NATURE CONSERVANCY CANADA | CONSERVATION DE LA NATURE

CONSERVATION ASSESSMENT FOR SOUTHERN CANADA

Nature Conservancy of Canada (NCC). 2018. *Conservation Assessment for Southern Canada*. vii+137 pp.

NCC staff Michael Bradstreet, Andrea Hebb and Dan Kraus (in alphabetical order) contributed to the concept, design, analysis and writing of this report.

ACKNOWLEDGEMENTS

The authors thank all of the partners and agencies that provided data used in the assessment. In addition, thanks to NCC staff and to Karen Beazley, Dalhousie University; Louise Gratton, Two Countries, One Forest Society; Dave Howerter, Ducks Unlimited Canada; Cathy Nielson, Environment and Climate Change Canada; Mike Patterson, International Institute for Sustainable Development; Dave Phillips, formerly Saskatchewan Ministry of Environment; Justina Ray, Wildlife Conservation Society Canada; and Oscar Venter, University of Northern British Columbia who reviewed the assessment and provided valuable suggestions for improvement. Allan Edelsparre, University of Toronto, provided guidance and support for the statistical analysis.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

EXECUTIVE SUMMARY v

BACKGROUND 1
- The Loss of Canada's Biodiversity 1
- Need for a Conservation Assessment 1
- Goals of the Assessment 4

STUDY AREA 5

METHODS 7
- Data Assembly 7
  - Biodiversity 7
    - Species Richness (Criterion B1) 12
    - Species at Risk (Criterion B2) 12
    - Globally Rare Species (Criterion B3) 13
    - Species of High Conservation Responsibility (Criterion B4) 13
    - Unique and Distinctive Species (Criterion B5) 14
    - Key Biodiversity Areas (Criterion B6) 14
    - Intactness (Criterion B7) 15
    - Ecosystem Distinctiveness (Criterion B8) 17
  - Threat 18
    - Human Footprint (Criterion T1) 19
    - Watershed Stress (Criterion T2) 19
    - Conservation and Habitat Risk Index (Criterion T3) 21
    - Fragmentation (Criterion T4) 21
    - Land Use Change (Criterion T5) 21
    - Rate of Climate Change (Criterion T6) 22
    - Lack of Water (Criterion T7) 23
  - Conservation Response 23
    - Protected Areas (Criterion R1) 25
    - Representation (Criterion R2) 26
- NCC's Assessment of the Criteria and Measures to Identify Important Ecoregions 26
  - Statistical Analysis 26
  - Scoring 27
  - Classifying Ecoregions by Biodiversity and Threat Values 28

RESULTS 29
- Statistical Analysis 29
  - Biodiversity 29
  - Threats 32
  - Final Suite of Criteria and Measures 33
- Ecoregion Scores for Biodiversity, Threat and Conservation Response 34
  - Biodiversity 35
  - Threat 39
  - Conservation Response 43
    - Protected Areas (Criterion R1) 43

Representation (Criterion R2) 44
Identifying Important Ecoregions 47

DISCUSSION AND APPLICATIONS 53
Identifying and Protecting Important Areas for Conservation 54
Species at Risk Recovery 55
Capacity Building 55
Monitoring Our Progress: A Living Conservation Assessment 56
Looking Forward 56

REFERENCES 58

Appendix A – Summary of Ecoregions 68
Appendix B – Datasets, Caveats and Limitations 71
Appendix C – Endemic Species 77
Appendix D – Habitat Block Analysis 80
Appendix E – Connectivity Results 82
Appendix F – Correlation Matrices 86
Appendix G – Results by Criteria 90
Appendix H – Ecoregion Scoring Table Workbook 115
Appendix I – Additional Ecoregion Information 116
Appendix J – Example of Ecoregion Summary 126

LIST OF ACRONYMS 137

EXECUTIVE SUMMARY

This conservation assessment analyzed ecoregions across southern Canada to inform the work of the Nature Conservancy of Canada (NCC) and our conservation partners. The study area is based on the 77 ecoregions in southern Canada that exist in the settled part of Canada and are under the greatest risk.

The assessment assembles readily-available, spatially referenced data with relatively uniform and comprehensive coverage across the study area. This information is grouped into criteria related to biodiversity, threat and conservation response. Twenty-one biodiversity measures, including species richness, concentrations of rare species and intact habitats are grouped into eight criteria. Twelve threat measures that are likely to exert a negative influence on biodiversity such as human footprint and recent changes in land cover are grouped into seven criteria. Finally, two conservation response criteria, protected areas and representation, depict the distributions and relative values of existing conservation efforts that are likely to support biodiversity conservation. The individual measures/criteria are summarized by ecoregion and mapped.

Three different statistical methods are then used to identify biodiversity, threat and conservation response measures that are highly correlated with each other so that these measures can be removed from the analysis to avoid double-counting. The redundancy analyses resolves artificial relationships arising from how measures are calculated thus retaining meaningful biological relationships. A redundancy analysis detects measures with significant collinearity, a cluster analysis groups measures that are similar to a degree that they can be regarded as a single measure and correlation matrices help visualize relationships between the measures and identify significant linear correlations. For all three redundancy analyses, a conservative correlation coefficient cut off value of 0.70 (e.g. adjusted $R^2 = 0.70$) is used to identify measures for removal. The three statistical methods used to assess the individual measures for redundancy eliminate eight biodiversity measures (and consequently two biodiversity criteria) and two threat measures from the final analysis. Regression analysis is used to determine if ecoregion area has an effect on the raw values computed for measures. For those significantly affected by area, the residual variation from the effect for each ecoregion is extracted from the mean value of that measure; this adjusted value is used for the remainder of the analysis.

For each of the remaining measures in the analysis, raw values are assigned scores from 1 to 5 based on the relative values of the measure across the study area. The scores are summed two ways to identify ecoregions with the highest total scores for biodiversity, threat and conservation response. Individual measures are first summed to produce total scores for each of the biodiversity, threat and conservation response assessments using a “Measures” approach. The results are also summed using a “Criteria” approach where all measures within each criterion are added together and rescaled back to a score from 1 to 5; the rescaled scores of each criterion are then summed to produce total scores.

For both the Measures and Criteria approaches, the resulting total scores for biodiversity and threat for each ecoregion are plotted on a scatter diagram to identify ecoregions with similar characteristics. To distinguish between higher and lower scoring ecoregions, the resulting total biodiversity and threat scores are each reclassified into five natural break categories with the threshold between the third and fourth highest categories defining ecoregions with higher relative total scores for biodiversity and threats. The ecoregion priorities from both approaches (Measures versus Criteria) are mapped individually and then combined together into one final map with the highest scores from either approach taking precedence.

With the Combined results, nine ecoregions have relatively higher biodiversity and threat scores compared to other ecoregions in the study area (Figure i). Eight (88.9%) of these ecoregions have lower total conservation response scores (i.e. both percent protected and representation below 17%). Twenty-one ecoregions have relatively higher biodiversity but relatively lower threat scores; six of these ecoregions have relatively higher conservation response (28.0% have higher percent protected, 19.0% have higher representation). Located in the more intact northern and western portions of the study area, and along the west coast, these ecoregions tend to have lower scores for measures related to species diversity, but score very high for intactness, habitat diversity and congregatory species and are more likely to contain intact ecological communities and processes. Thirteen ecoregions have relatively low biodiversity and high threat scores; all but two (15.4%) of these ecoregions have high conservation response with over 17% protection and/or representation. Finally, 34 ecoregions have relatively lower biodiversity and relatively lower threat; 25 (73.5%) of these ecoregions have over 5% protection, while 23 (67.6%) have over 5% representation.

The results of this assessment can be used to provide context to conservation by highlighting key biodiversity, threat and conservation attributes of ecoregions across southern Canada. Applications of this information include identifying important ecoregions for new protected areas, SAR recovery, capacity building and ecological monitoring. The results of the conservation assessment can be used to track progress towards national, regional and organizational conservation goals. Regular re-analysis of the ecoregions to track their trends in biodiversity, threats and conservation would be useful for monitoring the effectiveness of conservation programs, and to highlight ecoregions where greater conservation focus may be required.

NCC's application of this assessment will include prioritizing conservation resources to ecoregions with the highest biodiversity values, and using underlying, finer-scale data on rare species, land cover and connectivity to refine existing conservation plans. This finer-scale information will be analyzed to identify sites within ecoregions that have the highest biodiversity values and conservation needs. This will help highlight sites of high importance for biodiversity conservation that may not be identified in the ecoregional analysis because of scale. NCC will make the information contained in this assessment available on-line to support the conservation decision making of our partners. NCC will use the results to build on our tradition of using conservation planning to drive conservation to the most important and urgent places for biodiversity. To maintain the currency of this assessment, NCC will update the information on a regular basis and share the results to ensure that conservation decision-making is based on the best available information.

Figure ii: Final ecoregion designation (Combined results)

BACKGROUND

The Loss of Canada's Biodiversity

Over the last 50 years, the overall state of biodiversity in Canada has been declining. The decline in species and habitats has been particularly acute in the southern regions of Canada that have the longest history of agricultural, urban and industrial land uses, and is the region where most Canadians live. It is estimated that 50 million acres of Canada's wetlands have been lost. This includes the loss of over two-thirds of the Atlantic coastal salt marshes, two-thirds of southern Ontario's wetlands, over half of the prairie pothole wetlands, and the loss and degradation of 70% of southern British Columbia's estuary marshes (Federal, Provincial and Territorial Governments of Canada 2010). Almost all habitats in southern Canada have experienced decline and degradation. Only 25% of Canada's prairies remain, southern Ontario has lost 85% of its forest cover, lakes are being impaired by eutrophication and coastal areas are threatened by sea level rise (Federal, Provincial and Territorial Governments of Canada 2010).

Habitat loss is the main threat to wildlife in Canada, including species at risk (SAR) (WWF-Canada 2017b). Canadian breeding bird populations have decreased 12% since 1970 (NABCI 2012). Some bird groups, such as grassland birds, aerial insectivores and shorebirds, are showing steep declines of up to 70% (NABCI 2016). Other species are also becoming increasingly threatened. Canada has 724 SAR, a list that has grown by over 200 species in just the last decade alone (COSEWIC 2016b). Approximately 140 species of plants and animals are now presumed to be gone from Canada; over half of these appear to have disappeared in the last 20-40 years (NatureServe 2016).

Canada's biodiversity is facing serious threats: habitat loss and fragmentation, species decline and extinction, invasive species and climate change. A diminished natural world negatively impacts our quality of life, our health, and our environmental and economic sustainability. Effective conservation is needed throughout Canada, and protection of our north offers some of the last global opportunities to protect large, intact landscapes; however, the urgency for conservation is greatest in the south where our human footprint is the greatest and continues to expand.

Need for a Conservation Assessment

The identification of important areas to protect biodiversity is a cornerstone of effective conservation. Conservation assessments provide a framework for conservation practitioners to identify the relative conservation value of different regions based on measures such as rare species, intact landscapes and probability of loss, and to invest in actions that provide the greatest conservation impact. In the past, conservation assessments and the identification of important areas were based on the knowledge and experience of experts. An expert-driven processes can be very effective for identifying key areas, but can be limited by the knowledge of the experts engaged in the process and the selection process may not be repeatable.

Over the last decade, the ability to carry out systematic conservation assessments at broad geographic scales has been enhanced through the availability of new analytic tools and comprehensive datasets. These datasets include information on land use and land use change, species ranges, rare species and existing conservation lands. For example, recent national conservation assessments in the United States have shown gaps in the protection of rare species (Jenkins et al. 2015). Other studies over larger geographical scales have highlighted other

conservation needs, such as gaps in connectivity (McGuire et al. 2016), gaps in protected areas large enough to support populations of wide-ranging species such as grizzly bear (e.g. Newmark 1985, 1995) and gaps in representation (e.g. Parks Canada 2016). Global analyses have shown similar mismatches between conservation actions and migratory birds (Runge et al. 2015) and freshwater species (Darwall et al. 2011).

Until recently, data and tools have not been available to conduct a detailed, country-wide conservation assessment for Canada, similar to work done in the United States (Jenkins et al. 2015), Kenya (Habel et al. 2016) or Australia (NRMMC 2010). The recently published framework to guide protected areas designations in Canada (Coristine et al. 2018, in press) focuses on gaps in protected areas to guide the establishment of new parks and conservation lands, but does not include threats or the full range of biodiversity values that NCC and other conservation groups are working to protect (e.g. globally rare species, freshwater), particularly in southern Canada on the private land base. Although detailed regional assessments have recently been done for some parts of Canada, such as the Northern Appalachian/Acadian Ecoregion (Trombulak et al. 2008) or southern Ontario (ECCC 2014) and for freshwater ecosystems (WWF-Canada 2017a), an assessment has not been done nationally or for large regions of Canada using common approaches and methods. Some global (Olson & Dinerstein 2002) and North American (Ricketts et al. 1999) conservation assessments have included Canada (Table 1). These assessments contextualize the importance of Canadian regions from a broader conservation perspective (Figure 1). However, they do not assess priorities from a Canadian context, such as national SAR or connectivity between national parks, or use some more recently available national information on biodiversity, threats and conservation response.

Table 1: Global and continental conservation assessments that overlap with the study areas

Assessment/ Source	Description/Criteria
Ecoregions identified as a *globally outstanding ecoregion* in Terrestrial Ecoregions of North America Ricketts et al. 1999	16 criteria and indices on biodiversity, threat and protection
Global 200 ecoregions (terrestrial and marine) Olson & Dinerstein 2002	Biodiversity features were compared among ecoregions to assess their irreplaceability or distinctiveness. These features included species richness, endemic species, unusual higher taxa, unusual ecological or evolutionary phenomena, and the global rarity of habitats
Crisis Ecoregions Hoekstra et al. 2004 Brooks et al. 2006	Global assessment of Conservation Risk Index (habitat converted: habitat protected) Vulnerable: Ecoregions in which habitat conversion > 20% and CRI > 2 Endangered: Ecoregions in which conversion > 40% and CRI > 10 Critically Endangered: Ecoregions with conversion > 50% and CRI > 25

Canada is in need of a broad assessment of biodiversity and conservation, particularly in the relatively data-rich south where conservation is urgent. A southern Canada assessment will help to support the identification of key areas for habitat conservation and restoration, including concentrations of SAR, "hotspots" of globally rare species and intact habitats. Data-driven, place-based priorities for conservation that are founded on an assessment of biodiversity, threats and existing conservation responses can be used to provide context for existing efforts and to better focus future conservation activities. For example, the identification of concentrations of rare and threatened species can help identify key areas for multi-species and ecosystem-based recovery for Canadian SAR.

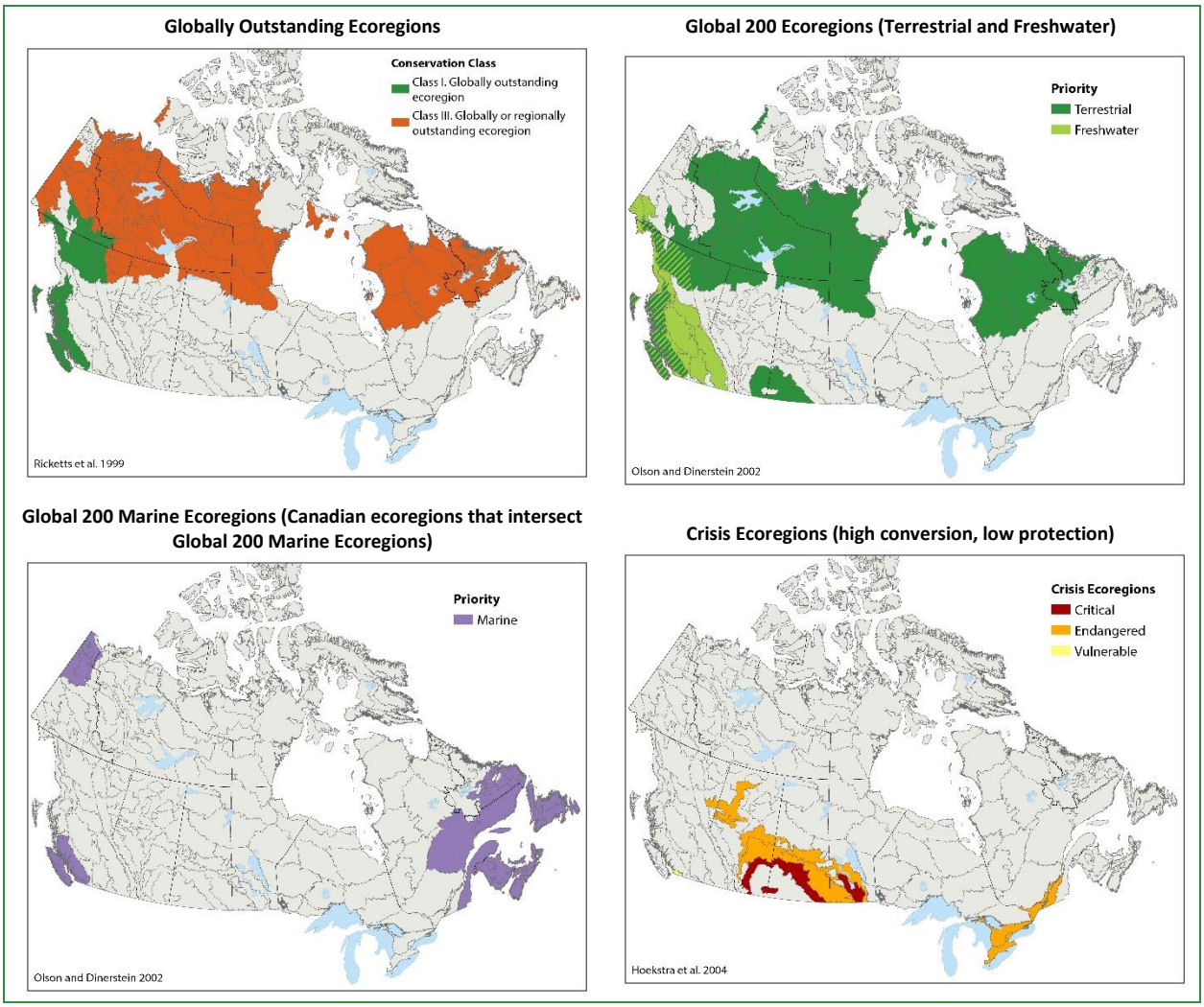

Figure 1: Globally significant ecoregions based on existing conservation assessments

A conservation assessment would support measuring Canada's progress towards meeting international biodiversity commitments including the Convention on Biological Diversity (CBD). Parties to the CBD adopted 20 "Aichi Biodiversity Targets" for the period of 2011–2020 (SCBD 2010). In particular, a conservation assessment can support Canada in meeting and reporting on key elements of Aichi Target 11 including "connectivity", "representation" and "areas of particular importance for biodiversity". A Canadian conservation assessment would also support measuring the status and trends of biodiversity and conservation. In particular, reporting on biodiversity within ecoregions would provide greater resolution and consistent indicators to existing national reporting (Federal, Provincial and Territorial Governments of Canada 2010).

Perhaps most importantly, the maps and information from a conservation assessment of southern Canada can provide Canadians with a better understanding of our country's biodiversity and most urgent conservation priorities.

Goals of the Assessment

The goals of this assessment are to:

- Assemble and share a data catalogue of maps and datasets on biodiversity, threat and conservation response that can support the identification of place-based priorities for nature conservation in southern Canada.
- Develop a transparent scoring system that uses the data to help support the identification of ecoregions with high biodiversity and high threat values.
- Identify how the analysis can be used to help review and fine-tune the boundaries of existing conservation plans and land protection efforts, support the work of conservation agencies, and be shared with Canadians to inform and inspire conservation.

The intent of this project is to provide an assessment, not a plan. It provides a decision support tool to help build the case for accelerated conservation efforts in the ecoregions of southern Canada with the highest biodiversity values that are at the greatest risk. In some of these ecoregions, existing plans are guiding conservation actions. In other ecoregions, new conservation plans may need to be developed. This approach of conservation assessments followed by more detailed implementation planning builds on the current approaches used by the Nature Conservancy of Canada (NCC) in the form of ecoregional assessments/conservation blueprints and natural area conservation plans. Now, the availability of new national-scale information on biodiversity, threats and conservation response, enables the entire geography of southern Canada to be analyzed and assessed. The output is intended to help guide conservation planning and delivery, and provide the first national 'lens' on important ecoregions for conservation in southern Canada.

STUDY AREA

The southern region of Canada was selected as the focus of the assessment because biodiversity is generally under a higher level of threat, and it has more comprehensive information. The study area for this assessment includes all ecoregions south of the Boreal ecozones (Boreal Cordillera, Boreal Plains, Boreal Shield), 23 ecoregions in the southern Boreal ecozone and the island of Newfoundland. This study area encompasses the predominant area of private lands in Canada, and is where NCC currently has landscape-level conservation plans, called Natural Area Conservation Plans (NACPs) as of December 31, 2017. In total, 77 ecoregions are included in the analysis (Figure 2; also see Appendix A: Summary of Ecoregions).

The ecoregions used in the assessment is based on the National Ecological Framework for Canada, a joint consultative initiative by Agriculture and Agri-Food Canada (AAFC) and Environment and Climate Change Canada (ECCC) (AAFC 1999). The framework defines four levels of ecosystems from ecozones to ecoprovinces, ecoregions and ecodistricts providing a consistent spatial framework for national monitoring and reporting. Statistics Canada recently derived a standardised classification structure for each level of unit in the framework and adopted this "ecological land classification" as its standard for national assessments (Statistics Canada 2017).

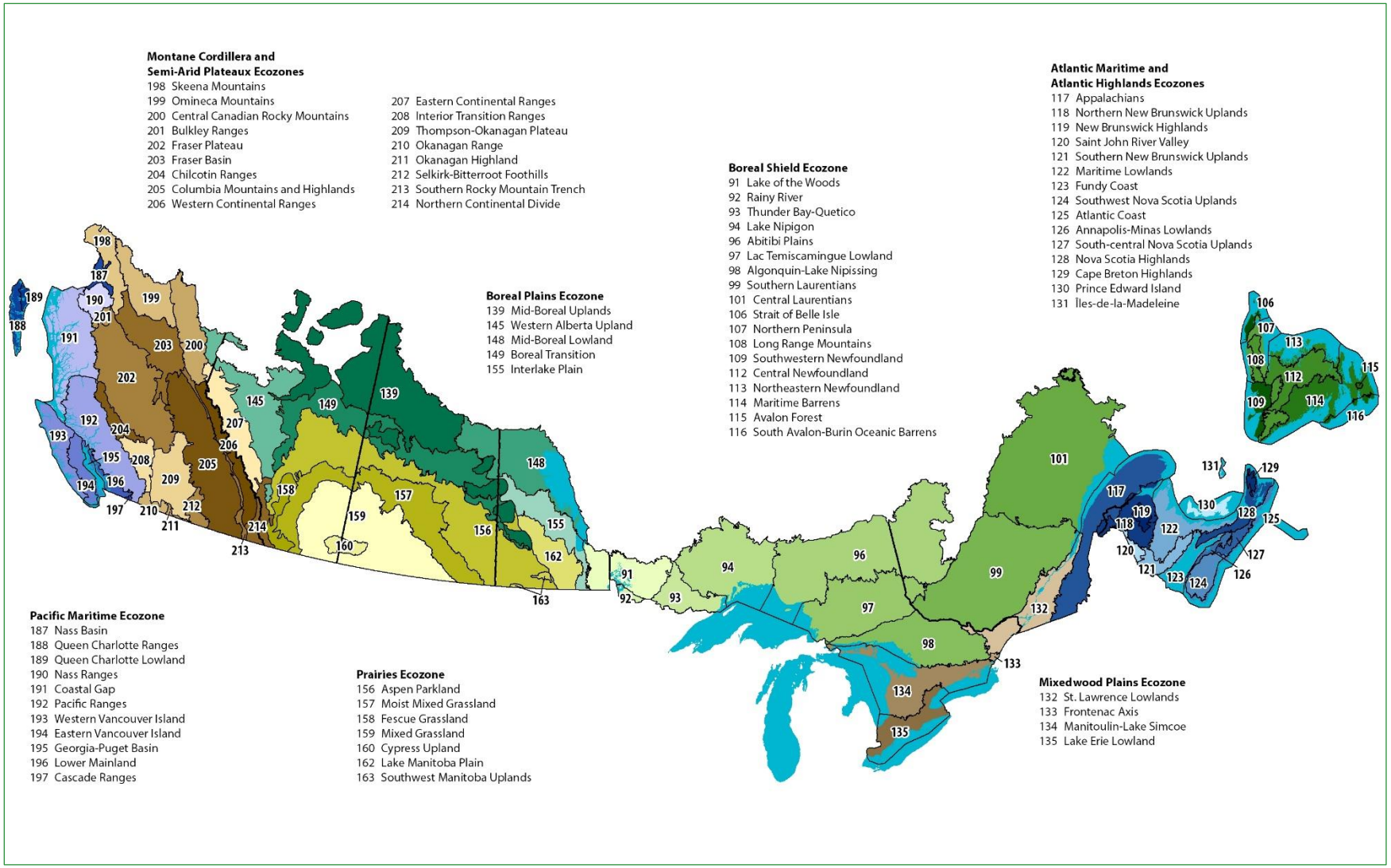

Figure 2: Study area (77 ecoregions)

METHODS

This section first outlines the assembly and mapping of the data followed by a description of the methods used to score the ecoregions and identify priorities.

Data Assembly

Several existing conservation and biodiversity assessments at many scales are reviewed to assess the data and methods applied including Ricketts et al. 1999 (continental), Jenkins et al. 2015 (national) and ECCC 2015 (different ecozones in Canada).

This assessment assembles information on Canadian biodiversity, threats and conservation responses that is readily-available, spatially referenced data with relatively uniform and comprehensive coverage across the study area as of August 2017. Data confidence is noted for each of the measures in the tables below and ranked based on the completeness, accuracy and age of the underlying information. Data with high confidence include absolute measures available for the entire study area (e.g. amount of protected areas). Data with medium confidence include information that may not be complete for the entire study area (e.g. surveys for provincially or globally rare species available from NatureServe). Data is excluded from the analysis if it has low confidence.

The datasets are then grouped into criteria related to either biodiversity, threat or conservation response, and mapped. Some measures or criteria, however, could be included in more than one of these three groups (e.g. percent natural cover could be a measure of biodiversity or threat). An outline of the data assembled for each group and a description of the geospatial processes to produce the maps is provided below. In addition, a list of datasets, their sources and potential limitations of some of the data are provided in Appendix B.

Biodiversity

Twenty-one datasets measuring biodiversity features such as species richness, concentrations of rare species and intact habitats are grouped into eight criteria. A description of the criteria used for biodiversity, the scoring system, associated data sources and assessment of data quality is provided in Figure 3 and Table 2. Five of the eight criteria are based on species data (e.g. species richness, globally rare species), while three are based on landscape data including key biodiversity areas, intactness and ecological distinctiveness. Key biodiversity areas was included as a landscape criterion because they depict general areas of important habitat for congregatory and migratory birds. Unless otherwise indicated in Table 2, the total score for each measure is classified into five natural breaks (Jenks optimization method (ESRI 2012)) so that numeric scores from 1-5 could be applied to each ecoregion later in the analysis.

