentalis*									x			x		25	swamps and wetland edges as well as open upland
Estuarine Sedge	*Carex vacillans*		x	x	x		x								29	salt marsh, intertidal, lake edges
Estuary Beggarticks	*Bidens hyperborea*			x											25	tidal mud flats
False Mermaidweed	*Floerkea proserpinacoides*				x	x	x						x		29	floodplains, shores of rivers, lakes and streams
Farwell's Water Milfoil	*Myriophyllum farwellii*					x	x								29	found in rivers and lakes
Fernald's Serviceberry	*Amelanchier fernaldii*												x	x	25	barrens, open areas, calcareous soils
Flat-stemmed Pondweed	*Potamogeton zosteriformis*					x	x								29	lacustrine, in rivers, lakes and ponds

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Foxtail Sedge	*Carex alopecoidea*				x	x									29	disturbed areas, floodplains of rivers and streams
Frankton's Saltbush	*Atriplex franktonii*	x													25	salt water beaches and shorelines
Fringed Blue Aster	*Symphyotrichum ciliolatum*												x	x	29	disturbed areas forest edges, meadows and fields
Golden Alexanders	*Zizia aurea*				x		x							x	29	disturbed areas, riparian, forest edges, open areas
Greene's Rush	*Juncus greenei*													x	29	disturbed areas, cliffs, ledges, meadows and fields
Halberd-leaved Tearthumb	*Polygonum arifolium*					x	x	x							29	disturbed areas, lacustrine, marshes shorelines
Hayden's Sedge	*Carex haydenii*				x		x	x						x	29	marshes, shorelines of lakes and rivers, meadows
Heart-leaved Foamflower	*Tiarella cordifolia*				x					x			x		29	forests, swamps, wetland edges
Hop Flatsedge	*Cyperus lupulinus ssp. macilentus*													x	29	disturbed areas, open areas and fields
Horned Sea-blite	*Suaeda calceoliformis*	x	x												29	salt marsh and coastal beaches
Houghton's Sedge	*Carex houghtoniana*												x	x	29	terrestrial, forest, meadows, fields, ledges
Inflated Narrow-leaved Sedge	*Carex grisea*				x								x		29	river and stream floodplain
Kalm's Hawkweed	*Hieracium kalmii*				x		x						x	x	29	terrestrial, wetland
Large Round-Leaved Orchid	*Platanthera macrophylla*				x		x			x			x		29	forest, swamps
Large St John's-wort	*Hypericum majus*													x	29	edges of meadows, fields, lakes and rivers
Least Moonwort	*Botrychium simplex*				x	x	x							x	29	dixturbed areas, meadows, edges of rivers and

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
																lakes
Lesser Brown Sedge	*Carex adusta*												x		29	terrestrial, disturbed areas, woodlands
Lesser Pyrola	*Pyrola minor*									x	x				29	alpine, sub alpine, forest, swamps
Livid Sedge	*Carex livida var. radicaulis*								x						29	calcareous fens
Maritime Saltbush	*Atriplex acadiensis*	x	x	x											29	brackish or salt marshes and flats, beaches
Marsh Grass-of-Parnassus	*Parnassia palustris var. parviflora*	x	x												25	damp grassy hollows in sand dunes, coastal marshes
Moor Rush	*Juncus stygius ssp. americanus*							x	x						29	calcareous rich wetlands
Narrow-leaved Evening Primrose	*Oenothera fruticosa ssp. glauca*													x	29	terrestrial, slopes, fields
Narrow-leaved Panic Grass	*Dichanthelium linearifolium*												x	x	29	terrestrial, slopes, fields, woodland
Northern Adder's-tongue	*Ophioglossum pusillum*				x									x	29	disturbed areas, fields, wetland margins
Northern Bedstraw	*Galium boreale*								x				x		29	Fens (calcium-rich wetlands), meadows and fields, woodlands
Northern Bog Violet	*Viola nephrophylla*						x		x				x	x	29	Fens (calcium-rich wetlands), meadows and fields, shores of rivers or lakes
Orange-fruited Tinker's Weed	*Triosteum aurantiacum*											x	x		29	Forest edges, forests, woodlands
Ovate Spikerush	*Eleocharis ovata*				x	x	x								29	Floodplain, meadows and fields, shores of rivers or lakes
Pale Jewelweed	*Impatiens pallida*				x	x	x						x		29	Forests, shores of rivers or lakes