Table 2: Biodiversity criteria and measures*

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
B1 SPECIES RICHNESS	B1a Species Richness: Range Map Species	Total number of different species, based on range maps: mammals, birds, amphibians and trees by ecoregion	Adjusted number derived from the residual variation from the mean, log transformed 1-5 scoring categories based on natural breaks	Birdlife International and NatureServe 2014 IUCN 2014a, 2014b USGS 1999 HIGH
	B1b Species Richness: Tracked Species	Total number of different tracked species[1]	Sum, log transformed by taxonomic group 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
B2 SPEICES AT RISK	B2a Richness of COSEWIC assessed wildlife species	Total number of different COSEWIC assessed wildlife species (Endangered, Threatened, Special Concern) scored based on importance	Sum, log transformed by taxonomic group and weighted total number based on level of importance Endangered = 5 per species Threatened = 3 per species Special Concern = 1 per species 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 HIGH
	B2b Irreplaceability of COSEWIC assessed wildlife species	Each species scored based on number of occurrences	Sum, rarity weights 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 HIGH
	B2c Richness of COSEWIC candidate wildlife species	Total number of different COSEWIC candidate wildlife species	Sum, log transformed by taxonomic group 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
	B2d Irreplaceability of COSEWIC candidate wildlife species	Each species scored based on number of occurrences	Sum, rarity weights 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM

[1] Species or sub-species with a conservation status for SARA, COSEWIC, IUCN or a NatureServe conservation status rank (rounded Grank, Nrank or Srank from 1 to 3)

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
B3 GLOBALLY RARE SPECIES	B3a Richness of globally rare species	Total number of different globally rare species (G1-G3/T1-T3)[2] scored based on importance (T=subspecies or population)	Sum, log transformed by taxonomic group and weighted total number based on level of importance G1/T1 = 5 per species G2/T2 = 3 per species G3/T3 = 1 per species 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
	B3b Irreplaceability of globally rare species	Each species scored based on number of occurrences	Sum, rarity weights 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
B4 SPECIES OF HIGH CONSERVATION RESPONSIBILITY	B4a Irreplaceability of Canadian endemic species	Each species scored based on number of occurrences	Sum, rarity weights 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
	B4b Ecoregional Responsibility (range maps)	Total count of species by ecoregion with ≥75% of range within Canada Global range was calculated for mammals, breeding birds and amphibians. Trees based on North American range, which includes Canada, United States and Mexico	Adjusted number derived from the residual variation from the mean 1-5 scoring categories based on natural breaks	Birdlife International and NatureServe 2014 IUCN 2014a, 2014b USGS 1999 HIGH
B5 UNIQUE AND DISTINCTIVE SPECIES	B5a Unique Species: Species Range	Total number of species unique to one ecoregion based on range maps	Total number, log transformed by taxonomic group 1-5 scoring categories based on natural breaks	Birdlife International and NatureServe 2014 IUCN 2014a, 2014b USGS 1999 HIGH
	B5b Unique Species: Tracked Species	Total number of tracked species unique to one ecoregion	Total number, log transformed by taxonomic group 1-5 scoring categories based on natural breaks	ACCDC 2016 NatureServe et al. 2015 MEDIUM
	B5c Distinctive Species: Species Range	Each species scored based on the inverse of the number of occurrences across all ecoregions in study area	Sum, rarity weights 1-5 scoring categories based on natural breaks	Birdlife International and NatureServe 2014 IUCN 2014a, 2014b USGS 1999 HIGH

[2] Species or sub-species ranked G1-G3G4 are considered globally rare

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
	B5d Beta-Diversity: Species Range	Each species scored based on the inverse of the number of occurrences in adjacent ecoregions in study area	Sum, rarity weights 1-5 scoring categories based on natural breaks	Birdlife International and NatureServe 2014 IUCN 2014a, 2014b USGS 1999 HIGH
B6 KEY BIODIVERSITY AREAS	B6 Congregatory Species, Migrations	Each hectare of important bird and biodiversity area within the ecoregion (terrestrial and marine portion) scored based on importance for congregatory species	Sum, weighted area based on importance Global Importance = 5 per hectare Continental Importance = 3 per hectare National Importance = 1 per hectare 1-5 scoring categories based on natural breaks	BSC 2015 HIGH
B7 INTACTNESS	B7a Natural Cover	Percent (%) of ecoregion Includes all natural land use types (including freshwater)	5: >90% 4: 76-90% 3: 51-75% 2: 31-50% 1: 10-30% 0: <10% Based on ECCC 2013a	AAFC 2015b HIGH
	B7b Intact Mammal Fauna	Percent of ecoregion	1-5 scoring categories based on natural breaks	Morrison et al. 2007 Sanjayan et al. 2012 LOW-MEDIUM
	B7c Size of largest block of intact habitat	Number and extent of contiguous intact habitat blocks	1-5 scoring categories based on Habitat Block Analysis (Ricketts et al. 1999; see Appendix F)	GFWC 2014 HIGH
	B7d Connectivity	Percent of ecoregion containing (or with) least-cost corridors	1-5 scoring categories based on natural breaks	AAFC 2015b NRCan 2002, 2015 NRCan et al. 2013 USGS 2007 MEDIUM-HIGH
B8 ECOSYSTEM DISTINCTIVENESS	B8a Natural Cover Distinctiveness	Each land cover type scored based on number of occurrences across all ecoregions in study area	Sum, rarity weights 1-5 scoring categories based on natural breaks	AAFC 2015b MEDIUM-HIGH
	B8b Natural Cover Beta-Diversity	Each land cover type scored based on number of occurrences in adjacent ecoregions in study area	Sum, rarity weights 1-5 scoring categories based on natural breaks	AAFC 2015b MEDIUM-HIGH

* order does not denote priority

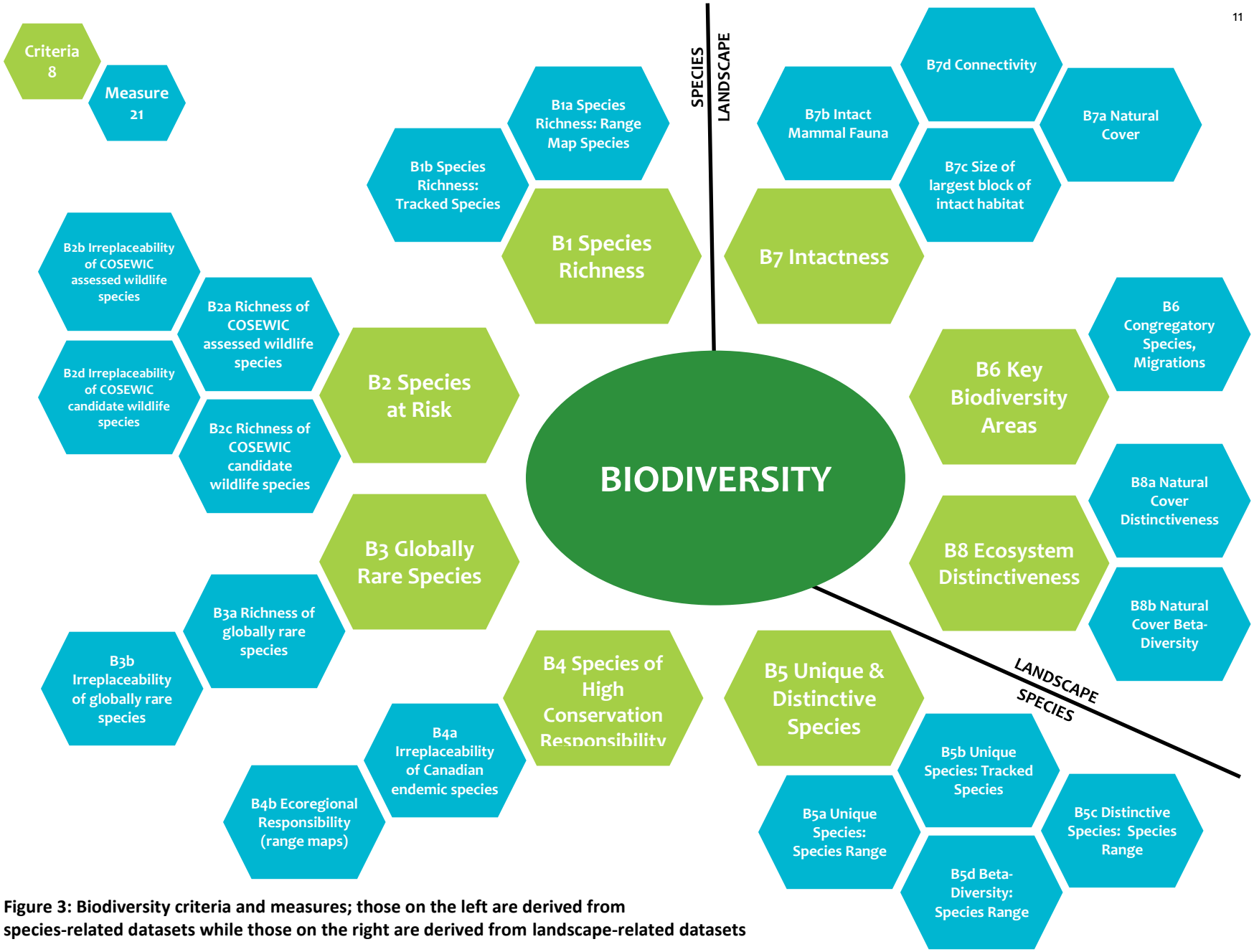

Figure 3: Biodiversity criteria and measures; those on the left are derived from species-related datasets while those on the right are derived from landscape-related datasets

Species Richness (Criterion B1)

There is an increasing understanding of the importance of monitoring and conserving all species to prevent decline, and to recognise their important role in ecosystem functions (Gaston 2010). Species richness is measured using range maps and element occurrences and observation of species tracked by Conservation Data Centres (CDCs). Current range maps are available for all amphibians (IUCN 2014a), mammals (IUCN 2014b), birds (BirdLife International and NatureServe, 2014) and trees (USGS 1999). These four datasets are overlaid with the ecoregion boundaries to generate a total number of species occurring within each ecoregion. The analysis is based on the presence or absence of each species, and did not include the range area or number of occurrences.

Species tracked by CDCs are taxa of conservation concern, i.e. COSEWIC-assessed species; species listed under the *Species At Risk Act* (*SARA,* 2002), and additional species that are considered rare or imperiled at the global or subnational level[3]. Species data analysed and provided by NatureServe et al. (2015), incorporated element occurrences and observations from all provinces and territories – except for Newfoundland and Labrador. The Atlantic Canada CDC (AACDC 2016) provided data for Newfoundland and Labrador. The CDC data excludes records prior to 1990 or those with a historic or extirpated ranking to ensure that records being used represent extant occurrences. Summary lists of species occurring within each ecoregion were provided to NCC. Taxa considered include birds, mammals, amphibians, reptiles, mollusks, freshwater fishes, arthropods, vascular plants, mosses and other nonvascular plants, algae and lichens. Freshwater species are included where data existed. Other invertebrate species (n = 3) and some species classified as sensitive (n = 15) are not included in this dataset.

The range map and tracked species data are used to produce counts of the total number of different species per taxonomic group in each ecoregion. The counts are then log transformed and summed for each ecoregion. Log transformation condenses the range of the data while preserving differences among taxa (Ricketts et al. 1999, pp. 110).

Species at Risk (Criterion B2)

SAR includes species that have been assessed by COSEWIC as special concern, threatened or endangered. In addition to species currently assessed by COSEWIC, this project also looks at candidate species that will be assessed by COSEWIC in the future (COSEWIC 2016a). These species have been grouped by COSEWIC as high, medium and low priorities for assessment. Most candidate species with available spatial information have undergone a preliminary screening based on COSEWIC criteria and are likely to be assessed as at risk. The candidate species list is prepared by Species Specialist Subcommittees of COSEWIC, and is not complete for some taxa groups. The list includes 396 candidate species and is current to February 2016.

---

[3] Species or sub-species with a conservation status for SARA, COSEWIC, IUCN or a NatureServe conservation status rank (rounded Grank, Nrank or Srank from 1 to 3)

The Species at Risk criterion incorporates four measures – two related to wildlife species assessed by COSEWIC and two related to COSEWIC candidate species. For COSEWIC assessed species, the summary list of tracked species created from the CDC data is filtered to only include species designated as endangered, threatened or special concern[4]. Richness is calculated by weighting each species based on the level of importance prior to log transforming the data; endangered species received a score of 5, threatened 3 and special concern 1. Irreplaceability is measured by further summarizing the list of species within each ecoregion to determine the number of ecoregions in which each species occur within the study area. Rarity-weights are then calculated for each species based on the inverse of this number; species occurring in fewer ecoregions have a higher rarity-weight than species occurring in many ecoregions. For example, a rare species such as Hill's thistle (*Cirsium hillii)* recorded in only two ecoregions within the study area – Manitoulin-Lake Simcoe and Algonquin-Lake Nipissing – is assigned a rarity weight value of 0.5 (1/2). Conversely, a species like bobolink (*Dolichonyx oryzivorus*), which is much more common and recorded in 43 ecoregions, is assigned a rarity weight of 0.023 (1/43). Subsequently, for each ecoregion, species rarity-weights are summed to produce an index of irreplaceability.

Similarly, richness and irreplaceability for COSEWIC candidate species is also calculated by filtering the CDC data to species designated as high, medium and low priorities for future assessment by COSEWIC.

Globally Rare Species (Criterion B3)

Canada has over 1,400 globally rare species (NatureServe 2016). Of these, 434 occur in the study area and have available data from NatureServe. Most of the globally rare species included in the analysis are vertebrates, vascular plants and invertebrates with relatively complete surveys (e.g. freshwater mollusks, butterflies). Approximately 815 (58%) of the globally rare species known in Canada are non-vascular plants and invertebrates.

The CDC summary list of tracked species is filtered to those identified as critically imperilled (G1/T1), imperilled (G2/T2) or vulnerable (G3/T3)[5] to calculate two measures for globally rare species: richness weighted by level of importance and irreplaceability of globally rare species. Species receive a score of 5 if designated critically imperilled, 3 if imperilled and 1 if vulnerable. Calculation methods for these two measures are similar to those described above for SAR.

Species of High Conservation Responsibility (Criterion B4)

This criterion includes two measures related to species endemic to Canada and species with a majority of their global range within Canada. Nationally endemic species are species that have only been documented in Canada. Some of these species have large ranges that are restricted to Canada, and others are limited to very specific areas within Canada. Canada has 100% jurisdictional responsibility for nationally endemic species, and national endemism is used as one of the criteria by COSEWIC to determine priority for species assessments. The study area has CDC records for 69 Canadian endemic species (of approximately 300 for all of Canada) (Appendix C).

---

[4] As of April 2017
[5] As of February 2017

Regional and ecoregional endemic species are not considered for this analysis; these are species that are restricted to small, local geographies but because they straddle the United States border are not considered nationally endemic. Regional and ecoregional endemic species are of high conservation importance and were included in most of NCC's EcoRegional Assessments (ERAs) as target species. Examples of these include Lakeside Daisy (*Tetraneuris herbacea*) in the Great Lakes region and Vancouver Island Beggarticks (*Bidens amplissima*) on Vancouver Island and the lower mainland of British Columbia. However, because of the small natural range of these ecoregional endemic species, they are often globally rare and included in the analysis of globally rare species.

The first measure, irreplaceability of endemic species, is calculated by filtering the CDC summary list of species by those species identified as being endemic to Canada. Calculation methods are similar to those described above for SAR.

The second measure in this criterion is conservation responsibility. For this, the percentage of global range within Canada is calculated for all mammal, breeding bird and amphibian species. Global range maps for trees are not available and thus the percentage of the North American (Canada, US, Mexico) range in Canada is calculated. To measure conservation responsibility, the total number of species per ecoregion with more than 75% of their range in Canada is used.

Unique and Distinctive Species (Criterion B5)

Unique and distinctive species measures are intended to highlight ecoregions that are different from others based on their species composition. For uniqueness, the total count of species only occurring in one ecoregion of the study area is calculated based on range maps and CDC data. Distinctiveness is examined by weighting the rarity or irreplaceability of species (based on range maps) across the entire study area to focus on species that occur in few ecoregions. For beta-diversity, the rarity or irreplaceability of species is only compared to adjacent ecoregions (versus all ecoregions in the study area) and is thus influenced by the number of adjacent ecoregions.

For both the CDC data (tracked species) and range map species, the lists of species are filtered to only include those species that are unique to or only occur in one ecoregion in the study area. The raw counts per ecoregion are then log transformed and mapped.

This criterion also includes measures for distinctiveness and beta-diversity in the range map data. Usually diversity is divided into its subcomponents – alpha, beta and gamma diversity. Alpha diversity refers to species composition within sampling units, whereas gamma diversity is the total diversity among all sampling points (Whittaker et al. 2001, Jurasinski et al. 2009). Beta diversity refers to how sampling units compare in terms of the variation in their species composition, and is defined in two ways (Anderson et al. 2011). For distinctiveness, the irreplaceability of species occurring in ecoregions across the entire study areas is calculated and for beta-diversity irreplaceability is calculated for each ecoregion based on the number of species occurrences in adjacent ecoregions within the study area.

Key Biodiversity Areas (Criterion B6)

Congregatory species can be vulnerable to human and natural disturbances that can impact a large portion of the population through a single or repeated event. Congregatory species represented by birds is one measure of Key Biodiversity Areas (KBAs) that has been mapped spatially. Areas recognized as KBAs are downloaded from Bird Studies Canada (BSC 2015) and intersected with the

entire ecoregions' area. Each hectare of KBA receives a score of 5 for global importance, 3 for continental importance and 1 for national importance and then summed for each ecoregion.

Intactness (Criterion B7)

Intactness is measured in four ways: by the amount of natural cover, the completeness of historic mammal assemblages, large intact habitat blocks and landscape connectivity. Intact habitats are more likely to contain the full suite of species and ecosystems, their condition is likely to be better and ecosystem functions intact.

For the first measure, amount of natural cover, the 2010 Land Use map (AAFC 2015b) is used as the main input. The land use map was derived from a number of existing source data and covers all areas of Canada south of 60^0N at a spatial resolution of 30 m. The map delineates 15 land use classes following the protocol of the Intergovernmental Panel on Climate Change (IPCC). For the purposes of this assessment, the land use classes are simplified into four general classes as shown in Table 3.

Table 3: Land use classification

General Land Use Class	Land Use Map Classification (AAFC 2015b)	
	Class	Description
Natural	Forest	Treed areas > 1 ha in size
	Forest Wetland	Wetland with forest cover (i.e. treed areas > 1 ha in size)
	Trees	Treed areas < 1 ha in size
	Treed Wetland	Wetland with treed cover (i.e. treed areas < 1 ha in size)
	Grassland Managed	Natural grass and shrubs used for cattle grazing
	Grassland Unmanaged	Natural grass and shrubs with no apparent use (forest openings, alpine meadows, tundra, etc.)
	Wetland	Undifferentiated wetland
	Wetland Shrub	Wetland with shrub cover
	Wetland Herb	Wetland with grass cover
	Other	Rock, beaches, ice, barren land
Water	Water	Natural and artificial
Converted	Settlement	Built-up and urban
	Roads	Primary, secondary and tertiary roads
	Cropland	Annual and perennial
Other	Unclassified	Areas not classified due to clouds

The 2010 land use map is cross-tabulated with the ecoregions to calculate the area of the general land use classes occurring within each ecoregion. The percent natural cover (including water) is then calculated and mapped into five classes using manual breaks based on How Much Habitat is Enough Guidelines (ECCC 2013a).

Intact mammal fauna is the second measure and is created by manually digitizing published maps depicting regions in Canada that have not lost any large mammals based on assemblages prior to European settlement (Morrison et al. 2007, Sanjayan et al. 2012). This data layer only includes polygons that have fully intact mammal fauna (i.e. there are no polygons and scoring for partial mammal loss). Intact mammal fauna is intersected with ecoregions, and percent of ecoregion calculated.

The third measure is size of largest block of intact habitat. For this, an intactness layer is created by removing areas of anthropogenic disturbance. Compiled by Global Forest Watch Canada (GFWC 2014), areas of anthropogenic disturbance included those with industrial activities (such as mines,

clear cuts, well sites, pipelines and transmission lines), agricultural clearings and roads all buffered by 500 m. The dataset is relatively conservative with regards to total human access. Similar to GFWC's (2010) approach in developing an intact forest landscape layer, large waterbodies over 4,000 square km in size and waterbodies that represented more than half of a remaining landscape fragment are also removed. Ecoregions are then scored based on the size and number contiguous intact blocks following the methodology in Ricketts et al. (1999) (see Appendix D).

To assess connectivity, the final measure, and to model corridors across the study area, a 250 m cost surface grid representing resistance to movement across the landscape is developed. The connectivity analysis extends 350 km beyond the study area to integrate core areas and corridors adjacent to the study area; all subsequent data used in the connectivity analysis is clipped to this boundary. The 350 km buffer takes into account a dispersal distance of 300 km for wide ranging mammals (Belote et al. 2016). The cost surface for the study area itself is derived from 2010 Land Use (AAFC 2015b), National Road Network for Canada (NRCan 2015) and 30 arc-second Digital Elevation Model (DEM) of Canadian Landmass (NRCan 2002) data. The DEM is used for elevation and also to generate a slope grid. Because the processing extent of the connectivity analysis extends north of 60^0N in Canada where land use data does not exist and south into the US, the cost surface incorporates several additional datasets. Land cover is supplemented in these areas with data produced for the North American Land Change Monitoring System (NALCMS, NRCan et al. 2013). NALCMS data are based on Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery at 250 m spatial resolution with a minimum mapping unit for an area of land cover class was 25 ha. Roads, elevation and subsequently slope data is augmented by the National Transportation Dataset (USGS 2017) and 1 km North American Elevation grid (USGS 2007).

The land use/cover, road, elevation and slope are either resampled or converted to 250 m grids and then reclassified based on resistance (or cost) values presented in Table 4 below. Resistance values are assigned according to the relative cost or resistance encountered by multispecies moving across the landscape; higher resistance values (1000) represent features or areas that impede migration or pose a danger to wildlife and lower resistance values (1) represent features congruent with or assist wildlife migration through the study area. These resistance values have been slightly modified from those recommended by Koen et al. 2012 and used by Bowman & Cordes (2015); here the lower cost values are reduced from 10 to 1. Furthermore, cost values are assigned to elevation and slope based on wildlife preferences. High values are assigned to areas of higher elevation and steep slopes. Although some wildlife species can use steeper slopes, most species avoid slopes greater than 25 degrees (BCEAG 2012). High peaks are also a barrier for wildlife; many species prefer low to moderate elevation for movement (Alberta Tourism 2010). The elevation classes used to define high and very high classes are based on the vegetation life zones defined by Mickalak et al. 2015 (see Representation (Criterion R2) for a further description and breakdown of these zones).

The four resistance (cost) grids are then combined together, with the maximum resistance value for each grid cell representing the final cost value. This final cost surface along with core areas is used as input to model wildlife habitat corridors in Linkage Mapper (McRae & Kavanagh 2011). Linkage Mapper is a Geographic Information System (GIS) software tool that uses core habitat areas and resistance to identify and map wildlife habitat corridors. The program identifies adjacent (neighbouring) core areas and creates maps of least-cost corridors between them and then mosaics the individual corridors to create a single composite map (McRae & Kavanagh 2011).

Table 4: Resistance (cost) surface layers

Resistance (Cost) Surface Layers	Resistance Value
ROADS	
Primary highways (Trans-Canada/National highway)	1000
Secondary highways (other highway/expressway/freeway, arterial, ramp)	100
Local roads (local, collector)	10
Other (resource/recreation, service, winter)	5
ELEVATION	
Very high (>2,130)	1000
High (1,521 - 2,130 m)	100
Low to medium (0 - 1,520 m)	1
SLOPE	
Steep (>25°)	1000
Strong (16 - 25°)	100
Moderate (10 - 15°)	1
Gentle (<10°)	1
LAND USE/COVER	
Settlement/urban	1000
Cropland	100
Freshwater	100
Forest (includes forest, forest wetland, trees, treed wetland)	1
Grassland (includes managed and unmanaged)	1
Wetland (includes wetland shrub, wetland herb)	1
Other (includes shrubland, lichen-moss, rock, beaches, barren, snow and ice)	1

Core areas are based on intact blocks and protected areas aggregated together into clusters if they were within 1 km of each other. Core areas include clusters of intact blocks greater than 100 km^2 in size (the smallest block size used in the habitat block analysis), in addition to clusters of intact habitat and protected areas greater than 10 km^2 in size for ecoregions within temperate forest or grassland major habitat types. Blocks from the global intact forest layer (Potapov et al. 2008) and Protected Areas Database of the United States (USGS, GAP 2016) greater than 100 km^2 in size are also incorporated for the United States. In Linkage Mapper, a maximum dispersal distance of 300 km for wide ranging mammals is used to define the maximum geographic distance between edges of cores to be connected for large areas (Belote et al. 2016).

The output corridors are clipped to a maximum cost-weighted width of 200 km to determine the corridors of least-cost for connectivity. The area of the truncated grid is cross-tabulated with the ecoregion to calculate total area connected and this percent is then mapped. The final cost surface and results of the connectivity analysis are provided in Appendix E.

Ecosystem Distinctiveness (Criterion B8)

The distinctiveness of ecosystems (land classes) within each ecoregion is measured as a "coarse-filter" for biodiversity (Poiani et al. 2000). Distinctiveness is based on comparing the land classes within each ecoregion to the land classes in other ecoregions, and between adjacent ecoregions. Ecoregions with more distinct natural land classes are more likely to contain species and vegetation communities that are less common in the study area, including in regions that have been poorly surveyed.

For natural cover distinctiveness, the 2010 Land Use map (AAFC 2015b) is summarized to determine the presence of each natural land class within each ecoregion using a threshold of 5% of the total area of an ecoregion. This is compared to the number of ecoregions in which each natural land use

class occurs within the study area. Similar to species data, rarity-weights are then calculated for each natural land use class based on the inverse of this number. For beta-diversity, irreplaceability is calculated for each ecoregion based on the number of natural land use occurrences in adjacent ecoregions within the study area.

Threat

Threat criteria and measures include factors that are likely to be exerting a negative influence on biodiversity, such as human footprint and recent changes in land cover. In total, 12 measures are mapped within seven different criteria. A summary of the criteria and measures for threat and the applied scoring and associated data sources are provided in Figure 4 and Table 5 below.

Table 5: Threat criteria and measures*

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
T1 HUMAN FOOTPRINT	T1a Human Footprint	Mean grid value for ecoregion	1-5 scoring categories based on natural breaks	Venter et al. 2016a MEDIUM-HIGH
	T1b Change in Human Footprint	Mean percent change from 1993 to 2009 in grid value for ecoregion	1-5 scoring categories based on natural breaks for values that have increased	Venter et al. 2016a MEDIUM-HIGH
T2 WATERSHED STRESS	T2 Watershed Stress	Cumulative sum of index values	Area-weighted by proportion of ecoregion 1-5 scoring categories based on natural breaks	Chu et al. 2015 MEDIUM-HIGH
T3 RISK INDEX	T3a Conservation Risk Index	Habitat protected : habitat converted (terrestrial portion)	1-5 scoring categories based on natural breaks	CCEA 2017 DUC 2016 MDDELCC 2017 ECCC 2016d BC NGO Conservation Areas Technical Working Group 2015 AAFC 2015b HIGH
	T3b Habitat Risk Index	Habitat natural : habitat converted (terrestrial portion) Natural excludes water	1-5 scoring categories based on natural breaks	AAFC 2015b HIGH
T4	T4 Fragmentation	Mean resistance value for ecoregion	1-5 scoring categories based on natural breaks	AAFC 2015b NRCan 2002, 2015 MEDIUM-HIGH
T5	T5 Land Use Change	Recent conversion from natural to urban and cropland, excluding water (2000-2010)	1-5 scoring categories based on natural breaks	AAFC 2015a, 2015b HIGH

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
T6 RATE OF CLIMATE CHANGE	T6a Mean Temperature Change	Rate of absolute change in mean temperature from the 1961-1990 and 1981-2010 climate normal period	1-5 scoring categories based on natural breaks	AdaptWest Project 2015 HIGH
	T6b Mean Precipitation Change	Rate of absolute change in mean precipitation (i.e. wetter or drier) from the 1961-1990 and 1981-2010 climate normal periods	1-5 scoring categories based on natural breaks	AdaptWest Project 2015 HIGH
	T6c Change in Growing Degree Days	Rate of absolute change in the mean number of growing degree days from the 1961-1990 and 1981-2010 climate normal period	1-5 scoring categories based on natural breaks	AdaptWest Project 2015 HIGH
T7	T7 Lack of Water	Mean score for ecoregion based on threats to water availability	1-5 scoring categories based on natural breaks	ECCC 2012 LOW-MEDIUM

* order does not denote priority

Human Footprint (Criterion T1)

Human footprint measures land uses and activities that are likely to have a negative impact on biodiversity and ecosystem functions and highlights areas where conservation actions may be more urgent. The global human footprint map (Venter et al. 2016a), which measures the cumulative human pressure on terrestrial ecosystems, is incorporated into this assessment and was based on population density, built-up areas, roads, railroads, navigable rivers, coastlines, land use/land cover and nighttime lights (Venter et al. 2016b). The mean 2009 footprint value and change in value from 1993 to 2009 of all grid cells within each ecoregion is calculated using zonal statistics and mapped.

Watershed Stress (Criterion T2)

Watershed stress is based on land uses and activities that are likely to impact the quality of freshwater ecosystems. This measure and criterion is derived from a Canada-wide assessment of watershed stress provided by Chu et al. (2015), which measures anthropogenic stress within tertiary watersheds by incorporating densities of dwellings, roads, crop farms, forestry operations, petroleum manufacturers, waste and remediation facilities, and discharge sites of industrial chimneys and laundry facilities. Here, the watershed stress values are area-weighted by the proportion of the watershed within the ecoregion and then summed to compute a cumulative watershed stress index value.

Figure 4: Threat criteria and measures

Conservation and Habitat Risk Index (Criterion T3)

Habitat and conservation risk provide a snapshot of the amount of natural habitat that is both remaining and protected. Based on Hoekstra et al. (2005), Conservation Risk Index (CRI) is calculated by dividing the percent of the ecoregion converted (i.e. developed or cropland) by the percent of the ecoregion protected by public or private lands. The percent converted is calculated from the 2010 Land Use map (AAFC 2015b). The computation for protected areas is described below (see Protected Areas (Criterion R1)). Although the CRI is also a measure of conservation response because it incorporates protected areas, it is included in the assessment of threats as ecoregions with fewer protected areas are at greater risk. Habitat risk index is calculated by dividing the percent of the ecoregion converted by the percent natural cover (excluding water).

Fragmentation (Criterion T4)

Fragmentation, or lack of connectivity, is based on landscape features that are likely to impede the movement and migration of wildlife, and shifts in habitats and species ranges. Connectivity is important for many species with respect to annual migrations, population dynamics and genetic interchange, and responding to changing environmental conditions including climate change. Fragmentation can be increased by human modifications to the landscape including roads, built-up areas and intensive agricultural use. Natural features such as large lakes, mountain ranges and ice fields can also limit overall landscape connectivity, and act to concentrate wildlife movements into specific areas. Climate change is increasing the importance of maintaining connectivity between natural habitats and protected areas to prevent local extinctions and facilitate range shifts of species and vegetation communities (Lindsay et al. 2016). The resistance values used to calculate the mean fragmentation score for the ecoregion can also be used to help identify corridors based on pathways of lower resistance. This final cost surface (see Intactness (Criterion B7)) is overlaid with the ecoregion boundaries and zonal statistics generated; the mean cost value for each ecoregion is then used to represent fragmentation.

Land Use Change (Criterion T5)

Land use change depicts very recent trends in natural habitat loss to agricultural and urban land uses. This criterion does relate to other criteria on biodiversity (e.g. B7 Natural Cover) and threat (e.g. T3 Risk Index), but highlights areas where conversion is a current issue. Ecoregions with higher rates of recent conversion to agricultural and urban land uses have higher probabilities of continued biodiversity losses.

For land use change, the 2000 (AAFC 2016a) and 2010 (AAFC 2016b) Land Use maps are combined and net changes in area from natural (excluding water) to converted (includes both urban and cropland) and vice versa are computed. Overall percent conversion from natural to converted is then calculated based on the difference in net gain (converted to natural) and net loss (natural to converted), relative to the total area in 2000. The net gain in natural cover is included to account for any misalignment of features (e.g. roads) at the pixel level in the original data between the two input years.

Rate of Climate Change (Criterion T6)

The impacts of climate change to biodiversity are based on observed changes (or deviations) to temperature, precipitation and growing degree days above 5°C[6] from the climate normal. Across all of Canada, temperatures have risen by 1.6°C, and are projected to continue to rise (Warren & Lemmen 2014). Forecasts of future temperature changes are not even across the study area. More rapid change is predicted to occur in boreal forests and temperate grasslands than temperate coniferous forests (Loarie et al. 2009). These forecasts are consistent with the observed rate of change in the study area. While some species and habitats may benefit from climate change, the rate of change may exceed the ability of these species to adapt, particularly in landscapes that are fragmented, lack refugia or have limited habitat for species to shift their range to (e.g. alpine). In general, the following species (or populations) are expected to be most vulnerable to climate change and are most likely to be affected by the smallest amount of change (CMP 2013, Feltmate & Thistlethwaite 2012, Rustad et al. 2012, Glick et al. 2011):

- Species with coastal habitats that may disappear with sea level rise;
- Species that are already living at the upper end of their biological temperature range and that may not be able to tolerate higher maximum temperatures and increasing fluctuations;
- Species that are already heavily stressed and that may be further impacted by increases in temperature or by precipitation changes, unpredictability and extreme weather events;
- Species restricted to specialized habitat or microhabitat requirements;
- Species with narrow climatic tolerances or thresholds that are likely going to be exceeded under climate change;
- Species that depend on specific environmental triggers or interactions with other species that are likely going to be disrupted by climate change;
- Species with a poor ability to disperse quickly or to colonize a new, more suitable range;
- Species with restricted geographical ranges or small isolated populations.

Species-specific climate change vulnerability assessments (e.g. Shank & Nixon 2014, Brinker & Jones 2012) are outside of the scope of this national assessment.

Gridded current climate data for North America are available from the AdaptWest Project (2015) at 1 km grid resolution. For this assessment, the mean annual temperature, mean annual precipitation and number of growing degree days above 5° Celsius (C) for both the 1961-1990 and 1981-2010 climate normal periods are downloaded. For these three variables, the difference, or absolute rate of change (also known as "climate velocity") between the two climate normal periods is calculated for each grid cell and then the mean value of all grid cells within each ecoregion is computed. Data on climate velocity based on recent observed changes is favoured over data based on modeling climate change scenarios because of its lower level of uncertainty. Past climate velocity is considered the best available nation-wide indicator of the pressure that is exerted on biodiversity from climate change, although vulnerability to climate change will be species- or population-specific.

---

[6] Accumulated difference between 5°C and the mean daily temperature for every day of the year when the mean temperature is above 5°C. Each degree Celsius above 5°C is considered one degree day. Measurement of heat accumulation to assess the suitability of temperature conditions for plant growth (NRCan 1981).

Lack of Water (Criterion T7)

Withdrawals of water for human use can impact terrestrial and aquatic ecosystems by altering the flow regimes of rivers and streams. A reduction in water supply can reduce the amount of available aquatic habitats and alter riparian processes (Patterson et al. 2017). For this analysis of threats, lack of water is based on water availability data from ECCC (2012), which was calculated at a sub-drainage level by dividing water demand by water supply. Water demand was determined from water intake data from industrial, agricultural and municipal water use, and wastewater surveys, while water supply was derived from hydrometric data. ECCC categorized water availability into four levels of threat: low (<10% water withdrawn), moderate (10 to 20%), medium (20 to 40%) and high (>40%). For inclusion here, the four threat categories are assigned a score from 1 (low) to 4 (high) and averaged across all sub-drainage units in the ecoregion; natural breaks are then applied to those averages.

Conservation Response

The two conservation response criteria, protected areas and representation, depict the distribution and relative values of existing conservation efforts that are likely to protect biodiversity. A summary of the criteria and the applied scoring and associated data sources is provided in Figure 5 and Table 6 below. International biodiversity designations (e.g. World Biosphere Reserves) were not included in the analysis because these designations are not counted as protected areas in Canada, and their effectiveness as a conservation response varies. Biodiversity designations are important to highlight places of national and global significance, and potential partnership opportunities, and can be incorporated into more detailed analysis of ecoregions.

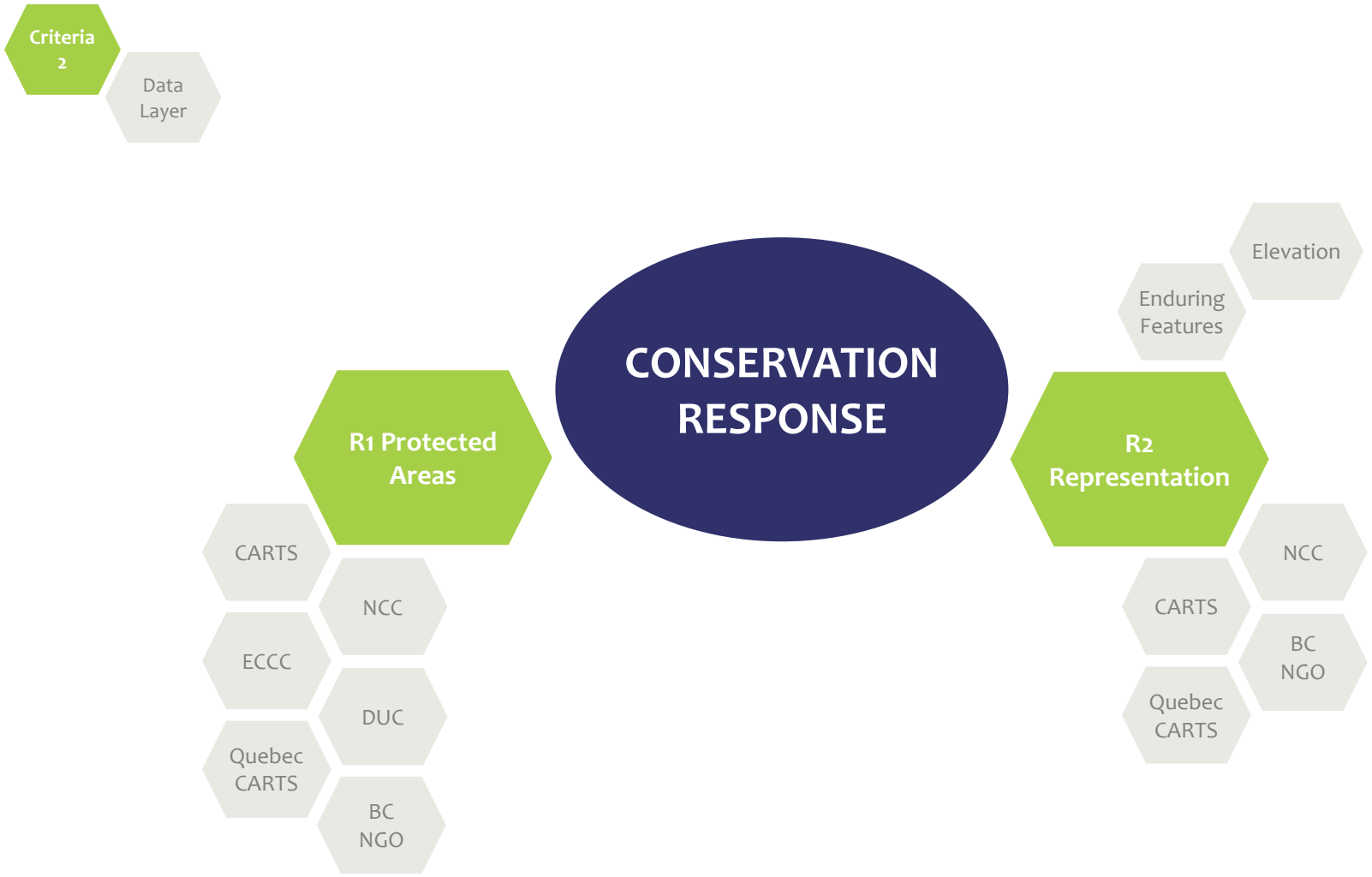

Figure 5: Conservation response criteria and associated source data

Table 6: Conservation response criteria and measures*

Criterion	Measure	Description	Map Classification (and Scoring)	Data Source / Assessment of Data Quality
R1 PROTECTED AREAS	R1 Protected Areas	Percent of ecoregion (terrestrial portion) Includes public lands and private fee simple and conservation agreements registered on title	5: >25 4: 17-25% 3: 10-17% 2: 5-10% 1: <5% Based on ECCC 2016a	CCEA 2017 DUC 2016 MDDELCC 2017 ECCC 2016d BC NGO Conservation Areas Technical Working Group 2015 HIGH
R2 REPRESENTATION	R2 Representation	Mean percent of enduring landform features protected in ecoregion (terrestrial portion) Includes public lands and private fee simple and conservation agreements registered on title	5: >25 4: 17-25% 3: 10-17% 2: 5-10% 1: <5% Based on ECCC 2016a	CCEA 2017 MDDELCC 2017 BC NGO Conservation Areas Technical Working Group 2015 WWF-Canada 2012 Kavanagh & Iacobelli 1995 NRCan 2002 MEDIUM

* order does not denote priority

Protected Areas (Criterion R1)

Protected areas are the foundation for effective conservation. As of the end of 2016, Canada has 10.5% of terrestrial and inland waters areas protected, with a goal of protecting 17% by 2020 (ECCC 2016a, 2016b). Canada's goal for protected areas reflects international Aichi targets, which, in addition to calling for the protection of at least 17%, also advises that the protected areas should be representative. One measure of effective representation would include protecting ecoregions across the country.

Percent protected areas is calculated using a variety of data. All protected public areas[7] included in Conservation Areas Reporting and Tracking System (CARTS, CCEA 2017) and Quebec's Protected Areas Network (MDDELCC 2017) are used to measure the percent of ecoregions protected. As not all privately protected areas are included in these two datasets, private conservation lands from other sources are incorporated in their place. The areas of private[8] protected lands from NCC[9] and the British Columbia's Non-governmental Organization (NGO) Conservation Areas Database (BC NGO Conservation Areas Technical Working Group 2015) are calculated and added to the total area of protected areas. The area of private lands is further supplemented with data from Ducks Unlimited Canada[10] (DUC 2016) and ECCC's Private Conservation Lands database (2016d) summarized at

[7] Excludes marine portions of protected areas and National Marine Conservation Areas
[8] Includes fee simple and conservation agreement lands
[9] As of February 28, 2018
[10] As of April 4, 2016

10x10 km grid squares for provinces outside of British Columbia. Each of the protected lands data layers is then intersected with each ecoregion (excluding marine areas) to determine the area of each type of protected area (public, private, NCC and DUC), and the total percentage protected.

Representation (Criterion R2)

The representation analysis identifies ecoregions where existing protected areas include the full diversity of landform features. Landform features, based on topography, texture, and type of surficial deposit identified from the World Wildlife Fund's (WWF's) enduring features layer (Kavanagh & Iacobelli 1995, WWF-Canada 2012) and elevation (NRCan 2002). Elevation is grouped into ten unique categories 0-60 m, 61-240 m, 241-460 m, 461-860 m, 861-1,200 m, 1,201-1,380 m, 1,381-1,520 m, 1,521-1,830 m, 1,831-2,130 m and >2,130 m based on latitude-adjusted elevation classes for vegetation life zones in mountainous areas of North America defined by Michalak et al. (2015). Enduring features and elements delineated from soil and landform information have been used as the basis for other gap analyses (Gerardin et al. 2002, Davis et al. 2006, Iacobelli et al. 2006, Environment and Natural Resources 2016), and is used here as a surrogate for ecological systems. In lieu of protected area size guidelines that have been used in other studies to score representation, the percent protected of each unique terrestrial landform feature is calculated and then averaged across each ecoregion. Public and privately protected areas, except for those only available at the 10x10 km grid square level are used for this calculation.

NCC's Assessment of the Criteria and Measures to Identify Important Ecoregions

There are numerous ways in which the information on biodiversity, threat and conservation response can be scored and analysed to classify ecoregions. This section describes the statistical analysis and scoring used by NCC to assess each ecoregion.

Statistical Analysis

A regression analysis is conducted to determine whether ecoregion size has an influence on any of the measures used in the assessment (e.g. do larger ecoregions yield higher species counts?). The raw values of each measure are regressed with ecoregion area and wherever area has a significant effect on a measure, the residual variation from the effect for each ecoregion is extracted from the mean value of that measure. For each of these measures, the raw values are replaced by the adjusted values derived from the residual variation for the remainder of the analysis.

Three different statistical methods are then used to identify biodiversity, threat and conservation response measures that are highly correlated with each other to remove potential redundancy (i.e. measures that do not add strength to the subsequent analysis of ecoregion priorities) and double-counting. It is important to note that strong collinearity between measures does not necessarily indicate redundancy. The redundancy analyses aim to remove artificial relationships arising from how measures are calculated (e.g. collinearity only arises because of how the measures are calculated and not because of real biological relationships), thus retaining meaningful biological relationships.

First, a redundancy analysis is completed to detect measures with significant collinearity (Legendre & Legendre 2012). The redundancy analysis is a multivariate additive model that uses regression splines to determine the degree to which each measure can be predicted from the remaining measures. In a stepwise fashion, the most predictable measure is removed based on a prior specified correlation coefficient value. The stepwise reduction is continued until none of the remaining measures can be predicted at the prior specified coefficient value (e.g. R^2). Second, a cluster analysis

groups measures that are similar to a degree that they can be regarded as a single measure (Legendre & Legendre 2012). Here, a hierarchical cluster analysis based on Spearman ranked correlations for which two measures are both positive is used. Although the clustering is based on ranks, the strength of the clustering is identified by the Spearman correlation coefficient, ρ^2. Third, correlation matrices are used to visualize relationships between the measures and identify significant linear correlations (Zar 1999).

For all three redundancy analyses, a conservative correlation coefficient cut off value of 0.70 (e.g. adjusted $R^2 = 0.70$) is used to identify and remove redundant measures from further analysis. The literature recommends cut off R^2 values ranging from 0.70 to 0.80 (Berry & Feldman 1985, Watts et al. 2015). However, because higher degrees of collinearity do not necessarily translate into greater R^2 values (Berry & Feldman 1985), a conservative cut off value of 0.70 is used here. After the statistical analysis, redundant measures (7 biodiversity, 2 threat) are removed from further consideration in the analysis.

Scoring

To assess relative importance across ecoregions, scores are assigned to measures for each ecoregion in the study area. This scoring value is based on the relative value of the measure across the study area and only uses those measures retained after redundant ones are removed. In most cases, the range of scoring values is classified into five natural breaks (Jenks optimization method (ESRI 2012)) so that a numerical score of 1-5 could be applied to each assessment measure for each ecoregion. Based on natural groupings inherent in the data, natural breaks also minimize the variance within each scoring class, while maximizing the variance between classes. Scores of 1 represented the lowest score and scores of 5 represented the highest scores. Scores of 0 were used in measures with no values. For three measures, scores are based on manual breaks. As noted above, classification and scoring of Natural Cover (B7a) is based on How Much Habitat is Enough Guidelines (ECCC 2013a), while Protected Areas (R1) and Representation (R2) are based on current protected areas targets committed to internationally and by Canada under Aichi Target 11. The scoring categories for one additional measure, Size of Largest Block of Intact Habitat (B7a), are based on a Habitat Block Analysis (Ricketts et al. 1999; see Appendix D).

The two broad categories of species- and landscape-related biodiversity criteria (see Figure 3) are generally contrasting, with important ecoregions for intact landscapes primarily found in the northern part of the study area, and ecoregions that are important for species conservation, particularly species at risk (Kerr & Cihlar 2004), generally in the southern part of the study area. To avoid averaging these two divergent categories, the final score for biodiversity is based on scores for all the individual species measures and all the individual landscape measures added together. The scores are then summed using two different approaches. First, a "Measures" approach is taken where all the individual measures are summed to produce total scores for each of the biodiversity, threat and conservation response assessments. The results are also scored using a "Criteria" approach that sums all measures within each criterion. The sum of each criterion is then rescaled back to a score from 1 to 5 using natural breaks. For example, Intactness (B7) is calculated by adding the scores for Natural Cover (B7a), Intact Mammal Fauna (B7b), Size of Largest Block of Intact Habitat (B7c) and Connectivity (B7d). The total score for B7 is then reclassified into five categories based on natural breaks and assigned a final rescaled score from 1 to 5. Rescaled scores are calculated for all criteria with multiple measures, and then the criteria scores are added together to produce a total score for each assessment.

Classifying Ecoregions by Biodiversity and Threat Values

For both the Measures and Criteria approaches, the resulting total scores for biodiversity and threat for each ecoregion are plotted on a scatter diagram to identify ecoregions with similar characteristics. Total biodiversity scores are shown on the x-axis and total threat scores on the y-axis. To distinguish between higher and lower scoring ecoregions on both axes, the resulting total biodiversity and threat scores are each reclassified into five natural break categories. The threshold between the third and fourth highest categories are used to define ecoregions with higher relative total scores. The ecoregion priorities from both methods (Measures and Criteria) are mapped individually and then combined together into one final map with the highest scores from either approach taking precedence.

RESULTS

This section includes results of the statistical analysis and the use of the final scores from the biodiversity and threat assessments to create plots using the Measures and Criteria approaches. The final map and list of highest scoring ecoregions created by combining the two approaches is then presented.

Statistical Analysis

The results of the statistical analysis is divided into three sections. The first presents the results related to biodiversity measures, the second related to threat measures. The third section summarizes the results of the redundancy analysis and identifies the final suite of criteria and measures used to assess ecoregions.

Biodiversity

The regression analysis indicates that only two of the 21 biodiversity measures are significantly influenced by ecoregion size (P<0.01; see Figure 6). Larger sized ecoregions yield a higher total number of species for Species Richness: Range Map Species (B1a) and Ecological Responsibility (B4b). For these two measures, the raw count values are replaced by the adjusted values derived from the residual variation from the mean. The log-transformation of these adjusted values are then used for the remaining analyses (i.e. redundancy analysis, mapping and scoring).

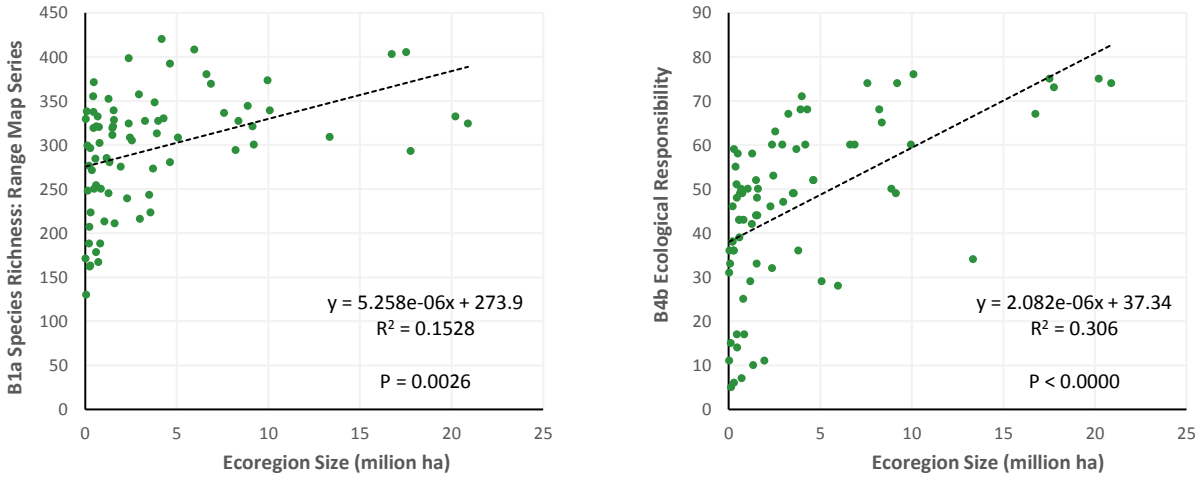

Figure 6: Regression of ecoregion size against biodiversity measures B1a and B4b
The three statistical methods used to assess the individual measures for redundancy produced similar results with a few exceptions. The redundancy analysis recommends removing eight of the 21 biodiversity measures – all related to species (

Table 7). The degree with which each of these redundant measures can be predicted from the remaining measures (R^2) is greater than 0.70.

Table 7: Redundancy analysis of species related biodiversity measures

Redundant Measures	Non-Redundant Measures
B1b Species Richness: Tracked Species	B1a Species Richness: Range Map Species (residuals)
B2b Irreplaceability of COSEWIC assessed wildlife species	B2a Richness of COSEWIC assessed wildlife species
B2c Richness of COSEWIC candidate wildlife species	B4a Irreplaceability of Canadian endemic species
B2d Irreplaceability of COSEWIC candidate wildlife species	B4b Ecoregional Responsibility (range maps; residuals)
B3a Richness of globally rare species	B5b Unique Species: Tracked Species
B3b Irreplaceability of globally rare species	B5d Beta-Diversity: Species Range
B5a Unique Species: Species Range	
B5c Distinctive Species: Species Range	

The cluster analysis based on ranks identified six redundant biodiversity measures, again all related to species (Figure 7). The individual measures included in the Species at Risk (B2) and Globally Rare Species (B3) criterion are clustered together and their cluster nodes fall to the left of the vertical line (i.e. $\rho^2 > 0.70$) indicating strong collinearity and possibly redundancy. Contrary to the redundancy analysis, the cluster analysis recommends retaining Species Richness: Tracked Species (B1b) and Unique Species: Species Range (B5a). The correlation matrix also supports retaining these measures (Figure F.1, Appendix F). Although B1a is correlated with other measures, none of the R^2 values are greater than the 0.70 cut off. Furthermore, B5a is only above the cut off value of 0.70 when correlated with four other measures: Irreplaceability of COSEWIC assessed wildlife species (B2b), Richness of COSEWIC candidate wildlife species (B2c), Irreplaceability of COSEWIC candidate wildlife species (B2d) and Distinctive Species: Species Range (B5c). When these measures are removed, B5a remains in the analysis and representative of these other four measures (Figure F.2, Appendix F).

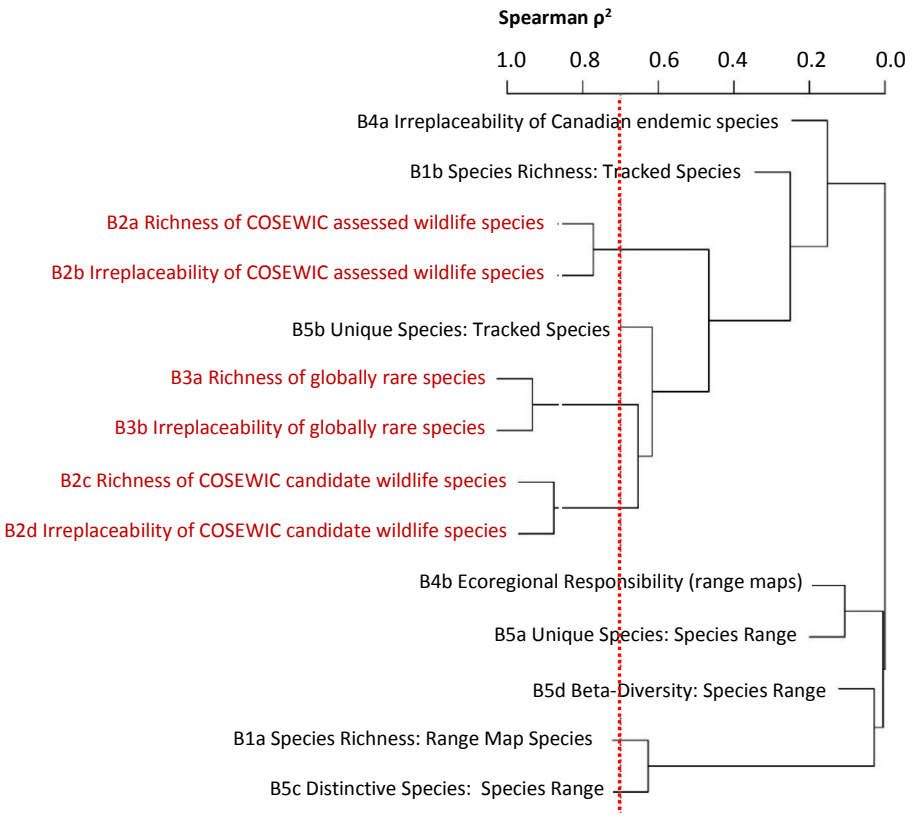

Figure 7: Cluster analysis of species-related biodiversity measures. The x-axis represents the Spearman ranked correlation coefficient ρ^2. Six measures (highlighted in red text) have cluster nodes left of the vertical red line ($\rho^2 = 0.7$) indicating they may be redundant

When the remaining biodiversity measures (i.e. landscape-related measures) were tested for redundancy with each other (Figure 8; Figure F.3, Appendix F) and with the species-related biodiversity measures, no significant relationships were found.

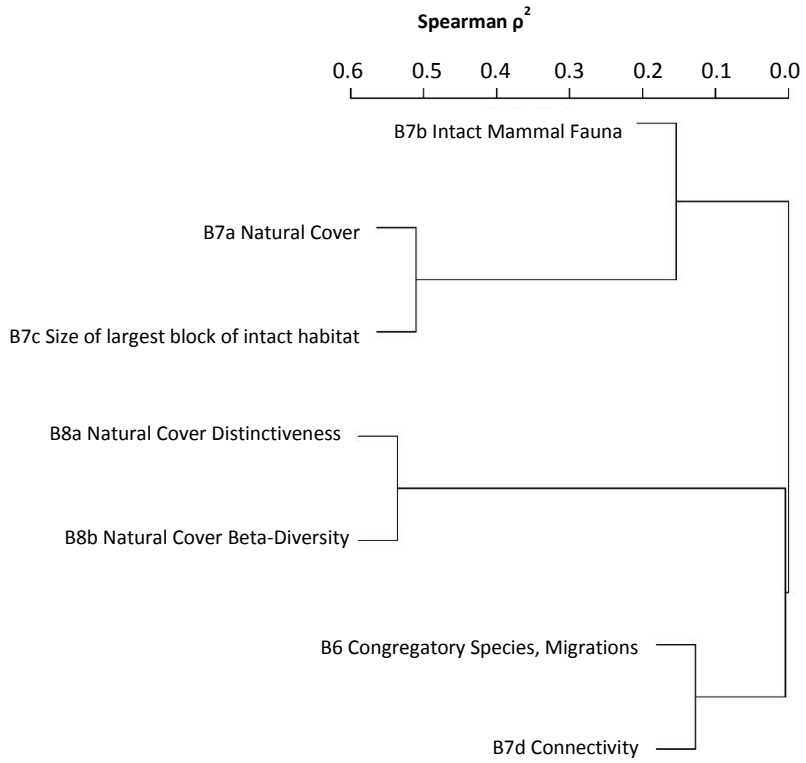

Figure 8: Cluster analysis of landscape-related biodiversity measures. The x-axis represents the Spearman ranked correlation coefficient ρ^2. Landscape measures are less similar.

Threats

The regression analysis indicates that none of the threat measures are significantly influenced by ecoregion size.

The results of the three statistical methods to address redundancy recommend removing two of the 11 threat measures: Human Footprint (T1a) and Habitat Risk Index (T3b). The redundancy analysis itself indicates that these two measures are highly correlated. The correlation matrix further supports this, as both of these measures can be predicted by the CRI (T3a; Figure F.4, Appendix F). The cluster analysis also identifies Land Cover Change (T5) as possibly being redundant to the three aforementioned measures (T1a, T3a and T3b). All four of these measures have a $\rho^2 > 0.70$, which exceeds the cut off value (Figure 9). However, neither the redundancy analysis nor the correlation matrix supports the removal of these additional measures. The two recommended measures for removal are based on data that is included in other threat measures. Both Human Footprint (T1a) and Habitat Risk Index (T3b) incorporate land use information, which is also integrated into Watershed Stress Index (T2).

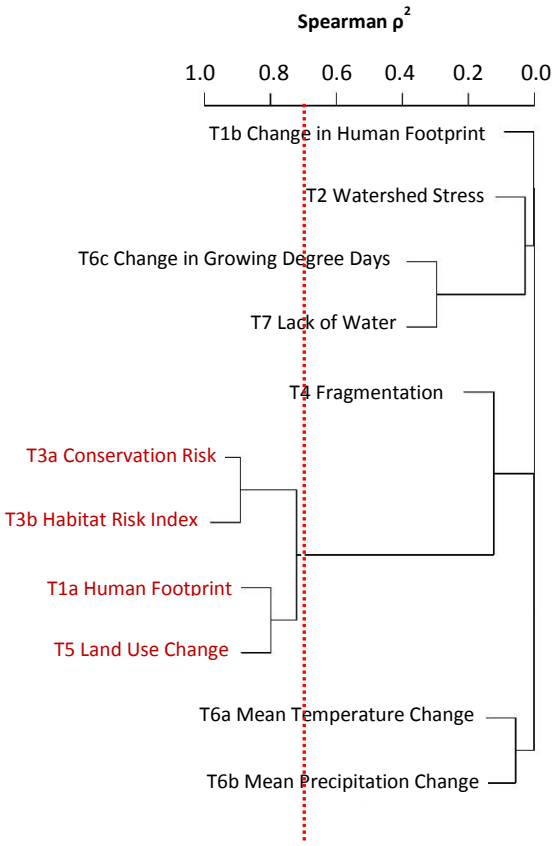

Figure 9: Cluster analysis of threat measures. The x-axis represents the Spearman ranked correlation coefficient ρ^2. Four measures (highlighted in red text) have cluster nodes left of the vertical red line ($\rho^2 = 0.7$) indicating they may be redundant.

Biodiversity and threat measures are also tested against each other for redundancy, but no significant relationships are found.

Final Suite of Criteria and Measures

A comparison of the results from the three statistical methods to identify redundancy is summarized in Table 8. Measures are removed from the analysis if two of the three statistical methods identified them as redundant. The number of biodiversity measures are reduced from 21 to 13, thereby eliminating two of the eight criteria. The number of threat criteria stayed the same, but the number of measures is reduced from 11 to nine. The conservation response measures remained unaffected. This final suite of criteria and measures are then used to generate the final ecoregional scores for biodiversity, threat and conservation response.

Table 8: Summary of criteria and measures; ✘ indicates redundant measures, ✓ indicates retained measures. Criteria and measures removed from the final analysis are also shaded and in red text.

Assessment	Criteria	Measure	Redundancy Analysis	Cluster Analysis	Correlation Matrix	Final Suite
Biodiversity	B1 Species Richness	B1a Species Richness: Range Map Species (residuals)	✓	✓	✓	✓
		B1b Species Richness: Tracked Species	✘	✓	✓	✓
	B2 Species at Risk	B2a Richness of COSEWIC assessed wildlife species	✓	✘	✘	✘
		B2b Irreplaceability of COSEWIC assessed wildlife species	✘	✘	✘	✘
		B2c Richness of COSEWIC candidate wildlife species	✘	✘	✘	✘
		B2d Irreplaceability of COSEWIC candidate wildlife species	✘	✘	✘	✘
	B3 Globally Rare Species	B3a Richness of globally rare species	✘	✘	✘	✘
		B3b Irreplaceability of globally rare species	✘	✘	✘	✘
	B4 Species of High Conservation Responsibility	B4a Irreplaceability of Canadian endemic species	✓	✓	✓	✓
		B4b Ecoregional Responsibility (range maps; residuals)	✓	✓	✓	✓
	B5 Unique and Distinctive Species	B5a Unique Species: Species Range	✘	✓	✓	✓
		B5b Unique Species: Tracked Species	✓	✘	✓	✓
		B5c Distinctive Species: Species Range	✘	✓	✘	✘
		B5d Beta-Diversity: Species Range	✓	✓	✓	✓
	B6 Key Biodiversity Areas	B6 Congregatory Species, Migrations	✓	✓	✓	✓
	B7 Intactness	B7a Natural Cover	✓	✓	✓	✓
		B7b Intact Mammal Fauna	✓	✓	✓	✓
		B7c Size of Largest Block of Intact Habitat	✓	✓	✓	✓
		B7d Connectivity	✓	✓	✓	✓
	B8 Ecosystem Distinctiveness	B8a Natural Cover Distinctiveness	✓	✓	✓	✓
		B8b Natural Cover Beta-Diversity	✓	✓	✓	✓
Threat	T1 Human Footprint	T1a Human Footprint	✘	✘	✓	✘
		T1b Change in Human Footprint	✓	✓	✓	✓
	T2 Watershed Stress	T2 Watershed Stress	✓	✓	✓	✓
	T3 Risk Index	T3a Conservation Risk Index	✓	✘	✓	✓
		T3b Habitat Risk Index	✘	✘	✓	✘
	T4 Fragmentation	T4 Fragmentation	✓	✓	✓	✓
	T5 Land Use Change	T5 Land Use Change	✓	✘	✓	✓
	T6 Rate of Climate Change	T6a Mean Temperature Change	✓	✓	✓	✓
		T6b Mean Precipitation Change	✓	✓	✓	✓
		T6c Change in Growing Degree Days	✓	✓	✓	✓
	T7 Lack of Water	T7 Lack of Water	✓	✓	✓	✓
Response	R1 Protected Areas	R1 Protected Areas	✓	✓	✓	✓
	R2 Representation	R2 Representation	✓	✓	✓	✓

Ecoregion Scores for Biodiversity, Threat and Conservation Response

This section presents the scores and final maps from the biodiversity, threat and conservation response assessment. Individual maps for all measures, including those excluded from the statistical analysis above, are provided in Appendix G along with a discussion of each. Scores for all measures are also included in Appendix H (ecoregion scoring table workbook) and additional information for each ecoregion is provided in Appendix I.