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Pale-Spiked Lobelia	*Lobelia spicata*													x	29	terrestrial, disturbed areas, meadows and fields
Parlin's Pussytoes	*Antennaria parlinii*												x	x	29	cliffs, balds, or ledges, meadows and fields, woodlands
Pennsylvania Buttercup	*Ranunculus pensylvanicus*				x	x	x	x		x					29	disturbed habitats, marshes, shores of rivers or lakes, swamps
Pennsylvania Sedge	*Carex pensylvanica*											x	x	x	29	terrestrial, forests, grassland, woodlands
Philadelphia Fleabane	*Erigeron philadelphicus*				x	x	x							x	29	meadows and fields, ridges or ledges, shores of rivers or lakes
Porcupine Sedge	*Carex hystericina*				x	x	x	x						x	29	fens (calcium-rich), meadows and fields, shores of rivers or lakes, swamps
Prickly Hornwort	*Ceratophyllum echinatum*					x	x								29	Lacustrine (in lakes or ponds), riverine (in rivers or streams)
Pubescent Sedge	*Carex hirtifolia*				x		x	x		x		x	x		29	Floodplain (river or stream floodplains), forests
Purple-veined Willowherb	*Epilobium coloratum*														29	marshes, shores of rivers or lakes, swamps, wetland margins
Quebec Hawthorn	*Crataegus submollis*												x	x	29	terrestrial, disturbed areas, forest edges, meadows and fields, shrublands or thickets
Ram's-Head Lady's-Slipper	*Cypripedium arietinum*									x		x			29	Forests, swamps
Red Ash	*Fraxinus pennsylvanica*				x		x					x			29	Floodplain (river or stream floodplains), forests, shores of rivers or lakes, swamps
Red Pigweed	*Chenopodium rubrum*	x	x												25	salt marshes, saline soils
Robinson's Hawkweed	*Hieracium robinsonii*				x		x								29	Shores of rivers or lakes
Robinson's Hawthorn	*Crataegus robinsonii*												x	x	29	terrestrial, meadows fields and woodlands

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Roland's Sea-Blite	*Suaeda rolandii*		x	x											30	salt marshes and tidal flats
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*											x			9	Moist, rich woods, esp. acidic soils
Rugel's Plantain	*Plantago rugelii*													x	29	terrestrial, disturbed areas, grassland, meadows and fields
Seaside Brookweed	*Samolus valerandi ssp. parviflorus*		x	x	x	x									29	wetlands, salt marshes and flats, fresh tidal marshes or flats, riverine, swamps
Shining Ladies'-Tresses	*Spiranthes lucida*					x	x							x	29	disturbed areas, meadows and fields, riverine , shores of rivers or lakes
Short-awned Foxtail	*Alopecurus aequalis*					x	x								29	aquatic, freshwater wetlands, disturbed areas
Showy Lady's-Slipper	*Cypripedium reginae*				x				x	x					29	Fens (calcium-rich wetlands), swamps, wetland margins (edges of wetlands)
Slender Cottongrass	*Eriophorum gracile*							x	x						29	Bogs, fens (calcium-rich wetlands), meadows and fields
Slim-stemmed Reed Grass	*Calamagrostis stricta*				x	x	x						x		29	aquatic, terrestrial, wetlands
Smooth Sweet Cicely	*Osmorhiza longistylis*											x			29,25	hardwood forests, intervales
Spreading Wild Rye	*Elymus hystrix var. bigeloviana*											x	x		29	forests, ridges or ledges, woodlands
Stalked Bulrush	*Scirpus pedicellatus*						x	x						x	29	Marshes, meadows and fields, shores of rivers or lakes, wetland margins
Sturdy Bulrush	*Schoenoplectus robustus*		x		x		x								29	Brackish or salt marshes and flats, fresh tidal marshes or flats, shores of rivers or lakes, swamps
Tender Sedge	*Carex tenera*												x	x	29	terrestrial, forests, meadows and fields
Tinged Sedge	*Carex tincta*												x	x	29	terrestrial, forests, meadows and fields