Biodiversity

Total biodiversity scores using the Measures approach have a potential maximum score of 70 (maximum score of 5 for each of 14 measures). Total scores range from 17 to 44, with 23 of the ecoregions scoring in the top two categories (Figure 10). Ecoregions with the highest total biodiversity scores are the Mid-Boreal Uplands, Eastern Continental Ranges, Northern Continental Divide, and Eastern and Western Vancouver Island.

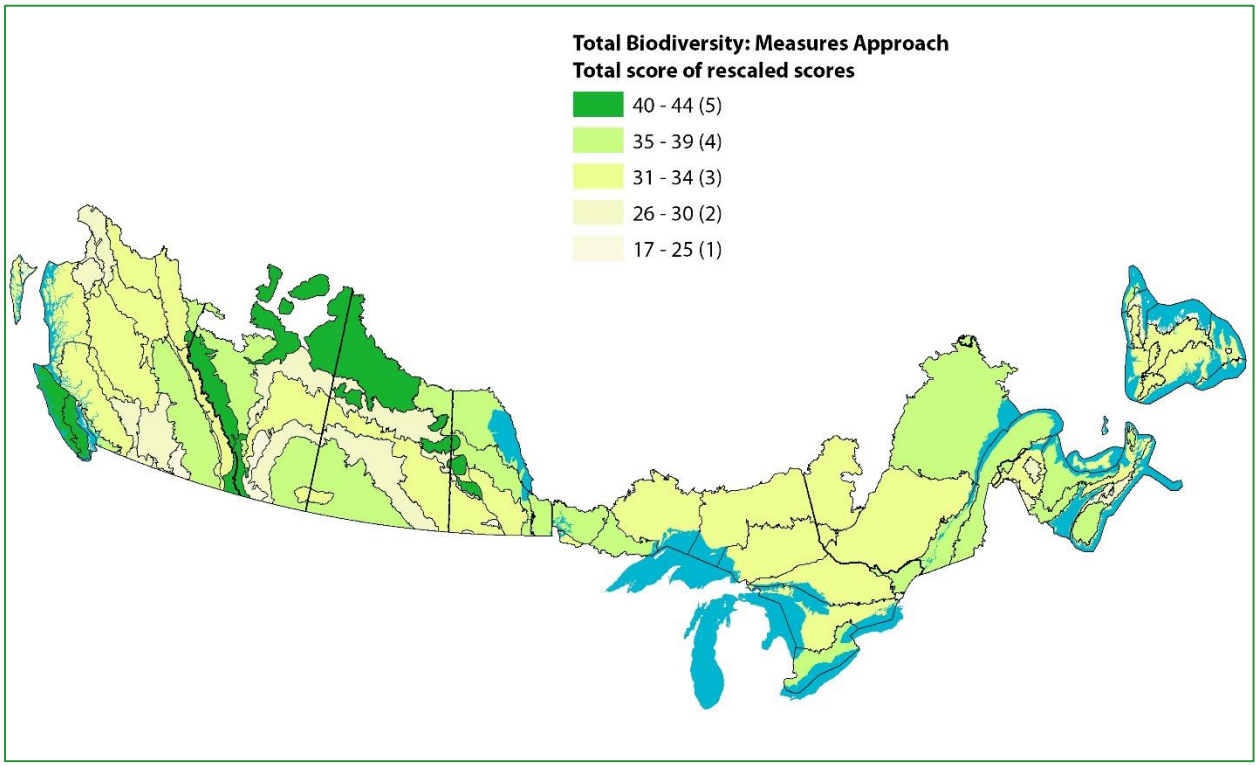

Figure 10: Total biodiversity scores (Measures approach)

The total biodiversity scores using the Criteria approach have a potential maximum score of 30 (maximum score of 5 for each of 6 criteria). Total scores range from 8 to 21; 29 ecoregions scored in the top two categories. Ecoregions with the highest total biodiversity scores are the Fundy Coast, Maritime Lowlands, Southern New Brunswick Uplands, Appalachians, St. Lawrence Lowlands, Lake Erie Lowland, Manitoulin-Lake Simcoe, Mid-Boreal Lowland, Mid-Boreal Uplands, Interlake Plain, Mixed Grassland, Eastern Continental Ranges, Northern Continental Divide and Eastern and Western Vancouver Island (Figure 11).

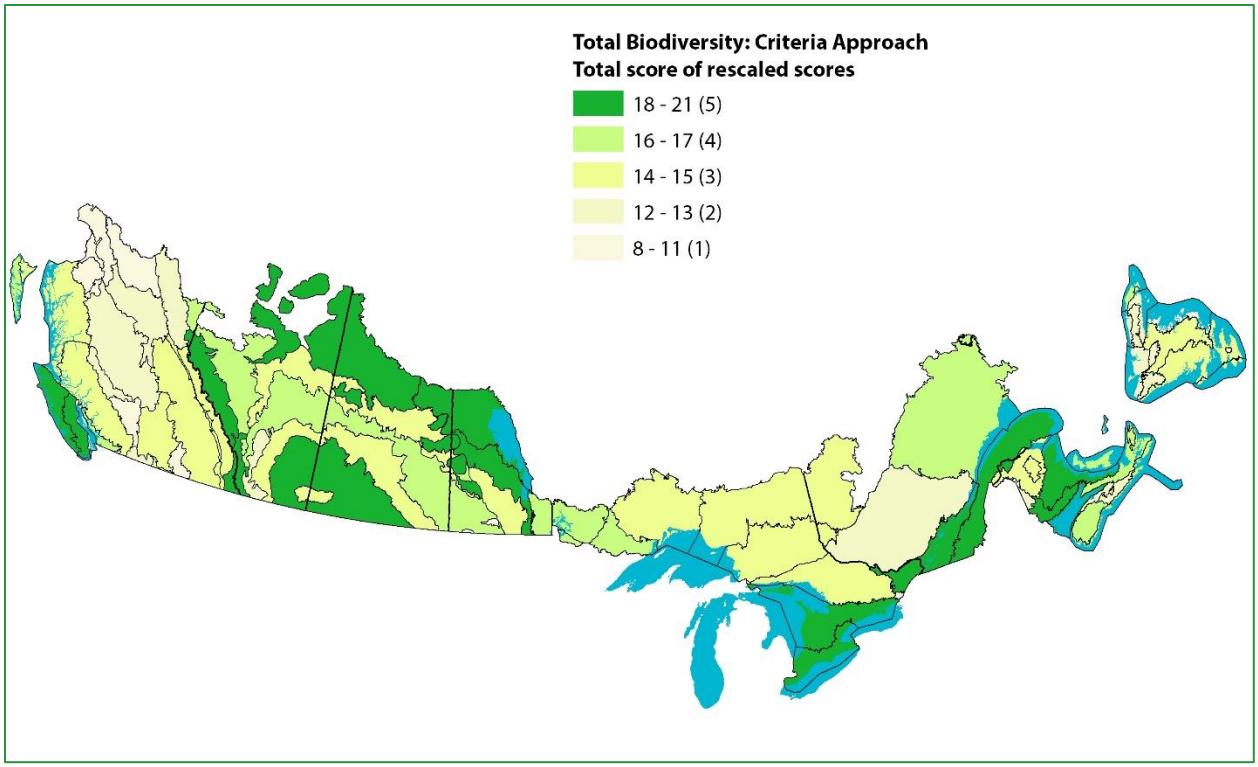

Figure 11: Total biodiversity scores (Criteria approach)

The individual measure scores and rescaled criteria scores for biodiversity along with the final total score using both the Measures and Criteria approach are presented in Table 9.

Table 9: Biodiversity scores of ecoregions (sorted by ecozone); colour indicates rescaled biodiversity scores (5 , 4 , 3 , 2 , 1 and 0).

ECOZONE NAME	ECOREGION NAME	ID	B1a Species Richness: Range Map Species (residuals)	B1b Species Richness: Tracked Species	B1 SPECIES RICHNESS	B4a Irreplaceability Canadian endemic species	B4b Ecological Responsibility (range maps, residuals)	B4 SPECIES OF HIGH CONSERVATION RESPONSIBILITY	B5a Unique Species: Species Range Maps	B5b Unique Species: Tracked Species	B5d Beta-Diversity: Species Range	B5 UNIQUE AND DISTINCTIVE SPECIES	B6 KEY BIODIVERSITY AREAS (Congregatory Species)	B7a Natural Cover	B7b Intact Mammal Fauna	B7c Size of largest block of intact habitat	B7d Connectivity	B7 INTACTNESS	B8a Natural Cover Distinctiveness	B8b Natural Cover Beta-Diversity	B8 ECOSYSTEM DISTINCTIVENESS	*TOTAL BIODIVERSITY SCORE: MEASURES APPROACH*	*TOTAL BIODIVERSITY SCORE: CRITERIA APPROACH*
Atlantic Highlands	Appalachians	117	4	5	5	5	4	5	0	4	3	3	2	4	0	1	5	3	1	1	1	39	19
	New Brunswick Highlands	119	2	3	3	1	5	4	0	1	4	2	0	5	0	1	5	3	1	2	2	30	14
	Northern New Brunswick Uplands	118	4	4	4	2	5	4	0	3	2	2	1	5	0	1	5	3	1	1	1	34	15
Atlantic Maritime	Annapolis-Minas Lowlands	126	4	4	4	1	4	3	0	2	2	2	1	3	0	1	3	2	1	1	1	27	13
	Atlantic Coast	125	4	4	4	2	4	4	0	3	2	2	3	5	0	2	2	2	1	2	2	34	17
	Cape Breton Highlands	129	1	3	2	1	4	3	0	2	4	3	2	5	0	3	5	3	2	4	3	36	16
	Fundy Coast	123	5	5	5	2	4	4	0	4	2	3	4	4	0	1	3	2	1	1	1	36	19
	Îles-de-la-Madeleine	131	1	1	1	2	2	3	0	1	5	3	1	4	0	1	0	1	2	5	4	25	13
	Maritime Lowlands	122	4	5	5	3	4	4	0	4	2	3	2	5	0	1	4	3	1	1	1	36	18
	Nova Scotia Highlands	128	4	5	5	2	4	4	0	2	1	1	2	5	0	2	5	3	1	1	1	34	16
	Prince Edward Island	130	2	4	3	2	3	3	0	5	3	4	3	3	0	1	1	1	1	3	2	31	16
	Saint John River Valley	120	3	3	3	0	5	3	0	3	3	3	0	4	0	1	5	3	1	1	1	29	13
	South-central Nova Scotia Uplands	127	4	3	4	0	4	3	0	0	2	1	0	5	0	1	4	3	1	2	2	26	13
	Southern New Brunswick Uplands	121	5	5	5	1	5	4	0	4	3	3	1	5	0	1	5	3	1	3	2	39	18
	Southwest Nova Scotia Uplands	124	4	4	4	2	3	3	0	4	3	3	1	5	0	2	4	3	1	2	2	35	16
Boreal Plains	Boreal Transition	149	3	4	4	0	5	3	0	2	2	2	3	2	0	4	2	2	1	1	1	29	15
	Interlake Plain	155	4	2	3	1	5	4	0	2	1	1	3	4	0	5	3	3	4	3	4	37	18
	Mid-Boreal Lowland	148	2	2	2	1	5	4	0	1	2	1	5	5	0	5	2	3	4	4	5	38	20
	Mid-Boreal Uplands	139	2	5	4	2	2	3	0	5	2	3	4	5	0	5	5	4	3	3	3	43	21
	Western Alberta Upland	145	3	4	4	1	5	4	0	2	2	2	1	5	2	5	5	4	1	1	1	37	16
Boreal Shield	Abitibi Plains	96	1	3	2	2	2	3	0	1	3	2	0	5	1	5	5	4	2	4	3	34	14
	Algonquin-Lake Nipissing	98	4	4	4	1	4	3	0	3	2	2	1	5	0	2	5	3	1	1	1	33	14
	Avalon Forest	115	1	2	1	0	3	2	0	1	2	1	0	5	0	1	5	3	2	4	3	26	10
	Central Laurentians	101	1	3	2	1	2	2	0	4	3	3	2	5	3	5	5	5	1	3	2	38	16
	Central Newfoundland	112	1	3	2	0	3	2	1	2	1	2	0	5	0	5	5	4	3	4	4	33	14
	Lac Temiscamingue Lowland	97	3	3	3	0	4	3	0	2	3	2	1	5	0	5	5	4	1	2	2	34	15
	Lake Nipigon	94	2	2	2	2	4	4	0	3	4	3	0	5	0	5	4	4	1	2	2	34	15
	Lake of the Woods	91	4	3	4	0	5	3	0	3	3	3	0	5	0	3	5	3	3	3	3	37	16
	Long Range Mountains	108	1	3	2	1	4	3	0	2	1	1	0	5	0	5	5	4	2	2	2	31	12
	Maritime Barrens	114	1	3	2	0	3	2	1	2	1	2	3	5	0	5	5	4	2	2	2	33	15
	Northeastern Newfoundland	113	1	2	1	1	2	2	0	1	1	1	2	5	0	4	3	3	1	2	2	25	11
	Northern Peninsula	107	1	3	2	3	3	4	0	2	1	1	1	5	0	5	4	4	1	1	1	30	13
	Rainy River	92	3	2	3	0	5	3	0	2	4	3	1	4	0	1	4	2	3	4	4	33	16
	South Avalon-Burin Oceanic Barrens	116	1	2	1	0	3	2	0	1	3	2	2	5	0	4	5	4	2	4	3	32	14
	Southern Laurentians	99	4	4	4	1	2	2	0	2	3	2	1	5	0	2	5	3	1	1	1	31	13
	Southwestern Newfoundland	109	1	3	2	1	4	3	0	3	2	2	1	5	0	3	5	3	1	2	2	31	13
	Strait of Belle Isle	106	1	3	2	4	2	4	0	4	3	3	0	5	0	3	4	3	3	5	5	37	17
	Thunder Bay-Quetico	93	3	2	3	0	5	3	1	2	4	3	0	5	0	5	5	4	2	3	3	37	16
Mixedwood Plains	Frontenac Axis	133	4	2	3	0	2	1	0	1	3	2	0	3	0	1	3	2	1	2	2	22	10
	Lake Erie Lowland	135	5	5	5	1	2	2	5	5	5	5	3	1	0	1	1	1	1	2	2	37	18
	Manitoulin-Lake Simcoe	134	5	5	5	1	3	3	0	4	4	4	4	2	0	1	2	1	1	2	2	34	19
	St. Lawrence Lowlands	132	5	5	5	3	4	4	3	5	3	5	2	2	0	1	2	1	1	1	1	37	18

ECOZONE NAME	ECOREGION NAME	ID	B1a Species Richness: Range Map Species (residuals)	B1b Species Richness: Tracked Species	B1 SPECIES RICHNESS	B4a Irreplaceability Canadian endemic species	B4b Ecological Responsibility (range maps, residuals)	B4 SPECIES OF HIGH CONSERVATION RESPONSIBILITY	B5a Unique Species: Species Range Maps	B5b Unique Species: Tracked Species	B5d Beta-Diversity: Species Range	B5 UNIQUE AND DISTINCTIVE SPECIES	B6 KEY BIODIVERSITY AREAS (Congregatory Species)	B7a Natural Cover	B7b Intact Mammal Fauna	B7c Size of largest block of intact habitat	B7d Connectivity	B7 INTACTNESS	B8a Natural Cover Distinctiveness	B8b Natural Cover Beta-Diversity	B8 ECOSYSTEM DISTINCTIVENESS	*TOTAL BIODIVERSITY SCORE: MEASURES APPROACH*	*TOTAL BIODIVERSITY SCORE: CRITERIA APPROACH*
Montane Cordillera	Bulkley Ranges	201	2	1	1	0	3	2	0	0	2	1	0	5	5	5	5	5	2	2	2	32	11
	Central Canadian Rocky Mountains	200	2	1	1	0	4	3	0	2	1	1	0	5	5	5	5	5	2	1	2	33	12
	Chilcotin Ranges	204	3	1	2	0	2	1	0	0	2	1	0	5	5	5	1	4	5	4	5	33	13
	Columbia Mountains and Highlands	205	3	3	3	1	2	2	1	2	2	2	1	5	3	5	2	4	2	3	3	35	15
	Eastern Continental Ranges	207	3	5	4	4	5	5	0	5	2	3	0	5	5	5	1	4	2	2	2	44	18
	Fraser Basin	203	2	1	1	1	3	3	0	1	1	1	1	5	5	5	5	5	1	2	2	33	13
	Fraser Plateau	202	3	2	3	0	2	1	0	1	1	1	1	5	4	5	5	5	1	1	1	31	12
	Northern Continental Divide	214	4	5	5	2	4	4	1	5	2	4	0	5	5	4	1	4	2	2	2	42	19
	Omineca Mountains	199	2	1	1	0	3	2	0	0	2	1	0	5	5	5	4	5	2	2	2	31	11
	Selkirk-Bitterroot Foothills	212	3	2	3	0	2	1	0	2	3	2	0	5	0	2	3	3	1	1	1	24	10
	Skeena Mountains	198	2	1	1	0	3	2	0	0	1	1	0	5	5	5	2	4	2	2	2	28	10
	Southern Rocky Mountain Trench	213	4	2	3	0	4	3	0	2	2	2	0	5	5	2	5	4	1	2	2	34	14
	Western Continental Ranges	206	3	2	3	2	4	4	0	1	2	1	0	5	5	5	1	4	2	2	2	34	14
Pacific Maritime	Cascade Ranges	197	4	1	3	0	1	1	0	0	4	2	0	5	0	1	4	3	1	1	1	22	10
	Coastal Gap	191	3	2	3	0	1	1	1	1	1	1	3	5	3	5	2	4	2	3	3	32	15
	Eastern Vancouver Island	194	3	4	4	4	1	3	1	4	3	4	2	5	5	4	4	5	1	1	1	42	19
	Georgia-Puget Basin	195	2	3	3	3	1	3	0	3	1	2	2	5	0	1	1	2	1	1	1	24	13
	Lower Mainland	196	5	3	4	2	1	2	1	4	4	4	3	3	2	1	2	2	1	3	2	35	17
	Nass Basin	187	3	1	2	0	3	2	0	0	2	1	0	5	5	5	2	4	1	1	1	28	10
	Nass Ranges	190	2	1	1	0	3	2	0	1	1	1	0	5	5	5	1	4	2	2	2	28	10
	Pacific Ranges	192	5	2	4	1	1	1	1	2	2	2	1	5	4	5	2	4	2	1	2	34	14
	Queen Charlotte Lowland	189	1	1	1	3	1	3	0	1	3	2	1	5	0	5	0	3	4	5	5	30	15
	Queen Charlotte Ranges	188	1	2	1	3	1	3	3	3	3	4	3	5	0	5	0	3	1	2	2	32	16
	Western Vancouver Island	193	2	2	2	4	1	3	1	3	2	3	4	5	5	4	5	5	1	1	1	40	18
Prairies	Aspen Parkland	156	4	5	5	2	3	3	0	5	2	3	4	1	1	1	1	1	1	1	1	31	17
	Cypress Upland	160	2	3	3	0	1	1	0	3	4	3	0	4	0	3	5	3	3	4	4	32	14
	Fescue Grassland	158	4	2	3	0	3	2	0	1	3	2	1	1	2	1	1	1	3	2	3	24	12
	Lake Manitoba Plain	162	4	2	3	0	5	3	0	2	3	2	3	2	0	3	1	1	3	3	3	31	15
	Mixed Grassland	159	2	4	3	2	1	2	3	5	4	5	4	2	0	3	2	2	3	1	2	36	18
	Moist Mixed Grassland	157	4	3	4	0	3	2	0	2	4	3	3	1	1	2	1	1	3	1	2	28	15
	Southwest Manitoba Uplands	163	3	1	2	0	3	2	0	0	3	1	0	2	0	1	1	1	1	2	2	17	8
Semi-Arid Plateaux	Interior Transition Ranges	208	4	2	3	0	2	1	0	1	2	1	0	5	4	4	2	4	2	2	2	30	11
	Okanagan Highland	211	3	3	3	0	1	1	0	3	3	3	1	4	0	1	4	2	3	4	4	30	14
	Okanagan Range	210	4	3	4	0	1	1	0	2	3	2	1	5	0	4	2	3	1	1	1	27	12
	Thompson-Okanagan Plateau	209	4	3	4	0	2	1	0	3	2	2	3	5	1	1	4	3	1	1	1	30	14

Threat

The total threat scores using the Measures approach have a potential maximum score of 45 (maximum score of 5 for each of 9 measures). Total scores range from 10 to 37 (Figure 12). Lake Erie Lowland and Manitoulin-Lake Simcoe have the highest threat score; another 20 ecoregions have relatively higher threat scores compared to other ecoregions in the study area.

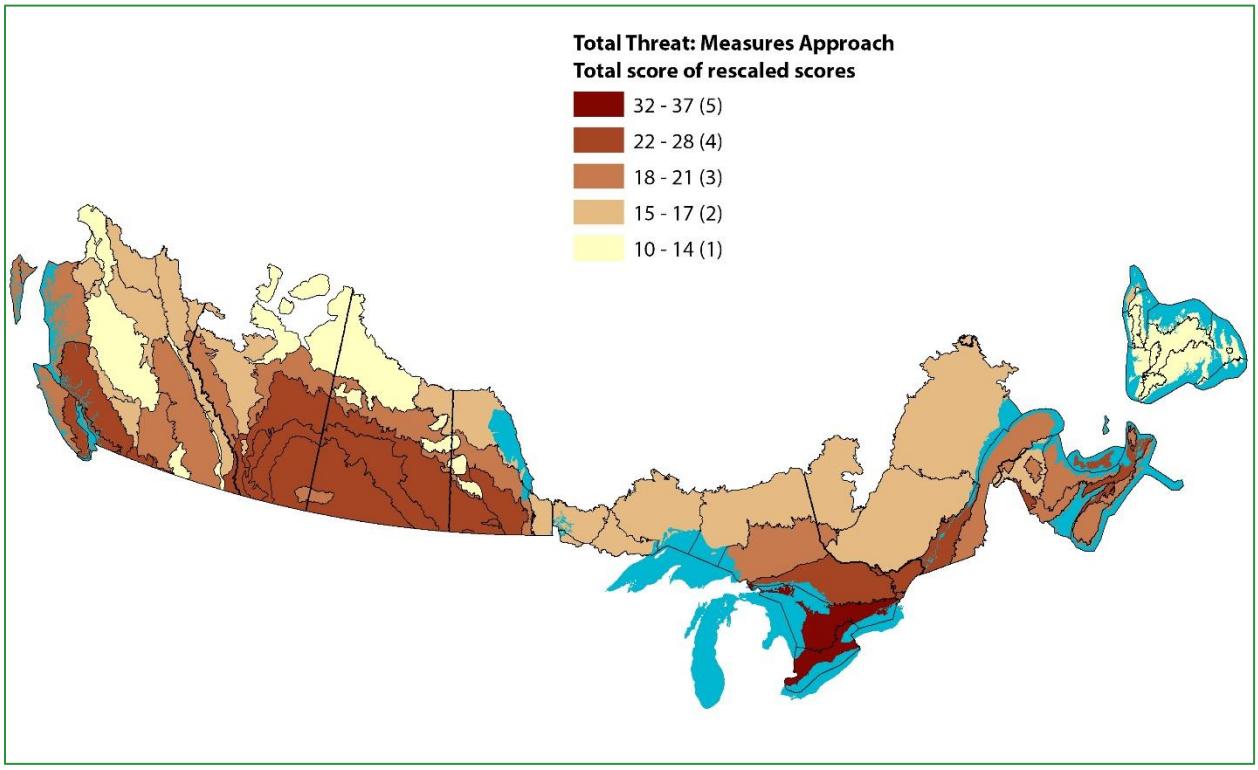

Figure 12: Total threat scores (Measures approach)

The total threat scores using the Criteria approach have a potential maximum score of 35 (maximum score of 5 for each of 7 measures). Total scores range from 6 to 31 (Figure 13). Lake Erie Lowland, Fescue Grassland and Manitoulin-Lake Simcoe have the highest threat scores for all ecoregions. Another 18 ecoregions have relatively higher threat scores.

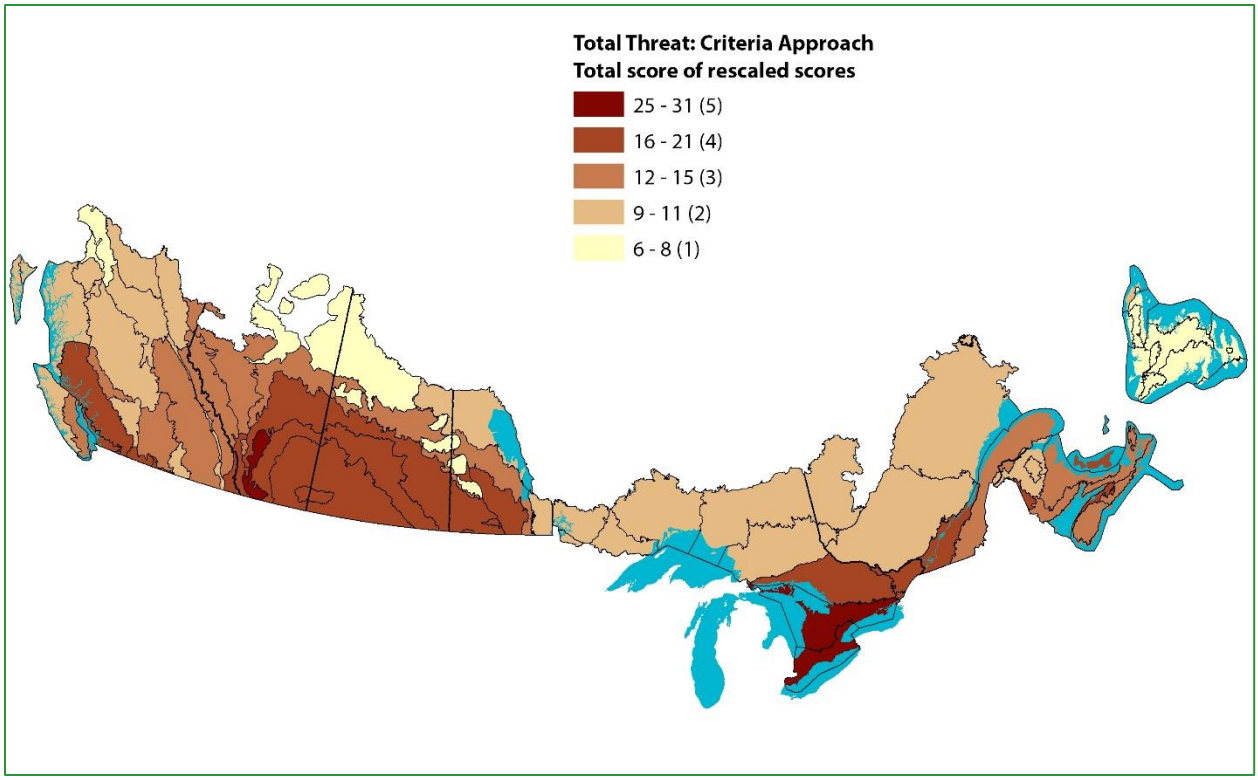

Figure 13: Total threat scores (Criteria approach)

Threats to ecoregions in the study area are concentrated in areas with the largest amount of agricultural land and settlement. This includes agricultural areas of the Maritimes (Annapolis and St. John's valleys, Prince Edward Island), southern Ontario and Quebec, the Prairies, the lower mainland of British Columbia and Eastern Vancouver Island. Ecoregions with the lowest total threat scores occur in the Boreal Shield and Boreal Plains ecozones and in the mountain regions of western Canada.

The scores for all the individual measures and rescaled criteria scores for threat along with the final total score using both the Measures and Criteria approach are presented in Table 10.

Table 10: Threat scores of ecoregions (sorted by ecozone); colour indicates rescaled threat scores (5, 4, 3, 2, 1 and 0).

Ecozone Name	Ecoregion Name	ID	T1b Change in Human Footprint	T2 WATERSHED STRESS	T3a Conservation Risk Index	T4 FRAGMENTATION	T5 LAND USE CHANGE	T6a Mean Temperature Change	T6b Mean Precipitation Change	T6c Change in Growing Degree Days	T6 RATE OF CLIMATE CHANGE	T7 LACK OF WATER	*TOTAL THREAT SCORE: MEASURES APPROACH*	*TOTAL THREAT SCORE: CRITERIA APPROACH*
Atlantic Highlands	Appalachians	117	0	3	1	2	2	3	4	3	4	1	19	13
	New Brunswick Highlands	119	0	3	1	1	1	3	4	4	4	1	18	11
	Northern New Brunswick Uplands	118	0	3	1	1	1	3	4	3	4	1	17	11
Atlantic Maritime	Annapolis-Minas Lowlands	126	0	5	4	3	3	3	1	4	2	1	24	18
	Atlantic Coast	125	0	5	1	3	2	2	3	4	3	1	21	15
	Cape Breton Highlands	129	0	5	1	1	1	3	5	4	5	1	21	14
	Fundy Coast	123	0	4	1	2	2	3	2	4	3	1	19	13
	Îles-de-la-Madeleine	131	0	0	1	3	4	3	4	4	4	1	20	13
	Maritime Lowlands	122	0	3	1	2	2	2	4	4	4	1	19	13
	Nova Scotia Highlands	128	0	5	1	2	2	3	4	4	4	1	22	15
	Prince Edward Island	130	0	3	3	3	3	3	4	4	4	1	24	17
	Saint John River Valley	120	0	3	3	3	3	3	4	3	4	1	23	17
	South-central Nova Scotia Uplands	127	0	5	1	2	2	2	2	4	2	1	19	13
	Southern New Brunswick Uplands	121	2	3	1	2	2	2	4	3	3	1	20	14
	Southwest Nova Scotia Uplands	124	0	5	1	2	2	2	1	4	2	1	18	13
Boreal Plains	Boreal Transition	149	0	3	2	3	2	5	1	1	2	2	19	14
	Interlake Plain	155	0	3	2	2	1	5	3	1	3	1	18	12
	Mid-Boreal Lowland	148	0	2	1	2	1	5	2	2	3	1	16	10
	Mid-Boreal Uplands	139	0	2	1	1	1	5	1	2	2	1	14	8
	Western Alberta Upland	145	0	4	2	1	1	4	1	1	1	3	17	12
Boreal Shield	Abitibi Plains	96	0	2	1	1	1	5	1	4	4	1	16	10
	Algonquin-Lake Nipissing	98	2	3	1	2	2	4	3	4	4	2	23	16
	Avalon Forest	115	0	2	1	2	1	1	2	3	1	1	13	8
	Central Laurentians	101	0	1	1	1	1	4	2	4	4	1	15	9
	Central Newfoundland	112	0	1	1	1	1	1	2	3	1	1	11	6
	Lac Temiscamingue Lowland	97	0	3	1	1	1	5	2	4	4	1	18	11
	Lake Nipigon	94	0	2	1	1	1	4	2	3	3	1	15	9
	Lake of the Woods	91	0	2	1	2	1	5	4	1	4	1	17	11
	Long Range Mountains	108	0	1	1	1	1	1	3	3	2	1	12	7
	Maritime Barrens	114	0	1	1	2	1	1	2	3	1	1	12	7
	Northeastern Newfoundland	113	0	1	1	1	1	1	1	3	1	1	10	6
	Northern Peninsula	107	0	1	1	1	1	1	3	4	2	1	13	7
	Rainy River	92	0	3	1	2	1	5	2	1	2	1	16	10
	South Avalon-Burin Oceanic Barrens	116	0	2	1	1	1	1	2	3	1	1	12	7
	Southern Laurentians	99	0	2	1	1	2	4	1	4	3	1	16	10
	Southwestern Newfoundland	109	0	1	1	2	1	1	3	3	2	1	13	8
	Strait of Belle Isle	106	0	2	1	2	1	2	3	4	3	1	16	10
	Thunder Bay-Quetico	93	0	2	1	2	1	4	3	2	3	1	16	10
Mixedwood Plains	Frontenac Axis	133	2	4	2	3	3	4	2	4	4	1	25	19
	Lake Erie Lowland	135	4	5	5	5	3	3	3	4	4	5	37	31
	Manitoulin-Lake Simcoe	134	3	4	4	4	2	4	3	4	4	4	32	25
	St. Lawrence Lowlands	132	0	4	3	4	3	4	2	4	4	1	25	19
Montane Cordillera	Bulkley Ranges	201	1	2	1	1	0	4	3	2	3	1	15	9
	Central Canadian Rocky Mountains	200	0	3	1	2	1	5	1	2	2	1	16	10

Ecozone Name	Ecoregion Name	ID	T1b Change in Human Footprint	T2 WATERSHED STRESS	T3a Conservation Risk Index	T4 FRAGMENTATION	T5 LAND USE CHANGE	T6a Mean Temperature Change	T6b Mean Precipitation Change	T6c Change in Growing Degree Days	T6 RATE OF CLIMATE CHANGE	T7 LACK OF WATER	*TOTAL THREAT SCORE: MEASURES APPROACH*	*TOTAL THREAT SCORE: CRITERIA APPROACH*
	Chilcotin Ranges	204	0	2	1	5	1	3	2	2	2	1	17	12
	Columbia Mountains and Highlands	205	0	3	1	4	1	2	3	1	1	3	18	13
	Eastern Continental Ranges	207	1	3	1	5	1	3	3	1	2	2	20	15
	Fraser Basin	203	0	3	1	1	1	5	1	3	3	1	16	10
	Fraser Plateau	202	1	2	1	1	1	4	1	2	2	1	14	9
	Northern Continental Divide	214	2	4	1	4	1	1	5	1	2	4	23	18
	Omineca Mountains	199	1	2	1	2	1	5	1	2	2	1	16	10
	Selkirk-Bitterroot Foothills	212	0	3	1	2	1	1	3	1	1	1	13	9
	Skeena Mountains	198	0	1	1	2	1	4	1	2	2	1	13	8
	Southern Rocky Mountain Trench	213	0	2	1	2	2	2	2	1	1	1	13	9
	Western Continental Ranges	206	0	2	1	5	1	1	4	1	1	2	17	12
Pacific Maritime	Cascade Ranges	197	4	5	1	3	1	3	4	4	4	1	26	19
	Coastal Gap	191	0	1	1	2	1	4	5	4	5	1	19	11
	Eastern Vancouver Island	194	1	3	1	3	2	3	4	4	4	1	22	15
	Georgia-Puget Basin	195	0	2	1	2	3	3	1	5	3	1	18	12
	Lower Mainland	196	2	4	2	5	3	3	2	5	4	1	27	21
	Nass Basin	187	1	1	1	1	1	4	1	3	2	1	14	8
	Nass Ranges	190	0	1	1	2	1	4	3	2	3	1	15	9
	Pacific Ranges	192	3	3	1	4	1	3	3	3	3	1	22	16
	Queen Charlotte Lowland	189	0	2	1	1	1	4	3	5	5	1	18	11
	Queen Charlotte Ranges	188	0	2	1	1	0	4	5	4	5	1	18	10
	Western Vancouver Island	193	0	2	1	1	1	3	5	5	5	1	19	11
Prairies	Aspen Parkland	156	0	3	3	3	4	4	2	1	2	3	23	18
	Cypress Upland	160	3	3	1	1	3	4	1	1	1	4	21	16
	Fescue Grassland	158	4	4	4	3	4	1	2	1	1	5	28	25
	Lake Manitoba Plain	162	0	3	5	3	1	5	4	1	4	2	24	18
	Mixed Grassland	159	0	3	2	3	4	4	1	1	1	5	23	18
	Moist Mixed Grassland	157	0	2	3	3	5	4	1	1	1	4	23	18
	Southwest Manitoba Uplands	163	0	3	2	3	2	4	3	1	2	4	22	16
Semi-Arid Plateaux	Interior Transition Ranges	208	0	2	1	4	1	4	2	2	2	1	17	11
	Okanagan Highland	211	3	3	1	3	2	2	1	3	1	4	22	17
	Okanagan Range	210	5	4	1	3	1	3	2	2	2	3	24	19
	Thompson-Okanagan Plateau	209	3	3	1	2	1	3	2	2	2	3	20	15

Conservation Response

Protected Areas (Criterion R1)

Currently, most of the ecoregions in the study area have low levels of protection, and are not well represented in Canada's systems of parks and protected areas. Only 13 of 77 ecoregions have at least 17% of their area in parks and protected areas (Figure 14).

Several ecoregions in western Canada have relatively very high levels of protection (score of 5; over 25% protected), generally as a result of large national or provincial parks (Figure 14). These include Queen Charlotte Lowland and Queen Charlotte Ranges (Gwaii Haanas National Park Reserve and Haida Heritage Site and Naikoon Provincial Park), Coastal Gap (several provincially protected areas including Spatsizi Plateau Wilderness Provincial Park), Chilcotin Ranges (Ts'yl-os Provincial Park), Okanagan Range (South Okanagan Grasslands Protected Area) and the Western Continental Ranges and Eastern Continental Ranges (Canada's Rocky Mountain parks such as Banff and Jasper National Parks). The only ecoregion outside of western Canada within the study area that has over 25% protected area is Cape Breton Highlands (Cape Breton Highlands National Park).

Ecoregions with very low coverage of protected areas (under 5%) are most common in highly altered landscapes or in ecoregions with few or no protected areas. In 23 of southern Canada's 77 ecoregions (30%), protected areas comprise 5% or less of the landscape. In highly settled areas, the high amount of land conversion and intensive use makes the establishment of protected areas (particularly very large protected areas) challenging.

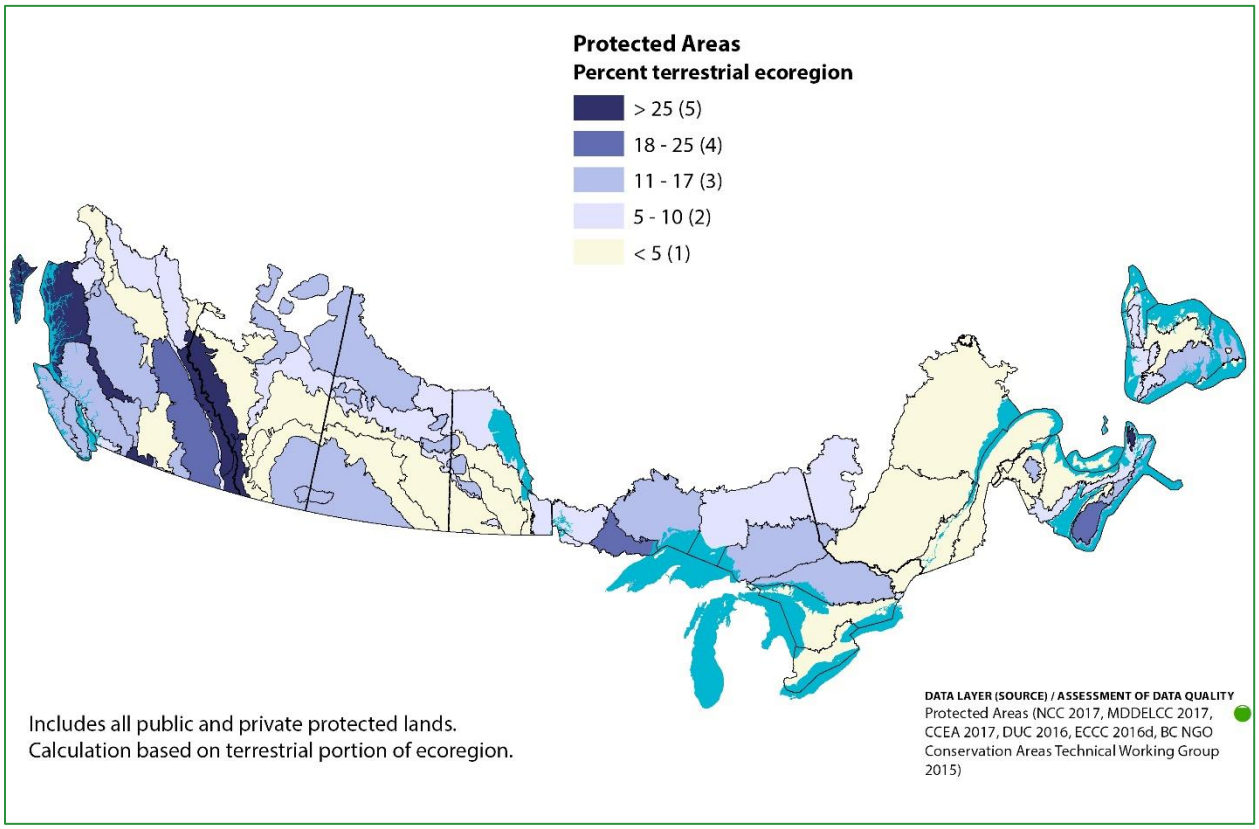

Figure 14: R1 Percent Protected Areas

Across the study area, the majority of ecoregions (64/77 = 83%) do not meet the Aichi target of at least 17% of the land base protected for conservation.

Representation (Criterion R2)

Figure 15 shows all of the unique landform features in the study area and the amount that is protected. Figure 16 is an average of the amount of protected areas for all landform features within each ecoregion. While there is generally a high concordance between ecoregions with a higher percentage of protected areas (i.e. at least 17%) and representation (for example the Eastern and Western Continental Ranges, home to Canada's Rocky Mountain parks, score in the highest category for both percent of protected areas and representation), the analysis does reveal some areas where protected areas appear to be under-representing the full diversity of landform features in some ecoregions. Ecoregions with a higher score for total protected areas than representation include Îles-de-la-Madeleine, Cascade Ranges, Selkirk-Bitterroot Foothills and Queen Charlotte Lowland ecoregions; this indicates that protected areas are not capturing or well representative all of the diverse landform features present in these ecoregions.

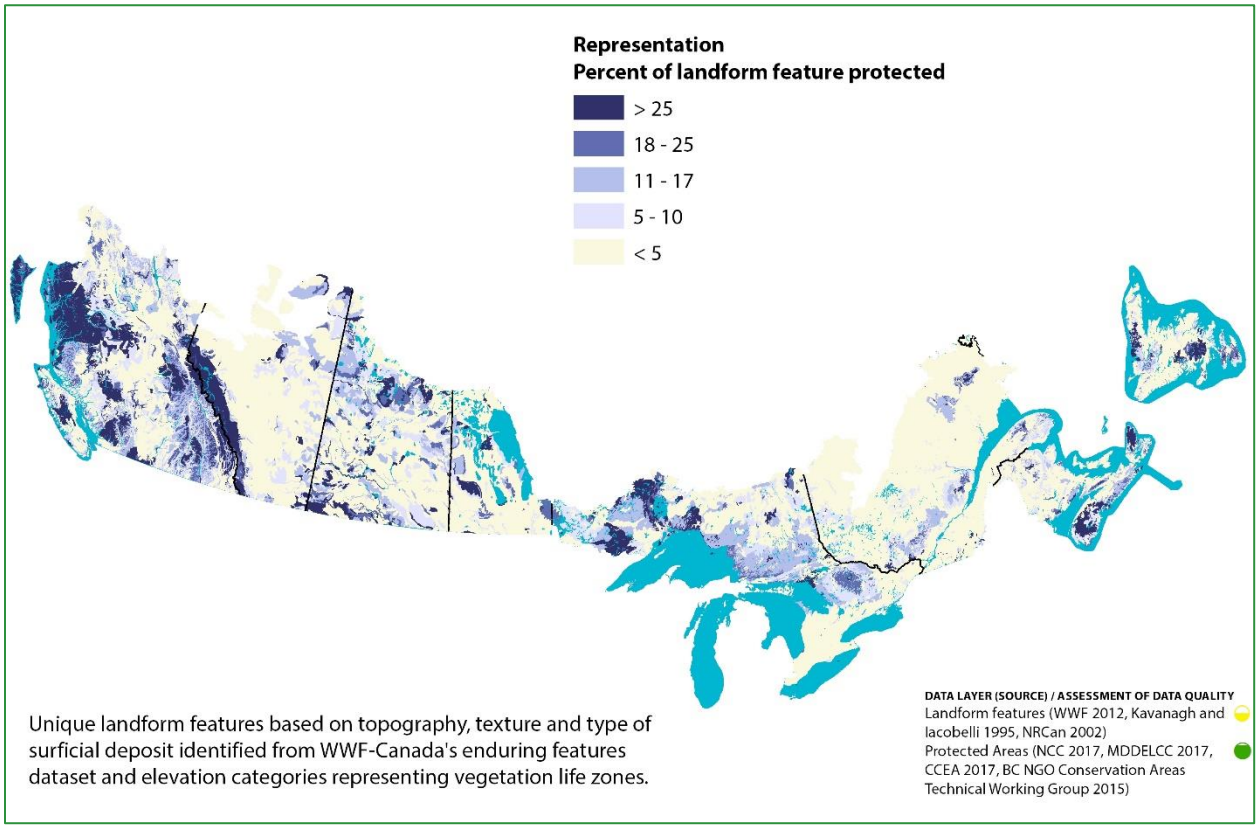

Figure 15: Representation of landform features

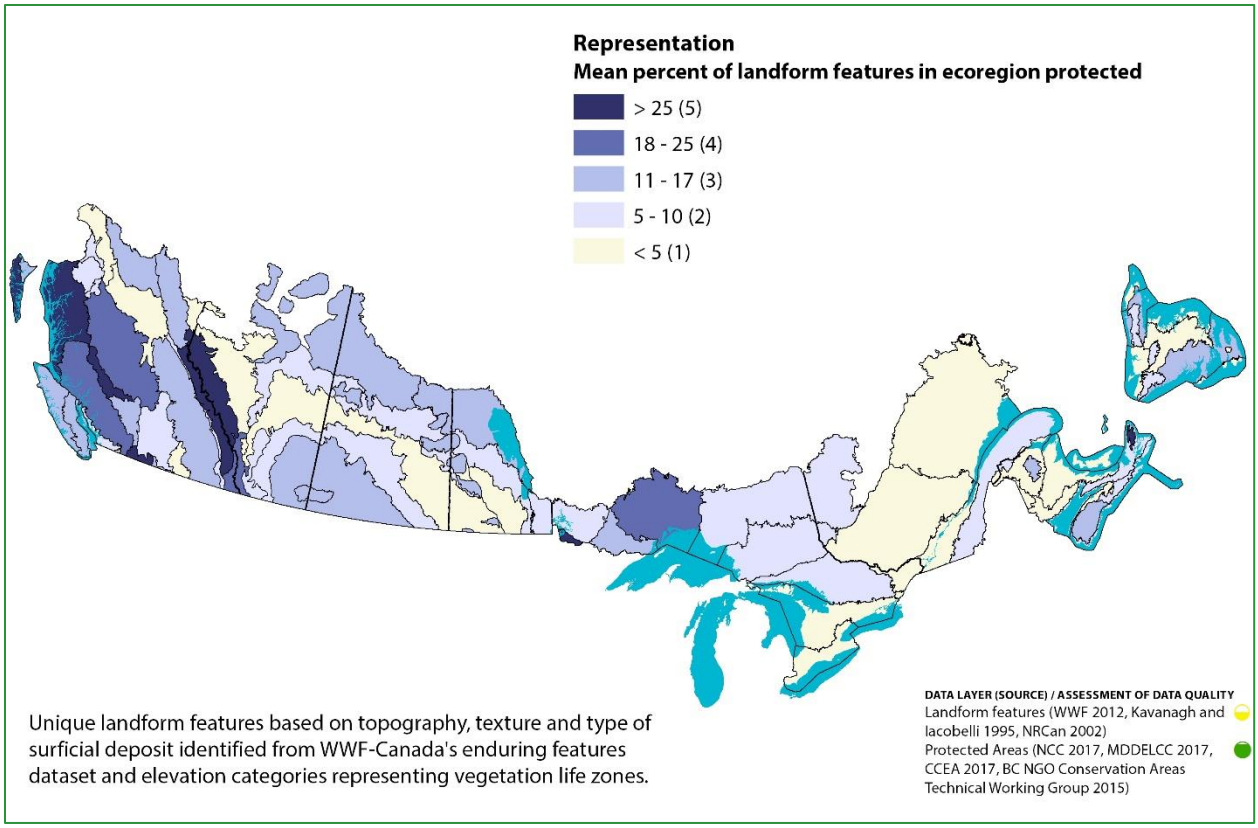

Figure 16: R2 Representation

The scores for both percent protected and representation are represented in Table 11.

Table 11: Conservation response scores of ecoregions (sorted by ecozone); colour indicates rescaled conservation response scores (5, 4, 3, 2 and 1).

Ecozone Name	Ecoregion Name	ID	R1 PROTECTED AREAS	R2 REPRESENTATION
Atlantic Highlands	Appalachians	117	1	2
	New Brunswick Highlands	119	3	3
	Northern New Brunswick Uplands	118	1	1
Atlantic Maritime	Annapolis-Minas Lowlands	126	1	1
	Atlantic Coast	125	3	2
	Cape Breton Highlands	129	5	5
	Fundy Coast	123	2	2
	Îles-de-la-Madeleine	131	3	1
	Maritime Lowlands	122	1	2
	Nova Scotia Highlands	128	2	2
	Prince Edward Island	130	1	1
	Saint John River Valley	120	1	1
	South-central Nova Scotia Uplands	127	3	2
	Southern New Brunswick Uplands	121	2	1
	Southwest Nova Scotia Uplands	124	4	3

Ecozone Name	Ecoregion Name	ID	R1 PROTECTED AREAS	R2 REPRESENTATION
Boreal Plains	Boreal Transition	149	2	2
	Interlake Plain	155	1	2
	Mid-Boreal Lowland	148	2	3
	Mid-Boreal Uplands	139	3	3
	Western Alberta Upland	145	1	1
Boreal Shield	Abitibi Plains	96	2	2
	Algonquin-Lake Nipissing	98	3	2
	Avalon Forest	115	1	1
	Central Laurentians	101	1	1
	Central Newfoundland	112	1	1
	Lac Temiscamingue Lowland	97	3	2
	Lake Nipigon	94	3	4
	Lake of the Woods	91	2	2
	Long Range Mountains	108	2	2
	Maritime Barrens	114	3	3
	Northeastern Newfoundland	113	1	1
	Northern Peninsula	107	2	3
	Rainy River	92	2	5
	South Avalon-Burin Oceanic Barrens	116	1	1
	Southern Laurentians	99	1	1
	Southwestern Newfoundland	109	2	1
	Strait of Belle Isle	106	1	1
	Thunder Bay-Quetico	93	4	3
Mixedwood Plains	Frontenac Axis	133	2	1
	Lake Erie Lowland	135	1	1
	Manitoulin-Lake Simcoe	134	1	1
	St. Lawrence Lowlands	132	1	1
Montane Cordillera	Bulkley Ranges	201	3	2
	Central Canadian Rocky Mountains	200	2	3
	Chilcotin Ranges	204	5	5
	Columbia Mountains and Highlands	205	4	3
	Eastern Continental Ranges	207	5	5
	Fraser Basin	203	1	1
	Fraser Plateau	202	3	4
	Northern Continental Divide	214	5	4
	Omineca Mountains	199	2	3
	Selkirk-Bitterroot Foothills	212	3	1
	Skeena Mountains	198	1	1
	Southern Rocky Mountain Trench	213	2	2
	Western Continental Ranges	206	5	5
Pacific Maritime	Cascade Ranges	197	3	1
	Coastal Gap	191	5	5
	Eastern Vancouver Island	194	3	3
	Georgia-Puget Basin	195	3	3
	Lower Mainland	196	2	2
	Nass Basin	187	2	2
	Nass Ranges	190	2	2
	Pacific Ranges	192	3	4
	Queen Charlotte Lowland	189	5	3
	Queen Charlotte Ranges	188	5	5
	Western Vancouver Island	193	3	3
Prairies	Aspen Parkland	156	1	1
	Cypress Upland	160	3	3
	Fescue Grassland	158	1	2

Ecozone Name	Ecoregion Name	ID	R1 PROTECTED AREAS	R2 REPRESENTATION
	Lake Manitoba Plain	162	1	1
	Mixed Grassland	159	3	3
	Moist Mixed Grassland	157	1	2
	Southwest Manitoba Uplands	163	2	3
Semi-Arid Plateaux	Interior Transition Ranges	208	3	3
	Okanagan Highland	211	3	3
	Okanagan Range	210	5	5
	Thompson-Okanagan Plateau	209	1	2

Identifying Important Ecoregions

When the total biodiversity and threat scores are plotted on a scatter diagram and the scatter diagram is divided into quadrants based on relatively higher and lower scores, ecoregions with similar characteristics can be described as being in one of four groups outlined below (based on (Margules & Pressey 2000).

- Higher Biodiversity/Higher Threat (upper right): These ecoregions all have a high number of rare species and are located in regions of southern Canada with large human populations and where much of the natural habitat has been converted
- Higher Biodiversity/Lower Threat (upper left): These ecoregions have relatively high total biodiversity scores, but are in regions where total threat scores are relatively lower. These ecoregions have high numbers of rare species but also have less habitat conversion.
- Lower Biodiversity/Higher Threat (lower right).
- Lower Biodiversity/Lower Threat (lower left).

The scatter diagram derived from the Measures approach identifies six ecoregions as having higher biodiversity and higher threat: St. Lawrence Lowlands, Lake Erie Lowland, Mixed Grassland, Lower Mainland, Eastern Vancouver Island, and Northern Continental Divide (Figure 17a). Ecoregions in this category are generally those with high population and development pressures in the southern portion of the study area (Figure 18a). Seventeen ecoregions have higher biodiversity and lower threat. Many of these ecoregions are situated in relatively intact ecoregions along the northern portion of the study area in the Boreal, in portions of the Montane Cordillera ecozone and in Atlantic Canada. There are 16 ecoregions with lower biodiversity and higher threat. These ecoregions are generally located around or near ecoregions of higher biodiversity and higher threat, except for in Atlantic Canada. There is one ecoregion in this category approaching higher threat: Cape Breton Highlands. Finally, there were 38 ecoregions with lower biodiversity and lower threat scores. A large number of these ecoregions are located on the Island of Newfoundland, Boreal Shield ecozone in Ontario and in the Montane Cordillera in British Columbia. There are two ecoregions, the Atlantic Coast and Cypress Upland, which are approaching higher threat.

Figure 17: Scatter diagrams plotting biodiversity versus threat scores for the Measures (a) and Criteria (b) approaches

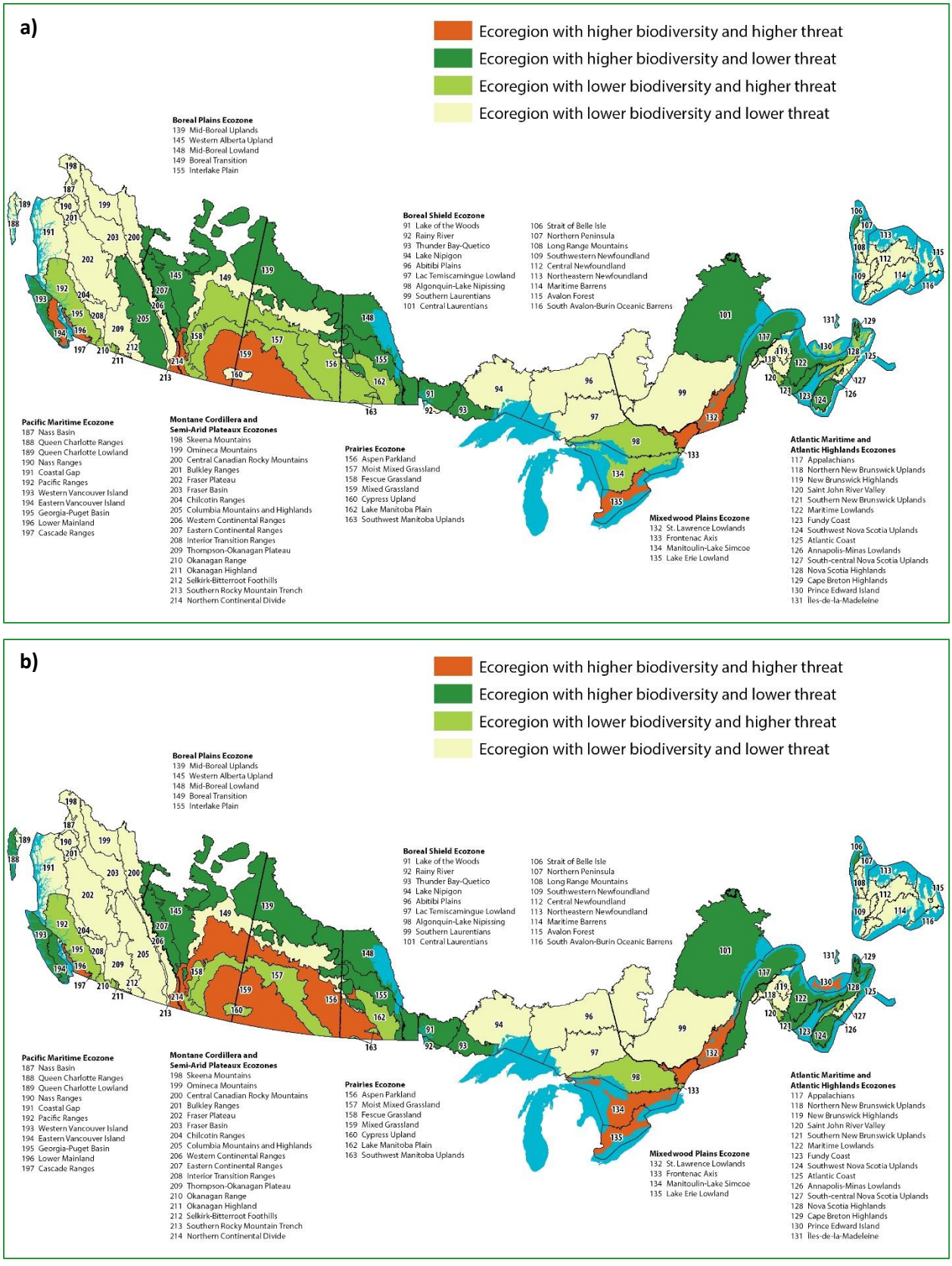

Figure 18: Interim results using the Measures (a) and Criteria (b) approaches

Eight ecoregions had higher biodiversity and higher threat when the total scores are plotted using the Criteria approach (Figure 17b). As with the Measures approach, St. Lawrence Lowlands, Lake Erie Lowland, Mixed Grassland, Lower Mainland and Northern Continental Divide fall into this category. The Criteria approach further identifies Prince Edward Island, Manitoulin-Lake Simcoe and Aspen Parkland with higher biodiversity and higher threat. Ecoregions in this category are generally located in ecoregions with high population and development pressures, including agriculture (Figure 16b). There are 21 ecoregions with higher biodiversity and lower threat. Four of these ecoregions are approaching the threshold for higher threat: Atlantic Coast, Nova Scotia Highlands, Eastern Vancouver Island and Eastern Continental Ranges. Thirteen ecoregions had lower biodiversity and higher threat. The majority of these ecoregions are smaller in area. Lastly, there are 35 ecoregions with lower biodiversity and lower threat, including Pacific Ranges, which was identified as an ecoregion with higher biodiversity and higher threat under the Measures approach. Ecoregions in this category are generally located on the Island of Newfoundland and in the Boreal Shield, Montane Cordillera and Pacific Maritime ecozones. One ecoregion with lower biodiversity is approaching the threshold for higher threat: Thompson-Okanagan Plateau.

When the results of the Measures and Criteria approaches are combined, with the highest category from either approach taking precedence, nine ecoregions have relatively higher biodiversity and higher threat scores compared to other ecoregions in the study area (Figure 19 and Figure 20). These nine ecoregions represent 15.7% (459,945 km^2) of the study area. The majority of these ecoregions (88.9%) have lower conservation response scores. Five of these ecoregions are in the lowest category of percent protected and representation scores: three ecoregions in the Mixedwood Plains ecozone and the Prince Edward Island and Aspen Parkland ecoregions. Lower Mainland, Mixed Grassland and Eastern Vancouver Island also have lower conservation response (i.e. under 17%). Only the Northern Continental Divide has higher conservation response, with both percent protected and representation over 17%.

A total of 21 ecoregions (999,825 km^2 or 34.1% of the study area) fall in the upper left quadrant with higher biodiversity but lower threat. Six of these ecoregions have relatively higher conservation response (28.0% have higher percent protected, 19.0% have higher representation). Located in the more intact northern and western portions of the study area, and along the coast, these ecoregions tend to have lower scores for species criteria, but score very high for intactness, habitat diversity and congregatory species and are more likely to contain intact ecological communities and processes. Some of the large habitat blocks in these ecoregions include the 17% of the Earth's surface that has not been significantly influenced by humans, identified as the "last wild" (Venter et al. 2016b), and could qualify as KBAs under Criterion C (Ecological Integrity) (IUCN 2016).