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Triangle Moonwort	*Botrychium lanceolatum var. Angusti-segmentum*								x	x			x	x	29	Bogs, fens (calcium-rich wetlands), forests, meadows and fields, swamps, wetland margins
Triangular-valve Dock	*Rumex salicifolius var. mexicanus*													x	29	terrestrial, disturbed areas, meadows & fields
Tubercled Orchid	*Platanthera flava*				x	x		x					x	x	29	terrestrial, wetlands
Tuckerman's Panic Grass	*Panicum tuckermanii*					x	x							x	29	lacustrine, meadows and fields, riverine, shores of rivers or lakes
Tuckerman's Sedge	*Carex tuckermanii*				x	x	x								29	Floodplain, shores of rivers or lakes, swamps
Vasey's Rush	*Juncus vaseyi*				x		x							x	29	floodplain, meadows and fields, shores of rivers or lakes, disturbed areas
Virginia Anemone	*Anemone virginiana*				x		x						x		29	cliffs, floodplain, forest edges, forests, ridges or ledges, shores of rivers or lakes, woodlands
White Adder's-Mouth	*Malaxis brachypoda*								x	x					29	Fens (calcium-rich wetlands), ridges or ledges, swamps
White Sea-blite	*Suaeda maritima ssp. richii*	x	x												29	Brackish or salt marshes and flats, coastal beaches
White Snakeroot	*Ageratina altissima*											x	x		29	Forests
Whorled Water Milfoil	*Myriophyllum verticillatum*					x	x								29	lacustrine, riverine
Wiegand's Wild Rye	*Elymus wiegandii*				x							x	x		29	floodplain, forest
Wild Celery	*Vallisneria americana*					x	x								29	lacustrine, riverine
Wood Anemone	*Anemone quinquefolia*				x		x						x	x	29	Floodplain, forest edges, forests, meadows and fields, shores of rivers or lakes
Woolly Beach-heath	*Hudsonia tomentosa*	x													29	Dunes, grassland, shores of rivers or lakes

Common Name	*Scientific Name*	Coastal			Riparian			Freshwater Wetlands			Acadian Forest			Grasslands/agro-ecosystems	Data Source	Habitat Notes
		Beaches & Dunes	Salt Marshes	Tidal Flats	Floodplains	Aquatic	Banks & Shorelines	Marshes	Bogs & Fens	Shrub & Treed Swamps	Conifer	Deciduous	Mixed Wood			
Woolly Panic Grass	*Dichanthelium acuminatum var. lindheimeri*					x	x						x	x	29	terrestrial and wetlands
Woolly Sedge	*Carex pellita*						x	x						x	29	disturbed habitats, marshes, meadows and fields, shores of rivers or lakes
Yellow Lady's-slipper	*Cypripedium parviflorum*				x				x				x		29	fens (calcium-rich wetlands), forests, riverine, shores of rivers or lakes, swamps, wetland margins, woodlands
Yellow Marsh Marigold	*Caltha palustris*				x	x	x								29	Floodplain, forests, riverine, shores of rivers or lakes, swamps, wetland margins
Yellow Spikerush	*Eleocharis olivacea*		x		x	x	x		x						29	Bogs, brackish or salt marshes and flats, floodplain, marshes, shores of rivers or lakes

Data Sources

1. Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 14 and Marine Biogeographic Units 11 and 12 in Nova Scotia: Atlantic Northern Forest, Scotian Shelf and Bay of Fundy, and Gulf of St. Lawrence. Canadian Wildlife Service, Environment Canada, Sackville, New Brunswick.
2. Erskine, A. J. 1992. *Atlas of Breeding Birds of the Maritime Provinces.* Nimbus Publishing Ltd., the Nova Scotia Museum, and the Nova Scotia Department of Natural Resources, Halifax.
3. Bird Studies Canada, Environment Canada, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, Prince Edward Island Department of Agriculture and Forestry. 2012. Maritimes Breeding Bird Atlas Database. Data accessed from the Maritimes Breeding Bird Atlas website and/or Nature Counts, a node of the Avian Knowledge Network, Bird Studies Canada. http://www.naturecounts.ca/.
4. COSEWIC. 2007. COSEWIC assessment and update status report on the Wood Turtle *Glyptemys insculpta* in Canada, Committee on the Status of Endangered Wildlife in Canada, Ottawa.