There are 13 ecoregions in the lower right quadrant with higher threat and lower biodiversity scores, these ecoregions represent a total of 301,365 km^2 (or 10.3% of the study area). Of these ecoregions, two (Pacific Ranges and Okanagan Range) have higher total conservation response scores with over 17% protection and/or representation. The remaining 34 ecoregions (1,169,625 km^2, 39.9%) fall in the lower left quadrant with lower biodiversity and lower threat; 25 (73.5%) of these ecoregions have over 5% protection, while 23 (67.6%) have over 5% representation.

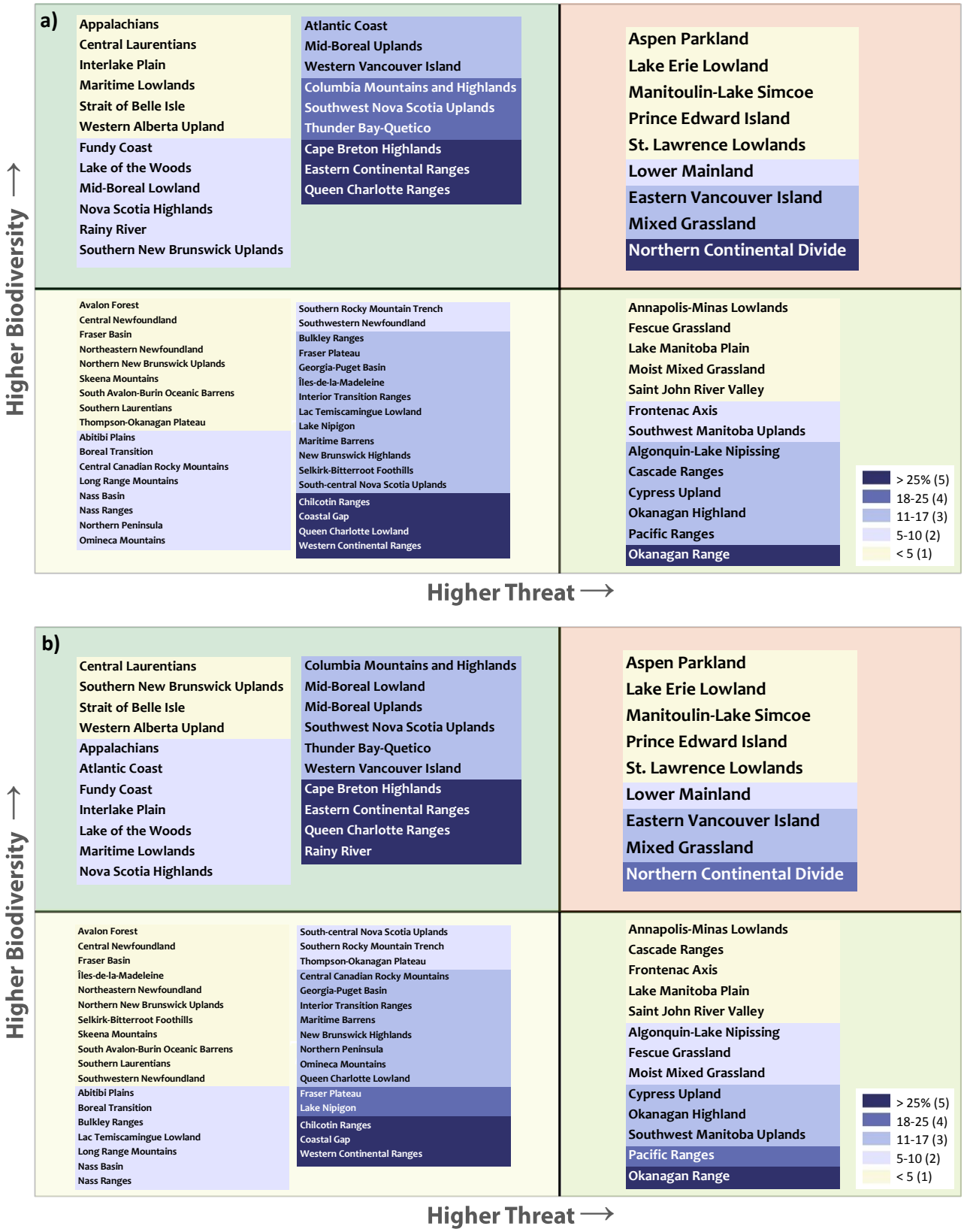

Figure 19: Final classification of ecoregions based on combining the Measures and Criteria approaches with percent of ecoregion protected (a) and representation (b)

Figure 20: Final ecoregion classification

DISCUSSION AND APPLICATIONS

Biodiversity and threats to biodiversity are not evenly distributed around the globe (Gaston 2000). In Canada, the total number of species and the number of nationally rare species is generally greater at lower latitudes. Globally rare and endemic species can have broad latitudinal distributions in Canada and are often associated with unique or energy-rich habitats and island environments that have driven speciation since the last period of glaciation.

Much of the variation in the distribution of Canada's biodiversity is a result of past and current human activities. Intact habitats and fauna generally occur in regions with low human populations and low agricultural capability. Many rare species are associated with habitat types that have undergone large scale conversion (e.g. prairies) or degradation (e.g. freshwater) in Canada and the United States. Intact landscapes, ecological processes and species assemblages occur in less settled areas including the north and mountainous regions.

While the availability and quality of datasets for the entire study area is not consistent for some criteria (see Datasets, Caveats and Limitations), this analysis uses the best available information and by first removing redundancy through statistical techniques and then combining multiple measures and criteria, illustrates the relative values for biodiversity, threats and conservation response across 77 ecoregions in southern Canada.

Based on total biodiversity scores, 30 ecoregions with top scores for total biodiversity tend to either have an abundance of species of conservation concern, and are often high in total species richness, or have large areas of natural, intact habitat. Nine also have high or very high total threat scores. These tend to be located in agricultural and settled landscapes in the south, which also have a high diversity of species that includes both naturally rare species (e.g. lakeside daisy in alvars) and species that are at risk because of human activities (e.g. Sprague's pipit in prairies).

Eight of these nine ecoregions have relatively low total conservation response scores and five have less than 5% protected areas. Ecoregions with higher biodiversity and threat values and relatively low levels of conservation response need immediate action because their biodiversity is threatened and there is little land protected for conservation. While there is an urgency to allocate resources in places with high biodiversity values and threats (Groves 2003, Belote et al. 2017), NCC realizes that it is also important to also allocate significant resources in ecoregions of high biodiversity value and lower threat due to the lower cost of land relative to ecoregions under higher threat, and the opportunity for proactive, landscape-scale conservation.

Many of the ecoregions with higher biodiversity value identified in this assessment are also identified in global and continental assessments, although the ecoregional boundaries differ. This includes ecoregions of the west coast and the prairies. In addition, ecoregions that intersect with the southern Pacific coast, Gulf of St. Lawrence and much of Atlantic Canada are adjacent to globally significant marine regions. The global assessment of "crisis" ecoregions identify the Mixedwood Plains, St. Lawrence Lowlands and Moist Mixed Grassland as areas of high threat/land conversion and low protection (Ricketts et al. 1999). Some ecoregions in the prairies have not been identified in this southern Canada assessment because of their relatively lower levels of species of conservation concern (e.g. species tracked by CDCs), but have been identified in global and continental assessments because of the global endangerment of temperate grasslands. Some of the differences between global/continental assessments and this assessment occur because criteria here included

national priorities. For example, many of Canada's species of conservation concern that are tracked by provincial CDCs are not globally rare or endemic, and while of high importance for Canada's biodiversity, do not drive the selection of ecoregions from a global/continental perspective.

The results can be used to provide context to conservation by highlighting key attributes of ecoregions across southern Canada. Applications of this information include identifying and protecting important areas for species and habitat conservation, building conservation capacity building in priority ecoregions and ecological monitoring.

Identifying and Protecting Important Areas for Conservation

Assessing the relative importance of biodiversity conservation over large scales is complex and depends on the measures and criteria that are applied (Brooks et al. 2006). These measures and criteria reflect organizational priorities and the availability of credible data for the entire study area. This assessment has integrated a wide variety of measures and criteria that reflect a diversity of conservation values, ranging from species to intact habitats.

The combination of this assessment of southern Canada with local and regional information provides NCC and other conservation practitioners with useful context. The results can be used to support linked discussions related to desired current state, future condition and a formalized situation analysis that explores the feasibility, constraints and opportunities related to achieving measurable conservation success in each ecoregion. This type of information can be used to better identify key sites for conservation action and investment.

NCC will be using the results to build on past ecoregional assessments (ERAs) and continue to refine the identification of important areas across southern Canada based on biodiversity, threats and existing conservation responses. NCC's conservation planning process has changed significantly since the first ERAs. Originally, ERAs were intended to identify specific conservation lands where action needed to occur. It became clear however, particularly in threatened landscapes, that information changed quickly and broad scale assessments, while providing useful context, were not wholly sufficient to direct resources to specific properties for conservation action (Kraus 2005). NCC introduced NACPs to fill this void, and merge the important contextual perspectives that ERAs provide, with the ability to integrate local content and rapidly adapt plans as conditions change (Freedman 2013). The results of this conservation assessment can be used to classify ecoregions of southern Canada where NCC should consider developing or modifying NACPs to implement conservation actions.

NCC's application of this assessment will include prioritizing conservation spending in ecoregions with the highest biodiversity values, and using underlying data on species, land cover and connectivity to validate and refine our existing NACPs. For example, much of the analysis completed for this assessment can also be displayed at a10 km grid scale to better detail the state of biodiversity and inform more specific conservation needs. Appendix J provides an example of "scaling-down" the information used in this report for one of the higher biodiversity and higher threat ecoregions in southern Canada, the St. Lawrence Lowlands. This finer scale approach provides more detail on the conservation landscape including the specific location and proximity of protected areas, land cover, concentrations of rare species. While the St. Lawrence Lowlands scores very high for several biodiversity measures, they are not evenly distributed across that ecoregion, and conservation action and investment are likely more critical at certain sites. This will allow NCC to compare our existing

NACP boundaries in an ecoregional context. This finer scale will also allow NCC and partners to incorporate other information that is not available at the scale of the entire study area such as regional studies on climate change adaptation, ecological services or Indigenous and community knowledge to refine important areas. Furthermore, a finer scale approach allows for the integration of socio-economic information (such as land values) into the decision-making process.

The results of this assessment will allow conservation practitioners to better understand the context of their work, and whether the status and trends within a project area reflect the status and trends of the broader ecoregion.

Species at Risk Recovery

While the analysis is based on summing the scores of different measures and criteria for biodiversity, threat and conservation response, the measures, criteria and scores can also be used separately or combined differently to provide additional perspectives on biodiversity and conservation needs. For example, a SAR "lens" could be applied by focusing the results on areas of highest importance for SAR.

Information on SAR and globally rare species can be analyzed at a 10 km grid scale to identify sites with high richness and high irreplaceability, which will help highlight sites of high importance for biodiversity conservation that may not have be identified from the ecoregional analysis because of scale (e.g. a high value site in a large ecoregion with lower relative values). Ecoregions that do not necessarily score high for biodiversity and threat may contain within them sites such as the South Okanagan and Tallgrass Prairie that are of very high conservation significance (e.g. species do not occur elsewhere in Canada). This suite of additional high value sites for biodiversity conservation will be used by NCC and partners to continue to focus conservation efforts on species of conservation concern.

Capacity Building

NCC will make the information contained in this assessment available on-line to support conservation decision making of our partners. Canadian land trusts and other conservation partners can use the results to better make the case about the relative national context of the places they are working in. NCC will use the results to build on our tradition of using conservation planning to demonstrate that resources from private donors and foundations are being directed to the places that are of greatest importance for conservation. For government conservation partners, such as NCC's current Natural Areas Conservation Program with ECCC, NCC can use the results to not only demonstrate strategic allocation of conservation funding, but also to demonstrate how this funding is supporting government legislation and mandates for biodiversity conservation.

Once the information is available on-line, partners will be able to apply their own approaches or methods to the raw or final scores for the individual measures to derive total scores that may better suite their own needs in identifying important ecoregions. Several approaches to scoring were considered for this analysis before settling on the final approach. In addition to the example provided above relating to SAR recovery, important ecoregions could be identified by selecting top-scoring ecoregions within each group of measures, combining top scores based on species and landscape measures, or stratifying the final scores based on ecozone.

Monitoring Our Progress: A Living Conservation Assessment

This assessment provides a conservation snap-shot of 77 ecoregions in southern Canada. To maintain the currency of this assessment, NCC will update the information annually and share the results. Updating these results will provide an important opportunity to track changes in these ecoregions overtime and the effectiveness of our conservation responses. The results of the conservation assessment can be used to track progress towards national, regional and organizational conservation goals. Regular re-analysis of the ecoregions to track their trends in biodiversity, threats and conservation would be useful for monitoring the effectiveness of conservation programs, and to highlight ecoregions where greater conservation focus may be required. This would be complimentary to existing national scale monitoring initiatives such as ECCC's Sustainability Indicators and WWF's Living Planet Index for Canada, and support conservation actions in the ecoregions of highest importance. In addition to monitoring and reporting at the ecoregional scale, the criteria used in the assessment could be used to develop new indicators for monitoring conservation in Canada, including indictors that support Aichi Target 11 such as representation and connectivity.

The National Ecological Framework is the system Canada uses to report on conservation outcomes nationally and internationally (ECCC 2016b, Statistics Canada 2017). The Canadian Council on Ecological Areas (CCEA) updated the ecozone boundaries in 2014 (CCEA 2014), but ecoregion boundaries have not yet been aligned. To ensure consistent reporting, there is a priority need to align ecoregion and ecozone boundaries.

Looking Forward

The results of this project will be used to support the conservation work of the NCC and partners by providing a systematic approach to categorizing ecoregions based on biodiversity values, threats and conservation responses. Although the significant biodiversity and threats levels are well-known in many southern ecoregions, this analysis provides information and evidence to support the urgency of conservation in these areas. Most of the ecoregions with higher biodiversity and higher threat have a high proportion of private lands and few protected areas. Conservation organizations in these ecoregions will need to work cooperatively with land owners and continue to protect key sites for biodiversity. Achieving Canada's goal of protecting a minimum of 17% of terrestrial and freshwater areas will be challenging in these ecoregions and may not be achieved for many generations. In most cases, protected areas in these ecoregions will be small, and will require intensive on-going management to maintain their biodiversity values and mitigate threats associated with small, fragmented nature reserves.

The analysis also identifies ecoregions in southern Canada that have very high biodiversity values but lower overall threats. These ecoregions tend to have a higher proportion of public lands and/or existing protected areas. There is an opportunity to protect large, functional intact areas that are effectively connected and integrated into surrounding, working landscapes. Achieving the goal of protecting 17% of terrestrial and freshwater areas has already been accomplished in several high biodiversity and low threat ecoregions, and can be accomplished in others through private and public land protection. Not all ecoregions within similar biodiversity and threat values will have the same specific conservation needs and actions.

It became very clear during this project that conservation information in Canada is highly dynamic. Novel and improved data layers are regularly available that will refine this analysis and ensure its

currency. For example, new species are regularly assessed by COSEWIC. Much of the biodiversity information that is currently available for the study area is species focused. Keeping the project as a "living assessment" will ensure that conservation decision-making is based on the best available information.

There are also important elements of biodiversity that may not be included in this study because they lack spatial information or have not yet been identified. The scoring system developed for this assessment of southern Canada was designed to be flexible and accommodate new measures, criteria and updated data. Additional measures and criteria that could be incorporated in the assessment include concentrations of migratory mammals or insects (i.e. Monarch butterflies), range maps for additional species (such as butterflies (Kerr pers. comm.)) and intact fauna (other than for mammals which are already considered). Information on nationally and globally rare vegetation communities does not exist across the study area because Canada does not have a comprehensive vegetation classification system, and vegetation communities are not tracked and ranked by many CDCs. Better information on the distribution and status of rare vegetation communities would help support future iterations of this assessment and other conservation efforts in Canada.

Climate change models could also be considered in identifying ecoregions most likely to continue to experience rapid changes in temperature and precipitation, and other variables. The current analysis uses information on observed changes in temperature and precipitation normal periods over time. As additional information on projected species' range shifts, climate stability and potential climate refugia (Iwamura et al. 2010) become available and the certainty of these predictions increase, such data could help identify conservation strategies.

In addition to new information on biodiversity, threats and conservation response, other ecological and socio-economic information could be considered for incorporation into the results. For example, ecoregions with higher ecological services such as water filtration and flood protection could be identified. Community profile information from Statistics Canada on population trends and forecasts in land values and in household income and other demographic criteria could also be considered. In some cases, such information was considered for this analysis but the data sources were incomplete or difficult to map within an ecoregional context.

Although biodiversity information for some criteria is poorly documented in the north, there is species information that would support the identification of important sites. For example, regions such as the Athabasca sand dunes and the Beringia region of the Yukon are known to have high concentrations of rare species. Information on threat and conservation response is generally very good in the north. A Canada-wide assessment would provide a more complete picture of the biodiversity, threat and conservation needs in Canada, and provide a complete national context for conservation actions.

At one level, conservation everywhere is important. Protecting all habitats and species within regional geographies protects representative biodiversity and is often critical in maintaining ecological services to communities. But, in a world of limited resources, focussed conservation requires decision-making that is based on an assessment of priorities. NCC has been developing landscape-level conservation plans to support conservation decision making for over 20 years, including ERAs and NACPs. This conservation assessment for southern Canada provides a framework to contextualize focused and effective place-based conservation actions.

REFERENCES

AAFC (Agriculture and Agri-Food Canada). (1999). A National Ecological Framework for Canada: Ecoregions. Ottawa/Hull. Retrieved April 30, 2015, from http://sis.agr.gc.ca/cansis/nsdb/ecostrat/index.html

AAFC (Agriculture and Agri-Food Canada). (2015a). Land Use 2000. Retrieved January 06, 2017, from http://open.canada.ca/data/en/dataset/b5f413d9-9acc-4ad7-b9a7-38486ed5fee7

AAFC (Agriculture and Agri-Food Canada). (2015b). Land Use 2010. Retrieved January 06, 2017, from http://open.canada.ca/data/en/dataset/9e1efe92-e5a3-4f70-b313-68fb1283eadf

ACCDC (Atlantic Canada Conservation Data Centre). (2016). Newfoundland Rare Species. Newfoundland: ACCDC.

AdaptWest Project. (2015). Gridded current and projected climate data for North America at 1km resolution, interpolated using the ClimateNA v5.10 software (T. Wang et al., 2015). Retrieved May 31, 2016, from adaptwest.databasin.org.

Alberta Tourism, Parks and Recreation. (2010). *Easter Bow Valley Wildlife Corridor Study: An Analysis of Winter Tracking and Monitoring Final Report.* Canmore, AB. Retrieved September 11, 2017, from https://www.albertaparks.ca/media/2157103/easternbowvalleywildlifecorridorstudy-wintertrackingreport.pdf

Anderson, M., Crist, T., Chase, J., Vellend, M., Inouve, B., Freestone, A., . . . Swenson, N. (2011). Navigating the multiple meanings of β diversity: a roadmap for the practicing ecologist. *Ecology Letters, 14*(1), 19-28. doi:10.1111/j.1461-0248.2010.01552.x

Bailey, R., Avers, P., King, T., & McNab, W. (1994). Ecoregions and subregions of the United States (map). Washington, DC: USGS.

BC NGO Conservation Areas Technical Working Group. (2015). BC NGO Conservation Areas Database – Fee Simple, Registerable Interests, and Unregisterable Interests (secured as of December 31, 2014). Version 2015.11.02.

BCEAG (The Bow Corridor Ecosystem Advisory Group). (2012). *Wildlife Corridor and Habitat Patch Guidelines for the Bow Valley.* Alberta, CA. Retrieved January 31, 2017, from http://biosphereinstitute.org/wp-content/uploads/2015/01/BCEAGFinalReport2012.pdf

Belote, R., Dietz, M., McKinley, P., Carlson, A., Carroll, C., Jenkins, C., . . . Aplet, G. (2017). Mapping Conservation Strategies under a Changing Climate. *BioScience, 67*(6), 494-497. doi:doi.org/10.1093/biosci/bix028

Belote, R., Dietz, M., McRae, B., Theobald, D., McClure, M., Irwin, G., . . . Aplet, G. (2016). Identifying Corridors among Large Protected Areas in the United States. *PLoS ONE, 11*(4), e015422. doi:10.1371/journal.pone.0154223

Berry, W., & Feldman, S. (1985). *Multi Regression in Practice.* London: Sage Publications Limited.

BirdLife International and NatureServe. (2014). Bird species distribution maps of the world. BirdLife International, Cambridge, UK and NatureServe, Arlington, VA.

Bowman, J., & Cordes, C. (2015). *Landscape connectivity in the Great Lakes Basin.* Ontario Ministry of Natural Resources and Forestry, Wildlife Research and Monitoring Section, Peterborough, ON. doi:http://dx.doi.org/10.6084/m9.figshare.1471658

Brinker, S., & Jones, C. (2012). *The Vulnerability of Provincially Rare Species (Species-at-Risk) to Climate Change in the Lake Simcoe Watershed, Ontario, Canada.* Applied Research and Development Branch, Ontario Ministry of Natural Resources and Forestry. Retrieved from http://www.natureserve.org/sites/default/files/publications/files/canada_ccrr_31.pdf

Brooks, T., Mittermeier, R., da Fonseca, G., Gerlach, J., Hoffmann, M., Lamoreux, J., . . . Rodrigues, A. (2006). Global Biodiversity Conservation Priorities. *Science, 313*(5783), 58. Retrieved from http://people.ucsc.edu/~cwilmers/ENVS220/brooks2006.pdf

BSC (Bird Studies Canada). (2015). Important Bird Areas of Canada Database. Port Rowan, ON: Bird Studies Canada. Retrieved February 29, 2016, from http://www.ibacanada.org/explore_how.jsp?lang=en

CCEA (Canadian Council on Ecological Areas). (2014). A National Ecological Framework for Canada: Ecozones. Version 5 (2014.02.18). Retrieved April 30, 2015, from Available http://www.ccea.org/ecozones-downloads/

CCEA (Canadian Council on Ecological Areas). (2017). Conservation Areas Reporting and Tracking System (CARTS). Version 2017.12.31. CA: CCEA. Retrieved March 1, 2018, from http://www.ccea.org/download-carts-data/

Chu, C., Minns, C., Lester, N., & Mandrak, N. (2015). An updated assessment of human activities, the environment, and freshwater fish biodiversity in Canada. *Canadian Journal of Fisheries and Aquatic Sciences, 72*(1), 135-148. Retrieved from http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2013-0609#.VWSxs0bYbOh

CMP (Conservation Measures Partnership). (2013). *The Open Standards for the Practice of Conservation.* Retrieved from http://www.iai.int/wp-content/uploads/2015/08/CMP_Open_Standards_Version_3.0_April_2013.pdf

Coristine, L., Jacob, A., Schuster, R., Otto, S., Baron, N., Bennett, N., . . . Woodley, S. (2018, in press). Informing Canada's commitment to biodiversity conservation: A science-based framework to help guide protected areas designation through Target 1 and beyond. *FACETS*.

Coristine, L., Soroye, P., Nobre Soares, R., Robillard, C., & Kerr, J. (2016). Dispersal limitation, climate change, and practical tools for butterfly conservation in intensively used landscapes. *Natural Areas Journal*, 440-452.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2016a). *Candidate Wildlife Species.* Environment and Climate Change Canada. Retrieved from http://www.cosewic.gc.ca/htmlDocuments/CandidateSpecies_List_e.pdf

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2016b, May). *Committee on the Status of Endangered Wildlife in Canada*. (Environment and Climate Change Canada) Retrieved May 9, 2016, from http://www.cosewic.gc.ca

Darwall, W., Holland, R., Smith, K., Allen, D., Brooks, E., Katarya, V., . . . Vié, J.-C. (2011). Implications of bias in conservation research and investment for freshwater species. *Conservation Letters, 4*, 474–482.

Davis, R., Chora, L., & Crins, W. (2006). GapTool: An Analytical Tool for Ecological Monitoring and Conservation Planning. *Parks Research Forum of Ontario Proceedings*, (pp. 139-150). Niagara Falls, ON. Retrieved January 18, 2017, from http://casiopa.mediamouse.ca/wp-content/uploads/2010/05/PRFO-2006-Proceedings-p139-150-Davis-Chora-and-Crins.pdf

DUC (Ducks Unlimited Canada). (2016). DUC Purchase Land and Conservation Easements (10 Grid).

ECCC (Environment and Climate Change Canada). (2012). Threats to Water Availability in Canada, 2009. Gatineau, QC. Retrieved September 12, 2017, from http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=1B1433B4-1

ECCC (Environment and Climate Change Canada). (2013a). *How Much Habitat is Enough? Third Edition.* Toronto, ON: ECCC. Retrieved April 30, 2016, from http://www.ec.gc.ca/nature/default.asp?lang=En&n=E33B007C-1

ECCC (Environment and Climate Change Canada). (2013b). The Canadian National Atmospheric Chemistry (NAtChem) Database And Analysis System. Retrieved December 05, 2016, from https://www.ec.gc.ca/natchem/

ECCC (Environment and Climate Change Canada). (2014). *Terrestrial biodiversity of federal interest in the Mixedwood Plains Ecozone of Ontario.* Toronto: Environment and Climate Change Canada. Retrieved from https://www.ec.gc.ca/nature/default.asp?lang=En&n=3B824EDF-1

ECCC (Environment and Climate Change Canada). (2015). *Terrestrial Biodiversity of Federal Interest in the Mixedwood Plains Ecozone of Ontario.* Toronto, ON: ECCC.

ECCC (Environment and Climate Change Canada). (2016a). *2020 Biodiversity Goals and Targets for Canada.* Ottawa: ECCC. Retrieved May 16, 2016, from http://biodivcanada.ca/9B5793F6-A972-4EF6-90A5-A4ADB021E9EA/3499%20-%202020%20Biodiversity%20Goals%20&%20Targets%20for%20Canada%20-%20%20Final%20Web_ENG.pdf

ECCC (Environment and Climate Change Canada). (2016b). *Canadian Environmental Sustainability Indicators: Canada's Protected Areas.* Ottawa: ECCC. Retrieved May 16, 2016, from www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=478A1D3D-1

ECCC (Environment and Climate Change Canada). (2016c). Interactive Indicator Maps. Retrieved December 05, 2016, from http://maps-cartes.ec.gc.ca/indicators-indicateurs/Default.aspx

ECCC (Environment and Climate Change Canada). (2016d). Private Conservation Lands 10 km Square Grid. Downsview, ON: Canadian Wildlife Service, ECCC.

Environment and Natural Resources. (2016). *NWT State of the Conservation Network Report 2016.* Government of the Northwest Territories, Department of Natural Resources, Yellowknife, NT. Retrieved January 18, 2017, from http://www.enr.gov.nt.ca/new-nwt-state-conservation-network-report-2016

ESRI. (2012). *What is the Jenks optimization method?* Retrieved Feb 12, 2016, from http://support.esri.com/technical-article/000006743

Federal, Provincial and Territorial Governments of Canada. (2010). *Canadian Biodiversity: Ecosystem Status and Trends 2010 [online].* Ottawa: Canadian Councils of Resource Ministers. Retrieved February 29, 2016, from http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1

Feltmate, B., & Thistlethwaite, J. (2012). *Climate Change Adaptation: A Priorities Plan for Canada.* Report of the Climate Change Adaptation Project (Canada). Retrieved from https://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/CCAP-Report-30May-Final.pdf

Freedman, B. (2013). *A history of the Nature Conservancy of Canada.* Oxford University Press.

Gaston, K. (2000). Global patterns in biodiversity. *Nature, 405*, 220-227.

Gaston, K. (2010). Valuing common species. *Science, 327*, 154-155.

Gerardin, V., Ducruc, J.-P., & Beauchesne, P. (2002). Planification du réseau d'aires protégées du Québec : principes et méthodes de l'analyse écologique du territoire. *Vertigo, 3*(1).

GFWC (Global Forest Watch Canada). (2010). Canada's Intact Forest Landscapes. Retrieved March 14, 2016, from http://www.globalforestwatch.ca/data/20100913A

GFWC (Global Forest Watch Canada). (2014). Human Access of Canada's Landscapes. Retrieved March 14, 2016, from http://www.globalforestwatch.ca/node/198

Glick, P., Stein, B., & Edelson, N. (2011). *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment.* Washington, DC: National Wildlife Federation. Retrieved from http://www.habitat.noaa.gov/pdf/scanning_the_conservation_horizon.pdf

Groves, C. (2003). *Drafting a conservation blueprint: a practitioner's guide to planning for biodiversity.* Arlington, VA: The Nature Conservancy.

Habel, J., Teucher, M., Mulwa, R., Haber, W., Eggermont, H., & Lens, L. (2016). Nature conservation at the edge. *Biodiversity and Conservation, 25*(4), 791-799.

Hoekstra, J., Boucher, T., Ricketts, T., & Roberts, C. (2005). Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters, 8*, 23–29.

Iacobelli, A., Alidina, H., Blasutti, A., Anderson, C., & Kavanagh, K. (2006). *A landscape-based protected areas gap analysis and GIS tool for conservation planning.* WWF-Canada. Retrieved January 18, 2017, from http://awsassets.wwf.ca/downloads/wwf_forest_aor_fullreport.pdf

Ibisch, P., Hoffmann, M., Kreft, S., Pe'er, G., Kati, V., Biber-Freudenberger, L., . . . Selva, N. (2016). A global map of roadless areas and their conservation status. *Science, 354*(6318), 1423-1427. Retrieved December 19, 2016, from http://www.roadless.online/

IUCN (International Union for Conservation of Nature). (2014a). IUCN Red List of Threatened Species (Amphibians). Version 4 (2014.1). Cambridge, UK. Retrieved April 29, 2015, from http://www.iucnredlist.org/technical-documents/spatial-data

IUCN (International Union for Conservation of Nature). (2014b). IUCN Red List of Threatened Species (Mammals). Version 4 (2014.1). Cambridge, UK, UK. Retrieved February 02, 2016, from http://www.iucnredlist.org/technical-documents/spatial-data

IUCN (International Union for Conservation of Nature). (2016). *A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0. First edition.* Gland, SUI: IUCN.

Iwamura, T., Wilson, K., Venter, O., & Possingham, H. (2010). A Climatic Stability Approach to Prioritizing Global Conservation Investments. *PLoS ONE, 5*(11), e15103. doi:10.1371/journal.pone.0015103

Jenkins, C., Van Houtan, K., Pimm, S., & Sexton, J. (2015). US protected lands mismatch biodiversity priorities. *Proceedings of the National Academy of Sciences. 112*, pp. 5081-5086. Washington, DC: PNAS. doi:10.1073/pnas.1418034112

Jurasinski, G., Retzer, V., & Beierkuhnlein, C. (2009). Inventory, differentiation, and proportional diversity: a consistent terminology for quantifying species diversity. *Oecologia, 159*(1), 15-26. doi:https://doi.org/10.1007/s00442-008-1190-z

Kavanagh, K., & Iacobelli, A. (1995). *A protected areas gap analysis methodology: Planning for the conservation of biodiversity.* Toronto, ON: World Wildlife Fund Canada.

Kerr, J., & Cihlar, J. (2004). Patterns and causes of species endangerment in Canada. *Ecological Applications*, 743-753.

Koen, E., Bowman, J., & Walpole, A. (2012). The effect of cost surface parameterization on landscape resistance estimates. *Molecular Ecology Resources, 12*, 686-696.

Kraus, D. (2005). Applying the Great Lakes Conservation Blueprint for the strategic protection of biodiversity at multiple scales. *Parks & Reserach Forum of Ontario Proceedings*, pp. 61-72. Retrieved from http://casiopa.mediamouse.ca/wp-content/uploads/2010/05/PRFO-2005-Proceedings-p61-72-Kraus.pdf

Kutner, L. (2015). *Species of Conservation Concern Analysis.* Ottawa, ON: NatureServe Canada.

Lawler, J., Ruesch, A., Olden, J., & McRae, B. (2013). Projected climate-driven faunal movement routes. *Ecology Letters, 16*(8), 1014-1022.

Lee, P., & Cheng, R. (2014). Human Access in Canada's Landscapes. *Global Forest Watch Canada Bulletin*. Ottawa, ON. Retrieved November 24, 2016, from http://globalforestwatch.ca/sites/gfwc/files/publications/20140109A_Canada_Access_Bulletin.pdf

Legendre, P., & Legendre, L. (2012). *Numerical Ecology. Developments in Environmental Modelling Volume 24.* (Third Edition ed.). Elsevier.

Lindsay, K., Gobeil, J.-F., Lawler, J., Schloss, C., Beazley, K., & Beechey, T. (2016). Wildlife Conservation, Protected Areas and Climate Change in Canada: Exploring Implications of Projected Species Range Shifts. *Canadian Council on Ecological Areas (CCEA) Occasional Paper 21*. Ottawa, ON: CCEA.

Loarie, S., Duffy, P., Hamilton, H., Asner, G., Field, C., & Ackerly, D. (2009). The velocity of climate change. *NATURE, 462*, 1052-1055.

Margules, C., & Pressey, R. (2000). Systematic conservation planning. *Nature, 405*, 243-253.

McGuire, J., Lawler, J., McRae, B., Nuñez, T., & Theobald, D. (2016). Achieving climate connectivity in a fragmented landscape. *Proceedings of the National Academy of Sciences*. doi:www.pnas.org/cgi/doi/10.1073/pnas.1602817113

McRae, B., & Kavanagh, D. (2011). Linkage Mapper Connectivity Analysis Software. Seattle, Washington. Retrieved April 01, 2016, from http://www.circuitscape.org/linkagemapper

MDDELCC (Ministry of Sustainable Development, Environment and the Fight against Climate Change). (2017). Quebec's Protected Areas Network. Version 2017.12.15. QC.

Michalak, J., C. Carroll, et al. (2015). *Description of land facet data for North America at 100m resolution*. Retrieved January 18, 2017, from https://adaptwest.databasin.org/pages/adaptwest-landfacets

Morrison, J., Sechrest, W., Dinerstein, E., Wilcove, D., & Lamoreux, J. (2007). Persistence of large mammal faunas as indicators of global human impacts. *Journal of Mammalogy, 88*, 1363-1380.

NABCI (North American Bird Conservation Initiative). (2012). *The State of Canada's Birds 2012.* Ottawa: Environment and Climate Change Canada (ECCC). Retrieved from http://www.stateofcanadasbirds.org/State_of_Canada's_birds_2012.pdf

NABCI (North American Bird Conservation Initiative). (2016). *The State of North America's Birds 2016.* Ottawa: Environment and Climate Change Canada (ECCC). Retrieved from http://www.stateofthebirds.org/2016/

NatureServe. (2016). *NatureServe*. Retrieved May 9, 2016, from http://www.natureserve.org/

NatureServe and its Natural Heritage member programs and Conservation Data Centres. (2015). Multi-Jurisdictional Dataset. Virginia, USA: NatureServe.

NCC (Nature Conservancy of Canada). (2015). *Conservation Blueprints*. Retrieved March 1, 2016, from http://www.natureconservancy.ca/en/what-we-do/resource-centre/conservation-blueprints

NCC (Nature Conservancy of Canada). (2018). LIS Database. Version 2018.02.28. Toronto, ON: NCC.

Newmark, W. (1985). Legal and Biotic Boundaries of Western North American National Parks: A Problem of Congruence. *Biological Conservation, 33*, 197-208.

Newmark, W. (1995). Extinction of Mammal Populations in Western North American National Parks. *Conservation Biology, 9*(3), 512-526. Retrieved from http://www.jstor.org/stable/2386606

NRCan (Natural Resources Canada). (1981). Canada - Growing Degree Days. (Atlas of Canada, 5th Edition). Ottawa, ON: Earth Sciences Sector, Canada Centre for Remote Sensing, NRCan. Retrieved November 21, 2016, from http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/610cd0b8-4791-5374-8245-a12a053bcd4a.html

NRCan (Natural Resources Canada). (2002). Digital Elevation Model of the Canadian Landmass 30. Ottawa, ON: Earth Sciences Sector, Canada Centre for Remote Sensing, NRCan. Retrieved January 18, 2017, from http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/aa3dc127-4d10-4c1c-a760-f19bef14042b.html

NRCan (Natural Resources Canada). (2015). National Road Network (NRN). Ottawa, ON: Earth Sciences Sector, Canada Centre for Remote Sensing, NRCan.

NRCan et al. (Natural Resources Canada, US Geological Survey (USGS), Insituto Nacional de Estadística y Geografía (INEGI), Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) and Comisión Nacional Forestal (CONAFOR)). (2013). 2010 Land Cover of North America at 250 meters. Ottawa, ON: Canada Centre for Mapping and Earth Observation (CCRS), NRCan; Sioux Falls, SD: USGS; Mexico City, MEX: INEGI, CONABIO and CONAFOR. Retrieved January 05, 2016, from http://www.cec.org/tools-and-resources/map-files/land-cover-2010

NRMMC (Natural Resource Management Ministerial Council). (2010). *Australia's Biodiversity Conservation Strategy 2010-2030.* Canberra, AUS: Australian Government, Department of Sustainability, Environment, Water, Population and Communities. Retrieved from http://www.environment.gov.au/system/files/resources/58321950-f8b6-4ef3-bb68-6f892420d601/files/biodiversity-strategy-2010.pdf

Olson, D., & Dinerstein, E. (2002). The Global 200: Priority ecoregions for global conservation. *Annals of the Missouri Botanical Garden, 89*(2), 199-224.

Parks Canada. (2016). *State of Canada's Natural and Cultural Heritage Places.* Ottawa, ON. Retrieved from https://www.pc.gc.ca/en/docs/pc/rpts/elnhc-scnhp

Patterson, L., Phelan, J., & Goudreau, C. (2017). Flow-Biology Relationships Based on Fish Habitat Guilds in North Carolina. *Journal of the American Water Resources Association*, 56–66.

Poiani, K., Richter, B., Anderson, M., & Richter, H. (2000). Biodiversity conservation at multiple scales: functional sites, landscapes, and networks. *BioScience, 50*, 133–146.

Potapov, P., Yaroshenko, A., Turubanova, S., Dubinin, M., Laestadius, L., Thies, C., . . . Zhuravleva, I. (2008). Mapping the World's Intact Forest Landscapes by Remote Sensing. *Ecology and Society, 13*(2). Retrieved from http://www.intactforests.org/data.ifl.html

Ricketts, T., Dinerstein, E., Olson, D., Loucks, C., Eichbaum, W., Kavanagh, K., . . . Walters, W. (1999). *Ecoregions of North America: A conservation assessment.* Washington DC: Island Press.

Robertson, C., Schuster, R., Mitchell, M., Cameron, R., Jacob, A., Preston, S., . . . McMillan, S. (2017). *Identifying Areas Important for Biodiversity and Ecosystem Services.* A Pathway to Canada Target 1 Expert Task Team Paper.

Runge, C., Watson, J., Butchart, S., Hanson, J., Possingham, H., & Fuller, R. (2015). Protected areas and global conservation of migratory birds. *Science*, 1255-1257. doi:http://dx.doi.org/10.1126/science.aac9180

Rustad, L., Campbell, J., Dukes, J., Huntington, T., Lambert, K., Mohan, J., & Rodenhouse, N. (2012). *Changing Climate, Changing Forests: The Impacts of Climate Change on Forests of the Northeastern United States and Eastern Canada.* Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station. Retrieved from http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs99.pdf

Sanjayan, M., Samberg, L., Boucher, T., & Newby, J. (2012). Intact faunal assemblages in the modern era. *Conservation Biology, 26*, 724–730.

SCBD (Secretariat of the Convention on Biological Diversity). (2010). *Global Biodiversity Outlook 3.* Montreal, QC: Secretariat of the Convention on Biological Diversity. Retrieved from https://www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf

Shank, C., & Nixon, A. (2014). *Climate Change Vulnerability of Alberta's Terrestrial Biodiversity: A Preliminary Assessment.* Biodiversity Management and Climate Change Adaptation Project, Alberta Biodiversity Monitoring Institute, Edmonton, AB. Retrieved from http://www.natureserve.org/sites/default/files/shankandnixon_2014_climatechangevulnerabilityofalbertasterrestrialbiodiversity_abmi.pdf

Statistics Canada. (2016). Road Network File, 2016 Census. *Catalogue no. 92-500-X*. Retrieved February 15, 2018, from http://www12.statcan.gc.ca/census-recensement/2011/geo/rnf-frr/index-eng.cfm

Statistics Canada. (2017). Ecological Land Classification (ELC) 2017. Retrieved February 15, 2018, from http://www.statcan.gc.ca/eng/subjects/standard/environment/elc/2017-1

Swaty, R., Blankenship, K., Hagen, S., Fargione, J., Smith, J., & Patton, J. (2011). Accounting for Ecosystem Alteration Doubles Estimates of Conservation Risk in the Conterminous United States. *PLoS ONE, 6*(8), e23002. doi:10.1371/journal.pone.0023002

Trombulak, S., Anderson, M., Baldwin, R., Beazley, K., Ray, J., Reining, C., . . . Gratton, L. (2008). *Priority Locations for Conservation Action in the Northern Appalachian/Acadian Ecoregion.* Two Countries, One Forest, Special Report 1.

USGS (United States Geological Survey). (1999). Digital representation of "Atlas of United States Trees" by Elbert L. Little, Jr. Retrieved June 17, 2015, from http://esp.cr.usgs.gov/data/little/

USGS (United States Geological Survey). (2007). North America Elevation 1-Kilometer Resolution. (3). Ottawa, ON: Natural Resources Canada; Aguascalientes, MEX: Instituto Nacional de Estadística y Geografía; Reston, VA: National Atlas of the United States, USGS. Retrieved August 27, 2015, from http://www.cec.org/tools-and-resources/map-files/elevation-2007

USGS (United States Geological Survey). (2017). USGS National Transportation Dataset (NTD) Downloadable Data Collection. (N. G. Center, Compiler) Reson, VA, US. Retrieved February 12, 2018, from https://catalog.data.gov/dataset/usgs-national-transportation-dataset-ntd-downloadable-data-collectionde7d2

USGS, GAP (United States Geological Survey, Gap Analysis Program). (2016). Protected Areas Database of the United States (PAD-US). (Version 1.4). Retrieved December 1, 2016, from http://gapanalysis.usgs.gov/PADUS/

Venter, O., Sanderson, E., Magrach, A., Allan, J., Beher, J., Jones, K., . . . Watson, J. (2016a). Data from: Global Terrestrial Human Footprint Maps for 1993 and 2009. Dryad Digital Repository. doi:dx.doi.org/10.5061/dryad.052q5.2

Venter, O., Sanderson, E., Magrach, A., Allan, J., Beher, J., Jones, K., . . . Watson, J. (2016b). Global Terrestrial Human Footprint Maps for 1993 and 2009. *Scientific Data, 3*(160067). doi:10.1038/sdata.2016.67

Warren, F., & Lemmen, D. (2014). *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation.* Government of Canada, Ottawa. Retrieved from http://www.climatechange.gc.ca/default.asp?lang=En&n=036D9756-1

Watts, A., Schliechting, P., Billerman, S., Jesmer, B., Micheletti, S., Fortin, M., . . . Murphy, M. (2015). How spatio-temporal habitat connectivity affects amphibian genetic structure. *Fronteers in Genetics, 6*, Art. 275.

Whittaker, R., Willis, K., & Field, R. (2001). Scale and species richness: towards a general, hierarchical theory of species diversity. *Journal of Biogeography, 28*(4), 453-470. doi:10.1046/j.1365-2699.2001.00563.x

WWF-Canada (World Wildlife Fund Canada). (2012). Enduring Features [Dataset]. Toronto, ON.

WWF-Canada (World Wildlife Fund Canada). (2017a). *A national assessment of Canada's freshwater Watershed Reports.* Toronto, ON. Retrieved from http://watershedreports.wwf.ca/#canada/by/threat-overall/profile

WWF-Canada (World Wildlife Fund Canada). (2017b). *Living planet report Canada.* Toronto: WWF.

Zar, J. (1999). *Biostatistical Analysis.* New Jersey: Prentice Hall.

APPENDIX A – SUMMARY OF ECOREGIONS

Table A.1: Summary of ecoregions

Ecozone Name	Ecoregion Name	ID	Major Habitat Type (MHT)	Total Area (ha)	Land Area (ha)	Marine Area (ha)
Atlantic Highlands	Appalachians	117	Temperate Broadleaf and Mixed Forests	7,907,878.00	6,631,339.90	1,276,538.10
	New Brunswick Highlands	119	Boreal Forest/Taiga	496,771.10	496,771.10	-
	Northern New Brunswick Uplands	118	Temperate Broadleaf and Mixed Forests	2,584,887.90	2,371,502.40	213,385.50
Atlantic Maritime	Annapolis-Minas Lowlands	126	Temperate Broadleaf and Mixed Forests	472,535.90	448,272.80	24,263.10
	Atlantic Coast	125	Temperate Broadleaf and Mixed Forests	2,936,542.50	678,236.40	2,258,306.20
	Cape Breton Highlands	129	Boreal Forest/Taiga	229,359.10	229,359.10	-
	Fundy Coast	123	Temperate Broadleaf and Mixed Forests	1,824,086.70	436,864.10	1,387,222.60
	Îles-de-la-Madeleine	131	Temperate Broadleaf and Mixed Forests	119,341.50	23,362.50	95,979.00
	Maritime Lowlands	122	Temperate Broadleaf and Mixed Forests	3,911,979.20	2,930,434.80	981,544.40
	Nova Scotia Highlands	128	Temperate Broadleaf and Mixed Forests	2,109,281.40	1,494,093.40	615,187.90
	Prince Edward Island	130	Temperate Broadleaf and Mixed Forests	1,803,403.10	589,323.00	1,214,080.10
	Saint John River Valley	120	Temperate Broadleaf and Mixed Forests	376,408.20	376,408.20	-
	South-central Nova Scotia Uplands	127	Temperate Broadleaf and Mixed Forests	623,597.60	618,785.80	4,811.80
	Southern New Brunswick Uplands	121	Temperate Broadleaf and Mixed Forests	1,287,612.80	1,278,395.50	9,217.30
	Southwest Nova Scotia Uplands	124	Temperate Broadleaf and Mixed Forests	1,595,689.20	1,572,288.80	23,400.30
Boreal Plains	Boreal Transition	149	Temperate Grasslands/Savanna/Shrub	10,089,724.10	10,089,724.10	-
	Interlake Plain	155	Temperate Grasslands/Savanna/Shrub	3,990,720.20	3,990,720.20	-
	Mid-Boreal Lowland	148	Boreal Forest/Taiga	9,201,622.30	9,201,622.30	-
	Mid-Boreal Uplands	139	Boreal Forest/Taiga	20,214,882.90	20,214,882.90	-
	Western Alberta Upland	145	Temperate Coniferous Forests	7,582,884.10	7,582,884.10	-
Boreal Shield	Abitibi Plains	96	Boreal Forest/Taiga	18,871,376.00	17,772,480.00	1,098,896.00
	Algonquin-Lake Nipissing	98	Temperate Broadleaf and Mixed Forests	7,458,768.80	6,870,842.80	587,926.00
	Avalon Forest	115	Boreal Forest/Taiga	48,476.60	48,476.60	-
	Central Laurentians	101	Boreal Forest/Taiga	22,402,780.20	20,898,966.40	1,503,813.80
	Central Newfoundland	112	Boreal Forest/Taiga	3,096,145.47	2,988,755.50	107,389.97
	Lac Temiscamingue Lowland	97	Temperate Broadleaf and Mixed Forests	8,867,736.30	8,364,481.00	503,255.30
	Lake Nipigon	94	Boreal Forest/Taiga	9,379,406.10	8,221,691.50	1,157,714.60
	Lake of the Woods	91	Temperate Broadleaf and Mixed Forests	4,517,167.90	4,288,498.50	228,669.30
	Long Range Mountains	108	Boreal Forest/Taiga	1,606,878.301	1,602,567.52	4,310.78
	Maritime Barrens	114	Boreal Forest/Taiga	6,447,538.70	3,566,686.60	2,880,852.10

Ecozone Name	Ecoregion Name	ID	Major Habitat Type (MHT)	Total Area (ha)	Land Area (ha)	Marine Area (ha)
Boreal Shield (continued)	Northeastern Newfoundland	113	Boreal Forest/Taiga	2,796,459.50	593,387.60	2,203,071.90
	Northern Peninsula	107	Boreal Forest/Taiga	1,726,674.77	819,981.39	906,693.38
	Rainy River	92	Temperate Broadleaf and Mixed Forests	340,750.90	288,806.20	51,944.70
	South Avalon-Burin Oceanic Barrens	116	Boreal Forest/Taiga	1,293,476.10	203,714.90	1,089,761.10
	Southern Laurentians	99	Temperate Broadleaf and Mixed Forests	16,817,182.60	16,742,865.10	74,317.50
	Southwestern Newfoundland	109	Boreal Forest/Taiga	1,939,738.60	1,048,709.70	891,028.90
	Strait of Belle Isle	106	Boreal Forest/Taiga	967,218.82	252,635.89	714,582.94
	Thunder Bay-Quetico	93	Temperate Broadleaf and Mixed Forests	2,662,943.70	2,546,453.20	116,490.50
Mixedwood Plains	Frontenac Axis	133	Temperate Broadleaf and Mixed Forests	98,585.40	87,688.00	10,897.30
	Lake Erie Lowland	135	Temperate Broadleaf and Mixed Forests	4,117,411.80	2,372,347.40	1,745,064.40
	Manitoulin-Lake Simcoe	134	Temperate Broadleaf and Mixed Forests	8,195,150.00	4,626,437.10	3,568,712.90
	St. Lawrence Lowlands	132	Temperate Broadleaf and Mixed Forests	4,506,107.80	4,182,091.70	324,016.00
Montane Cordillera	Bulkley Ranges	201	Temperate Coniferous Forests	290,108.10	290,108.10	0
	Central Canadian Rocky Mountains	200	Temperate Coniferous Forests	3,706,368.40	3,706,368.40	0
	Chilcotin Ranges	204	Temperate Coniferous Forests	1,178,641.90	1,178,641.90	0
	Columbia Mountains and Highlands	205	Temperate Coniferous Forests	8,880,639.40	8,880,639.40	0
	Eastern Continental Ranges	207	Temperate Coniferous Forests	3,920,951.50	3,920,951.50	0
	Fraser Basin	203	Temperate Coniferous Forests	4,630,017.50	4,630,017.50	0
	Fraser Plateau	202	Temperate Coniferous Forests	9,133,641.90	9,133,641.90	0
	Northern Continental Divide	214	Temperate Coniferous Forests	1,555,420.60	1,555,420.60	0
	Omineca Mountains	199	Temperate Coniferous Forests	3,502,211.40	3,502,211.40	0
	Selkirk-Bitterroot Foothills	212	Temperate Coniferous Forests	794,844.20	794,844.20	0
	Skeena Mountains	198	Temperate Coniferous Forests	2,288,864.40	2,288,864.40	0
	Southern Rocky Mountain Trench	213	Temperate Coniferous Forests	751,974.50	751,974.50	0
	Western Continental Ranges	206	Temperate Coniferous Forests	2,448,400.40	2,448,400.40	0

Ecozone Name	Ecoregion Name	ID	Major Habitat Type (MHT)	Total Area (ha)	Land Area (ha)	Marine Area (ha)
Pacific Maritime	Cascade Ranges	197	Temperate Coniferous Forests	31,543.10	31,543.10	0
	Coastal Gap	191	Temperate Coniferous Forests	6,947,259.70	5,074,968.10	1,872,291.60
	Eastern Vancouver Island	194	Temperate Coniferous Forests	1,477,088.50	1,331,490.50	145,598.00
	Georgia-Puget Basin	195	Temperate Coniferous Forests	704,008.00	138,036.20	565,971.90
	Lower Mainland	196	Temperate Coniferous Forests	628,572.60	473,245.50	155,327.10
	Nass Basin	187	Temperate Coniferous Forests	563,490.30	563,490.30	0
	Nass Ranges	190	Temperate Coniferous Forests	1,275,432.80	1,275,432.80	0
	Pacific Ranges	192	Temperate Coniferous Forests	6,284,677.10	5,963,894.60	320,782.40
	Queen Charlotte Lowland	189	Temperate Coniferous Forests	372,712.40	288,817.10	83,895.30
	Queen Charlotte Ranges	188	Temperate Coniferous Forests	1,091,103.50	715,682.50	375,421.00
	Western Vancouver Island	193	Temperate Coniferous Forests	2,464,872.50	1,948,781.40	516,091.10
Prairies	Aspen Parkland	156	Temperate Grasslands/Savanna/Shrub	17,518,350.40	17,518,350.40	0
	Cypress Upland	160	Temperate Grasslands/Savanna/Shrub	854,188.70	854,188.70	0
	Fescue Grassland	158	Temperate Grasslands/Savanna/Shrub	1,490,698.50	1,490,698.50	0
	Lake Manitoba Plain	162	Temperate Grasslands/Savanna/Shrub	3,265,434.20	3,265,434.20	0
	Mixed Grassland	159	Temperate Grasslands/Savanna/Shrub	13,345,784.10	13,345,784.10	0
	Moist Mixed Grassland	157	Temperate Grasslands/Savanna/Shrub	9,959,334.60	9,959,334.60	0
	Southwest Manitoba Uplands	163	Temperate Grasslands/Savanna/Shrub	215,612.50	215,612.50	0
Semi-Arid Plateaux	Interior Transition Ranges	208	Temperate Coniferous Forests	1,525,001.10	1,525,001.10	0
	Okanagan Highland	211	Temperate Coniferous Forests	120,916.20	120,916.20	0
	Okanagan Range	210	Temperate Coniferous Forests	451,620.50	451,620.50	0
	Thompson-Okanagan Plateau	209	Temperate Coniferous Forests	3,797,783.70	3,797,783.70	0

APPENDIX B – DATASETS, CAVEATS AND LIMITATIONS

Data Inventory

The following is a summary of the data collected for the biodiversity, threat and conservation response assessment measures and criteria.

Table B.1: Data inventory

Dataset	Vintage	Scale/Resolution	Source
Base			
Ecozones	2014	1:1,000,000	CCEA 2014
Ecoregions	1996	1:1,000,000	AAFC 1995
Land Use 2000, 2010	1998-2013	30 m	AAFC 2015a, 2015b
Land Cover of North America	2010	250 m	NRCan et al. 2013
Digital Elevation Model of the Canadian Landmass 30	2002	30 arc-seconds	NRCan 2002
North American Elevation	1993-2002	1 km	USGS 2007
National Road Network	2012-2014	1:10,000	NRCan 2015
Road Network File	2009-2015	1:10,000	Statistics Canada 2016
National Transportation Dataset	2006-2016	1:24,000	USGS 2017
Enduring Features	2012	1:1,000,000	WWF-Canada 2012 Kavanagh & Iacobelli 1995
Biodiversity			
Digital Distribution Maps of The IUCN Red List of Threatened Species (Amphibians)	1985-2014	Various	IUCN 2014a
Digital Distribution Maps of The IUCN Red List of Threatened Species (Mammals)	?-2014	Various	IUCN 2014b
Bird Species Distribution Maps of the World	1951-2014	1:1,000,000	BirdLife International and NatureServe 2014
Digital Representation of "Atlas of United States Trees" by Elbert L. Little, Jr.	1971-1977	Various	USGS 1999
Species of Conservation Concern	2015	Ecoregion and 10 km grid square	ACCDC 2016 NatureServe et al. 2015
Key Biodiversity Areas	2015	-	BSC 2015
Intact Mammal Fauna	2007-2012	-	Morrison et al. 2007 (Digitized) Sanjayan et al. 2012 (Digitized)
Human Access to Canada's Landscape	2010	-	GFWC 2014
Global Intact Forest Layer	2013	1:1,000,000	Potapov et al. 2008
Threat			
Global Terrestrial Human Footprint maps for 1993 and 2009	1980-2010	1 km	Venter et al. 2016a
Watershed Stress Index	2015	-	Chu et al. 2015
Gridded Climate Data for North America	-	1 km	AdaptWest Project 2015
Threats to Water Availability	2009	-	ECCC 2012
Conservation			
CARTS	2016	-	CCEA 2017
Quebec's Protected Areas Network	2017	-	MDDELCC 2017
Nature Conservancy of Canada – Fee Simple and Conservation Agreements, Natural Areas	2017	1:10,000	NCC 2017
Ducks Unlimited Canada - Fee Simple and Conservation Agreements	2016	10 km Grid	DUC 2016
Private Conservation Lands	2014-2016	10 km Grid	ECCC 2016d
BC NGO Conservation Areas Database	2015	-	BC NGO Conservation Areas Technical Working Group 2015

Dataset	Vintage	Scale/Resolution	Source
Protected Areas Database of the United States (PAD-US)	2016	1:100,000	USGS, GAP 2016

Data Caveats and Limitations

Datasets compiled for this assessment consist of readily available, spatially referenced data with relatively uniform coverage across the study area as of August 2017. It is important to note that the datasets have their own caveats and/or limitations, some of which are outlined below. The use of additional datasets was explored, but they were excluded from the analysis because they were not comprehensive (e.g. reptiles and freshwater species polygons) or complete for the study area. Some of these datasets are also identified at the end of this section.

Framework

As noted in the main section of the document, the National Ecological Framework for Canada is used for the assessment; this is the same system that Canada uses to report nationally and internationally. The Canadian Council on Ecological Areas (CCEA) updated the ecozone boundaries in 2014 (CCEA 2014); ecoprovinces, ecoregions and ecodistrict boundaries have not yet been updated, which means that the ecoregion and ecozone boundaries are not in exact alignment.

Other ecological framework systems have different boundaries. One such example of differences between framework systems is for Interlake Plain (Ecoregion 155), which is a separate ecoregion in the National Ecological Framework but not recognized in the Bailey et al. (1994) system. In the latter, the area from Lake Winnipeg south is part of the Northern Tallgrass Prairie ecoregion. The tallgrass prairie/aspen parkland found in the northern tallgrass prairie portion of Manitoba has more biological similarities to areas in southern Minnesota and northern Iowa than to lands up near the Porcupine Hills or Grand Rapids. Applying a different reporting framework to the analysis may yield slightly different results.

Several other systems that define ecoregions in Canada can also lead to discrepancies in reporting across boundaries. For example, global ecoregions used by the WWF (e.g. in Ricketts et al. 1999), and ERAs conducted by NCC for 15 ecoregions across southern Canada from 1998 to 2010 (NCC 2015) were developed prior to the updated CCEA boundaries in 2014 and do not fully match ecozones or ecoregions used here.

This analysis focused on lands and inland waters within the study area. Coastal waters are included in the boundaries of some ecoregions, however information on marine biodiversity, threat and conservation response was not explicitly included in the analysis.

Species Data

The CDC data used for several of the biodiversity criteria has certain limitations. Survey efforts vary across the study area and within ecoregions. National parks and more populated areas have likely been heavily surveyed compared to First Nation lands or sparsely populated, remote areas. Ecoregions with very high survey effort may have higher biodiversity scores than those with less survey effort. It is possible that some of the records excluded from the analysis based on the date of last occurrence or ranking of “historic” may still represent viable occurrences.

Few systematic surveys have been conducted for any of the species included in the analysis and completeness of the CDC data varies among species and regions. Surveys of terrestrial and freshwater vertebrate species, vascular plants and species with federal status under *SARA* or COSEWIC is largely complete for many parts of southern Canada, although area and species gaps persist. Certain vertebrate groups and non-vascular plants and fungi are well tracked but others may not be. Occurrences of many freshwater species are not tracked by CDCs, or are incomplete. Whether or not the species has complete location data, the absence of data for a particular species in a particular area does not necessarily mean the species does not occur there – it could mean the area has not yet been inventoried, or a certain program may not yet have developed spatial data for a certain species group (Kutner 2015, pp. 12). Data gaps reported by NatureServe related to taxonomic and geographic completeness in the CDC data include:

- Alberta – some invertebrate species are not tracked; many areas of the province do not have comprehensive inventories.
- British Columbia – only tracks element occurrences for species on the provincial red or blue list except for three bird species with seasonal high non-breeding concentrations and one species where the bird colonies have been maintained. Many geographic data gaps in the province including First Nation reserves, most private land, large crown areas that have not been surveyed along with the northern half of the province, except along rivers.
- Manitoba – tracks G1-G2 species, when data are available and S1 to S3 species.
- New Brunswick, Nova Scotia and Prince Edward Island – due to data sensitivity, some taxa were excluded from the assessment.
- Ontario - Northern portion of the province not as well surveyed as the south.
- Quebec – tracks species on subnational protected list; threatened, vulnerable, susceptible (may be threatened or vulnerable) and candidate species; and G1-G2 species. Amongst taxonomic groups considered at the endangered and threatened level, only vascular plants, bryophytes and vertebrate animals are fully covered. Beginning to account for invertebrates, but many other groups (e.g. fungi) are not. Northern portion of the province not as well surveyed as the south.