5. COSEWIC. 2010. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.
6. COSEWIC. 2012. Striped Bass (*Morone saxatilis*) Southern Gulf of St. Lawrence population status change, November 2012. http://www.COSEWIC.gc.ca.
7. COSEWIC, 2011. Status Appraisal Summary on the Barrow's Goldeneye (*Bucephala islandica*), Eastern Population in Canada.
8. COSEWIC. 2009. COSEWIC assessment and status report on the Bicknell's Thrush *Catharus bicknelli* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.
9. NatureServe. 2013. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer. (Accessed: November 28, 29, December 3,4, 2013).
10. Lauff R.F. 2009. First nest records of the Boreal Owl *Aegolius funereus* in Nova Scotia, Canada. In: Johnson D.H., Van Nieuwenhuyse D. & Duncan J.R. (eds) Proc. Fourth World Owl Conf. Oct–Nov 2007, Groningen, The Netherlands. Ardea 97(4): 497–502.
11. Tufts, R. W. 1962, 1963. *The Birds of Nova Scotia*. The Nova Scotia Museum.
12. Environment Canada. 2012. Recovery Strategy for the Piping Plover (*Charadrius melodus melodus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa.
13. Bird Studies Canada, Important Bird Area site NS 009 summary; Pomquet Beach Region, Antigonish Nova Scotia. http://www.bsc-eoc.org/iba/site.jsp?siteID=NS009.
14. COSEWIC. 2010. COSEWIC assessment status report on Bobolink *Dolichonyx oryzivoras* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.
15. Nova Scotia Department of Fisheries and Aquaculture Species Fact sheet. http://www/novascotia.ca/fish/sportfishing/species/eel.shtml.
16. Parker, G. 2003. Status Report on the Eastern Moose (*Alces alces Americana* Clinton) in Mainland Nova Scotia. Nova Scotia Department of Natural Resources, Nova Scotia.
17. Parker, G. 2001. Status Report on the Canada Lynx in Nova Scotia, Loup curvier *Lynx canadensis* (Kerr 1792, submitted to the Nova Scotia Species at Risk Working Group).
18. Massachusetts Division of Fisheries and Wildlife Natural Heritage Endangered Species Program. http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/gomphus-descriptus.pdf.
19. Maritimes Butterfly Atlas http://www.accdc.com/butterflyatlas/Checklist.html.
20. http://bugguide.net/node/view/4057.
21. Wisconsin odonata survey http://wiatri.net/inventory/odonata/SpeciesAccounts/SpeciesDetail.cfm?TaxaID=73.
22. COSEWIC. 2009. COSEWIC Assessment and Status Report on the Vole Ears *Erioderma mollissimum* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

23. COSEWIC. 2010. COSEWIC assessment and status report on the Blue Felt Lichen *Degalia plumbea* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa.
24. Hinds, H.R. 2000. Flora of New Brunswick, 2nd Ed. University of New Brunswick.
25. Roland, A.E., Smith, E.C. 1969. The Flora of Nova Scotia, The Nova Scotia Museum.
26. Montana Field Guide http://fieldguide.mt.gov/detail_PMPOA151M0.aspx.
27. New York Heritage Program http://www.acris.nynhp.org/guide.php?id=8991&part=2.
28. Peterson, R. T. 1986. Peterson First Guides. Wildflowers.
29. New England Wildflower Society. Go Botany https://gobotany.newenglandwild.org.
30. Flora of North America http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242415629.

Appendix E. 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 Nova Scotia Northumberland Strait bioregion:

1) Beaches and dunes
2) Salt marshes
3) Tidal flats
4) Acadian Forest mosaic
5) Riparian and floodplain systems
6) Freshwater wetlands
7) Grasslands/agro-ecosystems

Priority habitat data

Data pre-processing
All habitat priorities except grasslands were directly included in the prioritization analysis. Due to the lack of spatial data separating agriculture types in NS, it was agreed that grasslands could not be accurately prioritized. 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 Wetlands Inventory (WTY1 = B and D)
- **Tidal marsh** - Tidal marsh were selected from the 2011 Nova Scotia wetlands inventory (WETLAND = Tidal marsh. A 275 metre buffer was applied to all of the polygons (Environment Canada, 1998)
- **Freshwater wetlands** – Three types of freshwater wetlands were selected as habitat targets with the bioregion. They were selected from the 2011 Nova Scotia wetlands inventory and included: Peatlands (Bogs or Fens), Marsh, and Swamp. 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).
- **Riparian areas** - Riparian Areas were derived by combining the NAAP critical floodplains layer with the Nova Scotia Ecological Landscape Classification (ELC) Ecosites identifies as Smooth (SM) with Fluvial Deposits. 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.
- **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

Softwood forests were grouped based on species composition into 3 categories: Spruce/Fir, Spruce/Pine Hemlock Mix and Pine. From all of these community types, only Development Class Mature or Multi Aged and a Seral Class of 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.

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 priority habitat, 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 coastal islands, barrens, and riparian areas (see below), were scored using a three-tiered equation that equally divides the score by habitat uniqueness, representivity, and size:

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

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:

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

Habitat types that are not nested (i.e., tidal marsh, tidal flats, beaches and dunes) 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 16 below for a summary of the minimum size criteria used within the analysis.

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

Table 16. Minimum size criteria for each habitat type within the NS Northumberland Strait bioregion.

Habitat Conservation Priority	Minimum Size (Ha)
Beaches and Dunes	8.1
Tidal marsh	16.1[1]
Tidal Flats	40.5
Freshwater Wetlands	20.2
Acadian Forest Mosaic[2]	
Late Successional (LS) Hardwood	40
LS Mixedwood	60
LS Spruce/Fir	50
LS Pine	15
LS Spruce/Pine/Hemlock Mix[3]	50

- **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.

Additional 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 1998) 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

[1] NAAP size is 24 ha. Tidal marsh in this bioregion are naturally smaller and so min size was reduced.

[2] For forest communities, patch sizes were adapted from the NB Provincial Old Forest Community and Wildlife Definitions 2005. In all cases (except Spruce/Fir at 375 Ha), the largest patch size for each community was used to capture all species that were identified for each community type. Because of 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).*

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.

If a Forest Mosaic polygon contained any of the layers listed above, the scores from these layers were 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 SWNS bioregion can be found in Figure 25.

Appendix F. 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 composites 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 17. 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 17. Data layers, sources, and types used to describe priority species spatial distribution within the Nova Scotia Northumberland Strait 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 18). 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 39). 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 18. 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)).

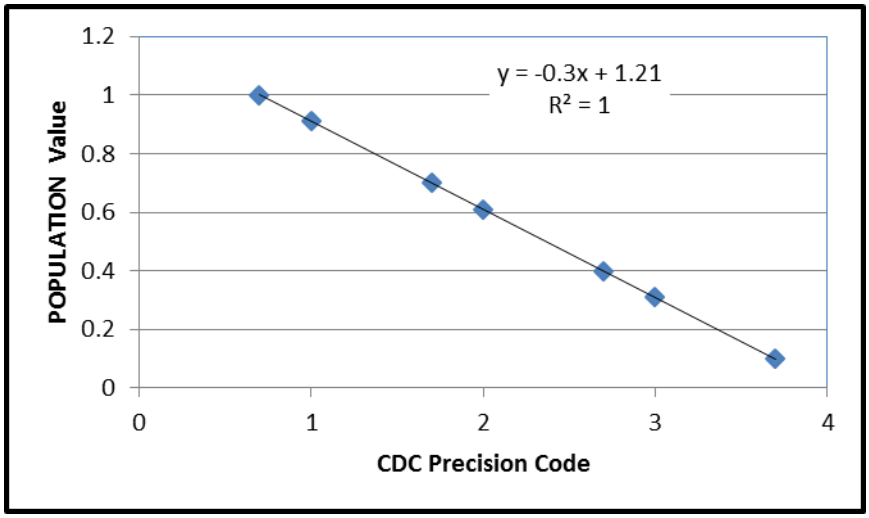


Figure 39. Population values derived for the purpose of informing the kernel density point process using precision code values found within the ACCDC dataset (linear equation can be used to populate a new attribute field with POPULATION value information).

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 39). 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 13 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 G. Conservation value index methodology

The scores generated through development of the priority habitat composite (see Appendix F) and the priority species composite using the full list of priority species (see Appendix G) were combined to yield a conservation value index for the Southwest Nova Scotia bioregion, presented in Figure 38, pg. 91. 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 individual species composites (GRIDS) were prepared, each was converted into raster format using a cell size of 10 m. 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. While combining these data sets may present some bias do to the differing methods used in creating the individual species rasters, it can still present a general indication of areas with the highest concentrations of priority species. Table 19 provides the list of all rasters that were combined for prioritization with their respective scoring.

Table 19. List of rasterized layers used in the conservation value index analysis with their respective scoring range.

Prioritization Raster	Scoring Values
Beaches and Dunes	0.18 - 1
Tidal marsh	0.29 - 1
Tidal Flats	0.14- 1
Acadian Forest Mosaic	0.18 – 0.85
Freshwater wetlands	0.16 - 1
Buffers (tidal marsh and freshwater wetlands)	0.16 - 1
Riparian Areas	0.2[1]
Calcareous Forest	0.2 or 0.3
NS DNR A-List Forests	0.2 or 0.3
Species composite	0 - 1

[1] NAAP critical floodplain and ELC SM with fluvial deposits

Appendix H. IUCN Threat Categories

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 I. IUCN Conservation Actions Classification

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

Conservation Actions	Action 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	Action 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 incentivies 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