Furthermore the NatureServe data are updated through data exchanges within each member program on a 12-18 month cycle and therefore may not be current or complete at a particular point in time. As a result of such time delays, there may be important areas for species that are not considered in this assessment.

There are several caveats with the range map data. Range maps provide general boundaries of species distributions and include areas larger than the actual extents of suitable habitat. Range map polygons represent the current known or inferred limits of a species' distribution. The species occurs within the polygon but will rarely occur within all areas of the polygon. Therefore, in some cases, a species may not actually occur in one or more ecoregions that intersect the range polygons. Furthermore, there are data deficiencies as some species are not mapped due to insufficient information on their distribution or subspecies being mapped within the parental species. Range map data for most taxonomic groups cover more than 90% of the species known to occur in the study area; however, the range map data for reptiles do not include more than 90% of reptile species known to occur in the study area and thus are not included. The groups covered by the range maps are biased towards terrestrial species, particularly animals and woody plants.

Land Use Data

The land use data used for the assessment was a national layer covering areas of the country south of 60^0N and is based on broad land cover classes. For example, the data do not differentiate between plantations and forests or native and perennial tame grasslands. Older growth stands of forest, which are exceedingly rare and important for conservation in some regions such as Atlantic Canada (Federal, Provincial and Territorial Governments of Canada 2010) are also not reflected in the assessment. The data do not include rare communities present within ecoregions; information on these communities has not been compiled or assembled in a readily available dataset for the entire study area. Incorporation of more detailed information is recommended for inclusion at an ecoregional scale of assessment (see Discussion and Applications). It should also be noted that areas of forest loss were not subtracted from the land use data in the final calculations of natural cover, percent converted, etc. as there is no indication in the forest loss layer as to the permanency of the losses (i.e. if the losses are temporary and the forest will regenerate or if the forest have been permanently cleared for agriculture or development). Losses could potentially show back up as a gain in logged areas with sustainably forestry operations. Permanent losses would eventually be reflected in updated land use data. Areas of forest loss could be included in future versions of the assessment with updated land use data or if the land use data is replaced by newer land cover data when it becomes available.

The selected boundary of the study area, and the use of ecoregions as sampling units also influences the results. In general, the northern portion of the study area represents some of the most intact landscapes. As a result, higher relative scores for measures related to landscape intactness tend to be focused on this northern region. Although these regions are the highest scoring within the study area, landscapes of similar, or greater, intactness with similar species, ecosystems and ecological processes may exist in ecoregions that are just outside of the study area. For analyses that scores ecoregions based on a comparison of features within neighboring ecoregions (i.e. beta-diversity), the number of adjacent ecoregions could impact scoring, particularly in ecoregions that are along the edges of the study area.

Connectivity

Connectivity models are based on paths of least resistance between core areas of intact habitat. The resulting corridors are intended to depict general areas that are most likely to provide habitat connectivity for species that cannot traverse, or want to avoid, human-dominated landscapes. Habitat connectivity that incorporates species-specific mobility, or using finer scale landscape permeability may provide different results. Connectivity will also be more important for some species (and species groups) than others. More threatened and specialist species that occur in the study are likely to require specific conservation actions (Coristine et al. 2016).

Within the National Roads Network (NRCan 2015), the classification of roads is inconsistent between provinces. For example, roads classified as “Highways” in Manitoba and Saskatchewan are classified as “Arterial” roads in Alberta. The assigned road class does impact the score assigned to each road, which in turn affects the resistance layer and associated scoring within ecoregions. Therefore, the Road Network File (Statistics Canada 2016) is used in conjunction with the National Roads Network to distinguish between primary and secondary highways. Accuracy and completeness of the National Roads Network also varies between provinces; not all roads, such as local or resource/recreation roads may be captured in the National Road Network.

Intactness

The access/disturbance layer used to find intact habitat polygons applied a 500 m buffer around all disturbances; since it was found relevant for woodland caribou (one of the most disturbance-sensitive species). The results are therefore an under-estimation of available habitat for some species. Despite this and the fact the layer combined different datasets created using different methodologies, the layer does represent the most current Canada-wide-human access dataset (Lee & Cheng 2014, pp. 2). The access/disturbance layer does not include natural disturbances (e.g. wildfire, insect damage), or disturbances that cannot be mapped across the country (e.g. terrestrial invasive species). The layer also does not account for old disturbances that may have recovered and may not account for recent changes or disturbances at local levels such as small recreational or access roads or trails, sites accessed by air or water only, etc. These same caveats also apply to any data layers created from the access/disturbance layer, i.e. intact habitat. Furthermore, because the intact habitat block layer is solely based on the access/disturbance layer, it assumes that the resulting intact habitat blocks are all similar in quality and biodiversity value.

Climate Data

With regards to the climate data for North America, the gridded 1-km data were interpolated between weather stations, and in some cases such weather stations were quite far apart. It should also be noted that some bias may be introduced by the two 30 year average periods chosen due to the Pacific decadal oscillation affecting western North America and an asynchronous Atlantic decadal oscillation affecting eastern North America.

Protected Areas Data

Protected areas vary considerably in their management and degree of protection. The strength of representative area protection varies both within and between Canadian jurisdictions. For example, *Saskatchewan's Wildlife Habitat Protection Act* allows so much discretion to regulators for allowing developments that it falls outside ECCC's Critical Habitat Protection Assessment categories for strong or moderate effective protection; lands protected under this legislation nonetheless are still listed as part of Saskatchewan's Representative Areas Network (lands protected for their ecological importance as representative areas) and included in ECCC's 2016 inventory of protected areas. Furthermore, privately protected areas in CARTS, Quebec's Protected Areas Network and ECCC's Private Conservation Lands database may be incomplete. For example, ECCC's data does not include private lands in Manitoba, New Brunswick and Newfoundland.

DUC lands and the ECCC's private lands data were provided to NCC summarized at a 10 km grid level; due to confidentiality reasons the actual polygon boundaries of these lands could not be shared. Subsequently, the total area of these lands may be accounted for more than once where these grid cells intersect with more than one ecoregion. For grid cells that intersect with more than one ecoregion, the areas of protected land are capped to the maximum area of that grid cell within the ecoregion. Of the 41 ecoregions with grids of private protected lands overlapping multiple ecoregions, the percentage of protected areas may be overestimated by 5-13% for four ecoregions, 2-5% for seven ecoregions and less than 2% for 30 ecoregions.

Other Datasets

Other indicators that were considered for inclusion in the assessment did not have supporting data layers available and could not be incorporated into the analysis. For example, there is a National Pollutant Release Inventory and National Air Pollution Surveillance Program with information on pollutant releases to air, water and land from emission facilities (ECCC 2016c). Releases from these point sources are best for looking at threats to aquatic systems and were incorporated into the watershed stress by Chu et al. 2015. Pollutant deposition is more difficult to model and there is little information as to where pollution emitted from these facilities or from facilities in the United States is actually deposited. There is also a National Atmospheric Chemistry Database with data on air and precipitation chemistry (ECCC 2013b), but there are insufficient measurement sites in western and northern Canada to accurately map acid rain depositions for the entire study area. Some other recent datasets were considered but not included, e.g. the Global Roadless Areas developed using OpenStreetMap data by Ibisch et al. (2016). Although that analysis is based on more recent data than the Global Forest Watch Canada data that were used to develop Intactness scores, it did not include or consider other disturbances on the landscape which are needed for determining intact natural areas (e.g. agricultural clearing, clear cuts and mines). Other datasets were also considered, e.g. WWF's national assessment of Canada's Freshwater Watershed Reports (WWF-Canada 2017a) and those referenced in a recently released Pathways Report (Robertson et al. 2017), but a) the scale of the data provided was not deemed suitable enough for summarizing at the ecoregion level, b) resolution for Canada was not deemed sufficient to produce meaningful results, or c) similar datasets were already included.

APPENDIX C – ENDEMIC SPECIES

The following is a summary list of endemic species included in the assessment. Of the 270 species in the preliminary list of Canadian endemic species provided by NatureServe (current to May 2016, Enns and Kraus in prep), digital range information was available for 108 species. Only 69 of these species occurred within the assessment study area.

Table C.1: Preliminary list of Canadian endemic species tracked in NatureServe and within assessment study area

Taxon	Informal Taxonomy	Scientific Name	Common Name	Ecoregions
Arthropods	Butterflies and Skippers	*Coenonympha nipisiquit*	Maritime Ringlet	Appalachians
Arthropods	Butterflies and Skippers	*Lycaena dospassosi*	Salt Marsh Copper	Maritime Lowlands Northern New Brunswick Uplands Nova Scotia Highlands Prince Edward Island
Arthropods	Butterflies and Skippers	*Papilio brevicauda*	Short-tailed Swallowtail	Maritime Lowlands Northern New Brunswick Uplands
Arthropods	Butterflies and Skippers	*Papilio brevicauda bretonensis*	Short-tailed Swallowtail	Maritime Lowlands Nova Scotia Highlands
Arthropods	Dragonflies and Damselflies	*Somatochlora septentrionalis*	Muskeg Emerald	Cape Breton Highlands Long Range Mountains New Brunswick Highlands Northern Peninsula Nova Scotia Highlands Southern New Brunswick Uplands
Birds	Birds	*Aegolius acadicus brooksi*	Northern Saw-whet Owl brooksi subspecies	Queen Charlotte Lowland Queen Charlotte Ranges
Birds	Birds	*Glaucidium gnoma swarthi*	Northern Pygmy-Owl swarthi subspecies	Western Vancouver Island
Birds	Birds	*Lagopus leucura saxatilis*	Vancouver Island White-tailed Ptarmigan	Eastern Vancouver Island Western Vancouver Island
Freshwater Fishes	Freshwater and Anadromous Fishes	*Coregonus huntsmani*	Atlantic Whitefish	Southwest Nova Scotia Uplands
Freshwater Fishes	Freshwater and Anadromous Fishes	*Cottus sp. 2*	Cultus Pygmy Sculpin	Lower Mainland
Freshwater Fishes	Freshwater and Anadromous Fishes	*Gasterosteus sp. 1*	Giant Threespine Stickleback	Queen Charlotte Lowland
Freshwater Fishes	Freshwater and Anadromous Fishes	*Gasterosteus sp. 16*	Vananda Creek Limnetic Threespine Stickleback	Georgia-Puget Basin
Freshwater Fishes	Freshwater and Anadromous Fishes	*Gasterosteus sp. 17*	Vananda Creek Benthic Threespine Stickleback	Georgia-Puget Basin
Freshwater Fishes	Freshwater and Anadromous Fishes	*Gasterosteus sp. 2*	Enos Lake Limnetic Threespine Stickleback	Eastern Vancouver Island
Freshwater Fishes	Freshwater and Anadromous Fishes	*Gasterosteus sp. 3*	Enos Lake Benthic Threespine Stickleback	Eastern Vancouver Island
Freshwater Fishes	Freshwater and Anadromous Fishes	*Moxostoma hubbsi*	Copper Redhorse	St. Lawrence Lowlands
Freshwater Fishes	Freshwater and Anadromous Fishes	*Spirinchus sp. 1*	Longfin Smelt - Pygmy populations	Lower Mainland Pacific Ranges
Lichens	Lichens	*Collema coniophilum*	Crumpled Tarpaper Lichen	Columbia Mountains and Highlands Fraser Basin

Taxon	Informal Taxonomy	Scientific Name	Common Name	Ecoregions
Mammals	Mammals	*Bos bison athabascae*	Wood Bison	Aspen Parkland Interlake Plain Mid-Boreal Lowland Mid-Boreal Uplands
Mammals	Mammals	*Marmota vancouverensis*	Vancouver Island Marmot	Eastern Vancouver Island
Mammals	Mammals	*Mustela erminea anguinae*	Vancouver Island Ermine	Eastern Vancouver Island
Mammals	Mammals	*Mustela erminea haidarum*	Queen Charlotte Islands Ermine	Queen Charlotte Lowland Queen Charlotte Ranges
Mammals	Mammals	*Sorex gaspensis*	Gaspé Shrew	Appalachians
Mammals	Mammals	*Sorex maritimensis*	Maritime Shrew	Annapolis-Minas Lowlands Fundy Coast Maritime Lowlands
Mammals	Mammals	*Sorex palustris brooksi*	Vancouver Island Water Shrew	Eastern Vancouver Island Western Vancouver Island
Mollusks	Freshwater Snails	*Physella johnsoni*	Banff Springs Snail	Eastern Continental Ranges Northern Continental Divide
Mollusks	Terrestrial Snails	*Staala gwaii*	Haida Gwaii Slug	Queen Charlotte Lowland Queen Charlotte Ranges Western Vancouver Island
Vascular Plant	Conifers and relatives	*Juniperus communis var. megistocarpa*	Magdalen Islands Juniper	Îles-de-la-Madeleine
Vascular Plant	Ferns and relatives	*Botrychium pseudopinnatum*	False Daisyleaf Moonwort	Lake Nipigon
Vascular Plant	Flowering Plants	*Amelanchier fernaldii*	Fernald's Serviceberry	Prince Edward Island Northern Peninsula
Vascular Plant	Flowering Plants	*Arnica frigida ssp. griscomii*	Griscom's Arnica	Appalachians
Vascular Plant	Flowering Plants	*Arnica louiseana*	Lake Louise Arnica	Eastern Continental Ranges
Vascular Plant	Flowering Plants	*Astragalus robbinsii var. fernaldii*	Fernald's Milk-Vetch	Northern Peninsula
Vascular Plant	Flowering Plants	*Atriplex franktonii*	Frankton's Saltbush	Fundy Coast Maritime Lowlands Nova Scotia Highlands Prince Edward Island
Vascular Plant	Flowering Plants	*Boechera quebecensis*	Quebec Rockcress	Appalachians
Vascular Plant	Flowering Plants	*Braya fernaldii*	Fernald's Braya, Fernald's rockcress	Northern Peninsula Strait of Belle Isle
Vascular Plant	Flowering Plants	*Braya longii*	Long's Braya, Long's rockcress	Strait of Belle Isle
Vascular Plant	Flowering Plants	*Braya humilis ssp. maccallae*	McCalla's Braya	Eastern Continental Ranges Western Continental Ranges
Vascular Plant	Flowering Plants	*Braya humilis ssp. porsildii*	Porsild's Braya	Eastern Continental Ranges
Vascular Plant	Flowering Plants	*Carex deweyana var. collectanea*	Round-fruited Sedge	Appalachians
Vascular Plant	Flowering Plants	*Carex misandroides*	Man-hater Sedge	Appalachians Central Laurentians
Vascular Plant	Flowering Plants	*Carex viridula var. saxilittoralis*	Rocky Shore Sedge	Atlantic Coast
Vascular Plant	Flowering Plants	*Cicuta maculata var. victorinii*	Victorin's Water-hemlock	St. Lawrence Lowlands
Vascular Plant	Flowering Plants	*Cochlearia tridactylites*	Limestone Scurvygrass	Atlantic Coast

Taxon	Informal Taxonomy	Scientific Name	Common Name	Ecoregions
Vascular Plant	Flowering Plants	*Corispermum hookeri*	Hooker's Bugseed	Lake Erie Lowland Manitoulin-Lake Simcoe
Vascular Plant	Flowering Plants	*Corispermum hookeri var. hookeri*	Hooker's Bugseed	Aspen Parkland
Vascular Plant	Flowering Plants	*Draba pycnosperma*	Dense Draba	Appalachians
Vascular Plant	Flowering Plants	*Elatine ojibwayensis*	Ojibway Waterwort	Abitibi Plains
Vascular Plant	Flowering Plants	*Erigeron pallens*	Pale Fleabane	Eastern Continental Ranges
Vascular Plant	Flowering Plants	*Erigeron trifidus*	Three-lobed Fleabane	Eastern Continental Ranges Northern Continental Divide Western Continental Ranges
Vascular Plant	Flowering Plants	*Gentianopsis detonsa ssp. raupii*	Raup's Fringed Gentian	Mid-Boreal Uplands
Vascular Plant	Flowering Plants	Gentianopsis nesophila	Island Fringed Gentian	Northern Peninsula Strait of Belle Isle
Vascular Plant	Flowering Plants	*Gentianopsis victorinii*	Victorin's Gentian	St. Lawrence Lowlands
Vascular Plant	Flowering Plants	*Geum schofieldii*	Queen Charlotte Avens	Queen Charlotte Ranges Western Vancouver Island
Vascular Plant	Flowering Plants	*Lechea maritima var. subcylindrica*	Beach Pinweed	Maritime Lowlands Prince Edward Island
Vascular Plant	Flowering Plants	*Limnanthes macounii*	Macoun's Meadowfoam	Eastern Vancouver Island Georgia-Puget Basin
Vascular Plant	Flowering Plants	*Lycopus laurentianus*	St. Lawrence Water-horehound	Algonquin-Lake Nipissing Northern New Brunswick Uplands Southern Laurentians St. Lawrence Lowlands
Vascular Plant	Flowering Plants	*Oxytropis campestris var. davisii*	Davis' Locoweed	Eastern Continental Ranges Western Alberta Upland
Vascular Plant	Flowering Plants	*Oxytropis campestris var. minor*	Small Northern Yellow Locoweed	Northeastern Newfoundland Northern Peninsula Southwestern Newfoundland Strait of Belle Isle
Vascular Plant	Flowering Plants	*Ranunculus allenii*	Allen's Buttercup	Appalachians
Vascular Plant	Flowering Plants	*Salix chlorolepis*	Green-scaled Willow	Appalachians
Vascular Plant	Flowering Plants	*Salix jejuna*	Barrens Willow	Strait of Belle Isle
Vascular Plant	Flowering Plants	*Saxifraga nelsoniana ssp. carlottae*	Queen Charlotte Islands Saxifrage	Queen Charlotte Ranges
Vascular Plant	Flowering Plants	*Solidago simplex var. chlorolepis*	Mt. Albert Goldenrod	Appalachians
Vascular Plant	Flowering Plants	*Spiranthes casei var. novaescotiae*	Nova Scotia Ladies'-tresses	Atlantic Coast Fundy Coast Southwest Nova Scotia Uplands
Vascular Plant	Flowering Plants	*Stellaria longipes ssp. arenicola*	Lake Athabasca Starwort	Mixed Grassland
Vascular Plant	Flowering Plants	*Symphyotrichum laurentianum*	Gulf of St. Lawrence Aster	Îles-de-la-Madeleine Maritime Lowlands Prince Edward Island
Vascular Plant	Flowering Plants	*Taraxacum laurentianum*	Laurentian dandelion	Strait of Belle Isle
Vascular Plant	Flowering Plants	*Trillium ovatum var. hibbersonii*	Dwarf Western Trillium	Western Vancouver Island

APPENDIX D – HABITAT BLOCK ANALYSIS

The methodology outlined in Ricketts et al. (1999) and described below was used to assess the number and extent of contiguous intact habitat blocks. First, ecoregions were assigned to one of five major habitat types (MHTs) covering the study area (Figure D.1). These were temperate broadleaf and mixed forests, temperate coniferous forests, temperate grasslands/savanna/shrub, boreal forest/taiga and tundra. Each MHT represents a set of ecoregions that experience comparable climatic regimes, have similar vegetation structure, display similar spatial patterns of biodiversity and contain flora and fauna with similar guild structures and life histories (Ricketts et al. 1999, pp. 438).

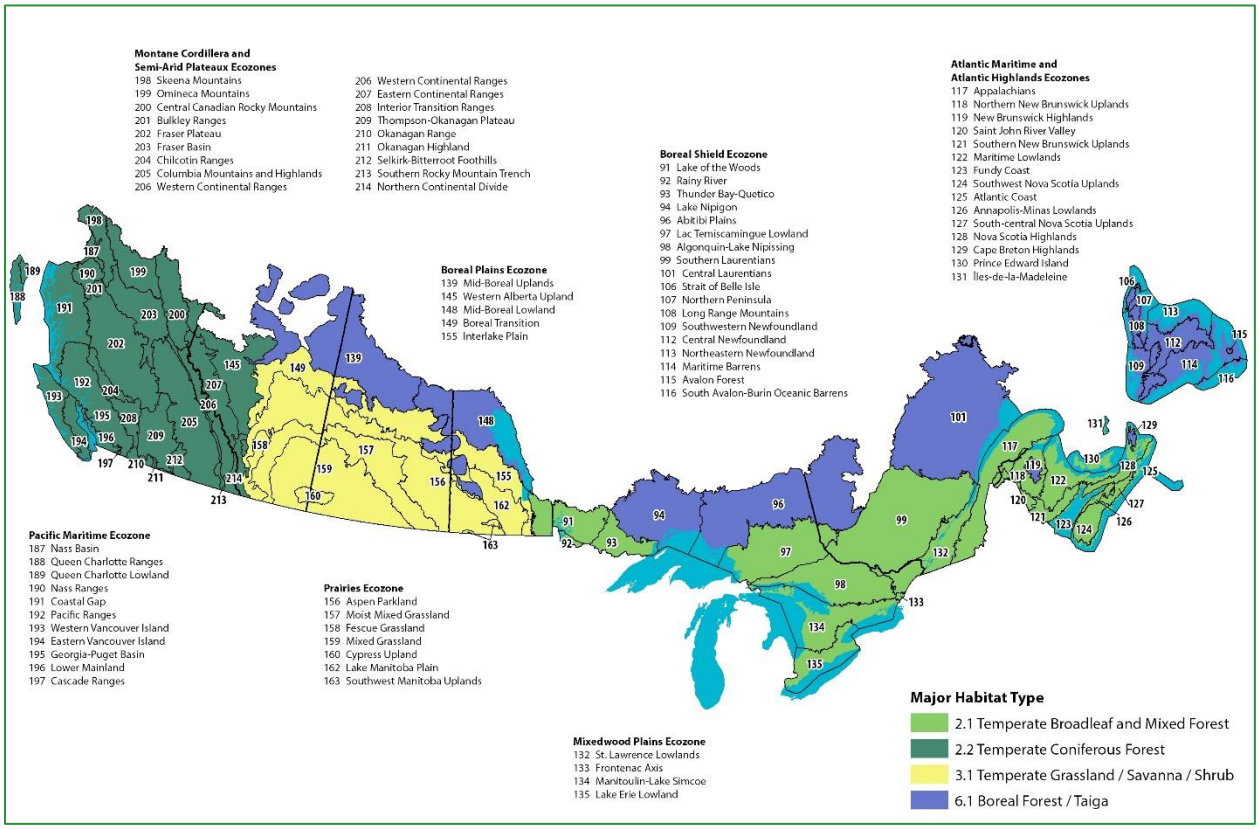

Figure D.1: Major habitat types of the study area (modified from Ricketts et al. 1999)

Then a habitat block analysis was completed for each MHT based on the size and number of habitat blocks within each ecoregion using the intactness layer. The intactness layer was created by removing areas of anthropogenic disturbance from the landscape and in essence represented all areas of undisturbed natural habitat. Table D.1 summarizes the analysis by MHT and ecoregion size; unless otherwise stated in the table, the minimum requirement is for at least one block of intact habitat.

Table D.1: Habitat block analysis by major habitat type

Score	MHTs 2.1 and 2.2 Ecoregion Size		MHT 3.1 Ecoregion Size		MHTs 6.1 and 6.2 Ecoregion Size	
	>10,000 km²	< 10,000 km²	>10,000 km²	< 10,000 km²	>20,000 km²	< 20,000 km²
5	>4,000 or ≥ 3 blocks > 1,500	> 2,500 or ≥ 3 blocks > 800	>2,000 or ≥ 3 blocks > 800	> 1,000 or ≥ 3 blocks > 500	>10,000 or ≥ 3 blocks > 5,000	> 4,000 or ≥ 3 blocks > 1,500
4	≥ 3 blocks > 1,000	> 800	> 1,000	> 500	>6,000 or ≥ 3 blocks > 2,500	> 1,500
3	> 2,000	≥ 3 blocks > 250	> 500	> 250	> 4,000	> 1,000
2	> 1,000	> 250	> 250	> 100	> 2,000	> 500
1	None > 1,000	None > 250	None > 250	None > 100	None > 2,000	None > 500

APPENDIX E – CONNECTIVITY RESULTS

The following figures, created in conjunction with the connectivity analysis (Criterion B7d), include the final cost surface used as input into the analysis, the normalized and truncated least cost corridors from Linkage Mapper and the final corridor surface.

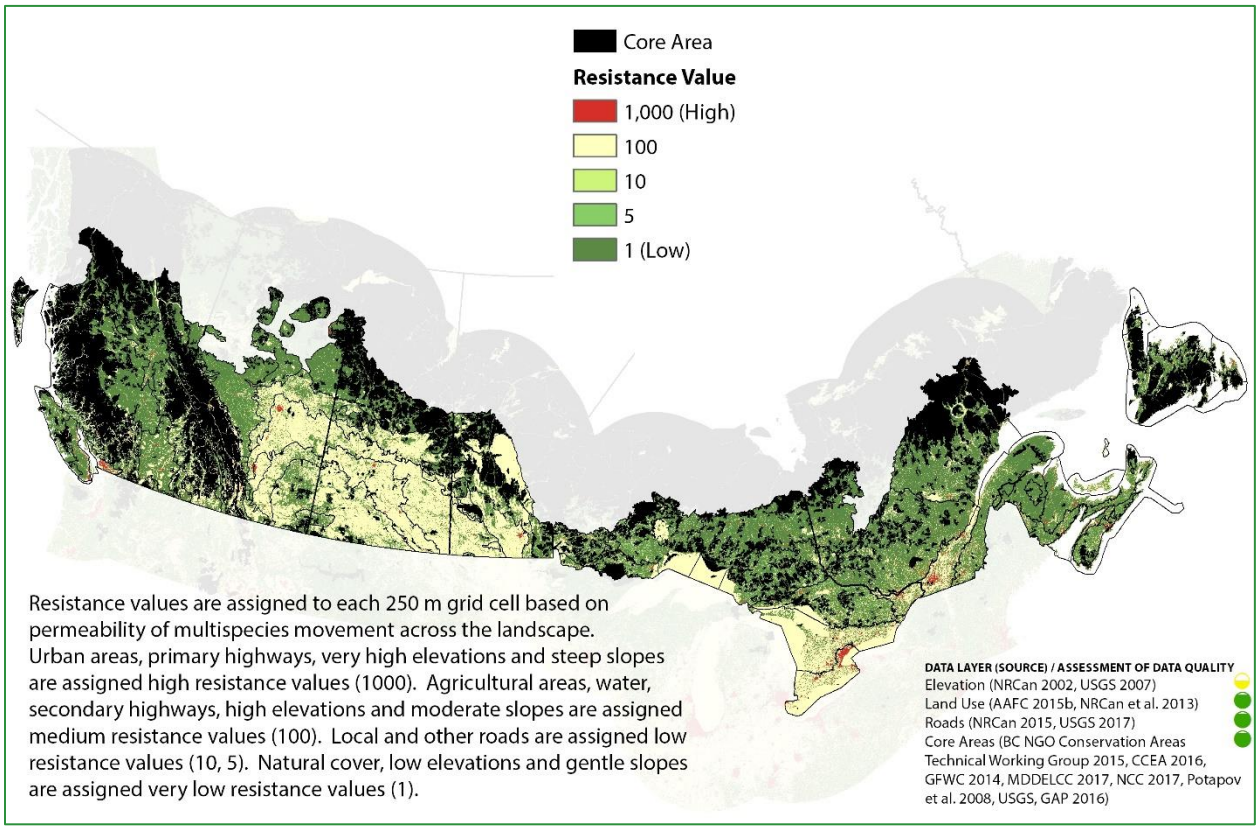

Figure E.1: Final cost surface used to model connectivity between core areas

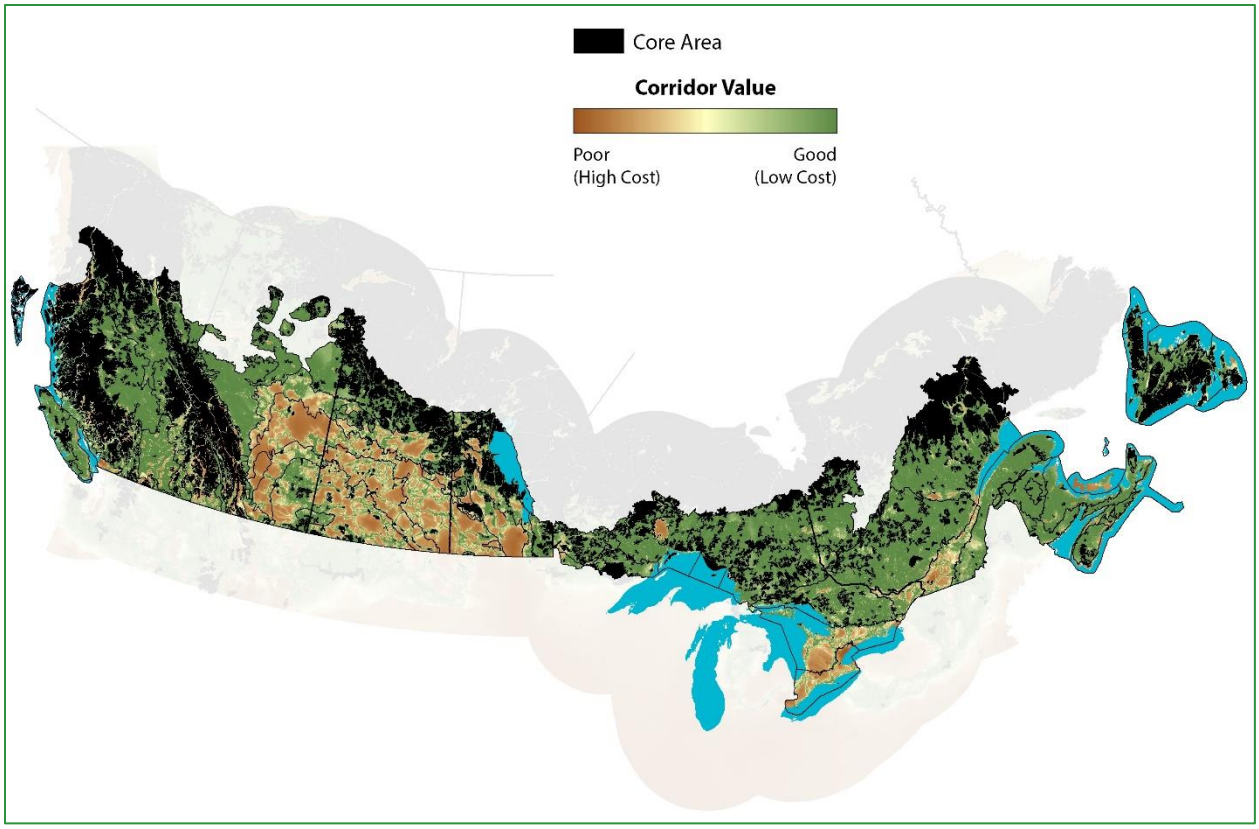

Figure E.2: Normalized least cost corridors after removing linkages >300 km

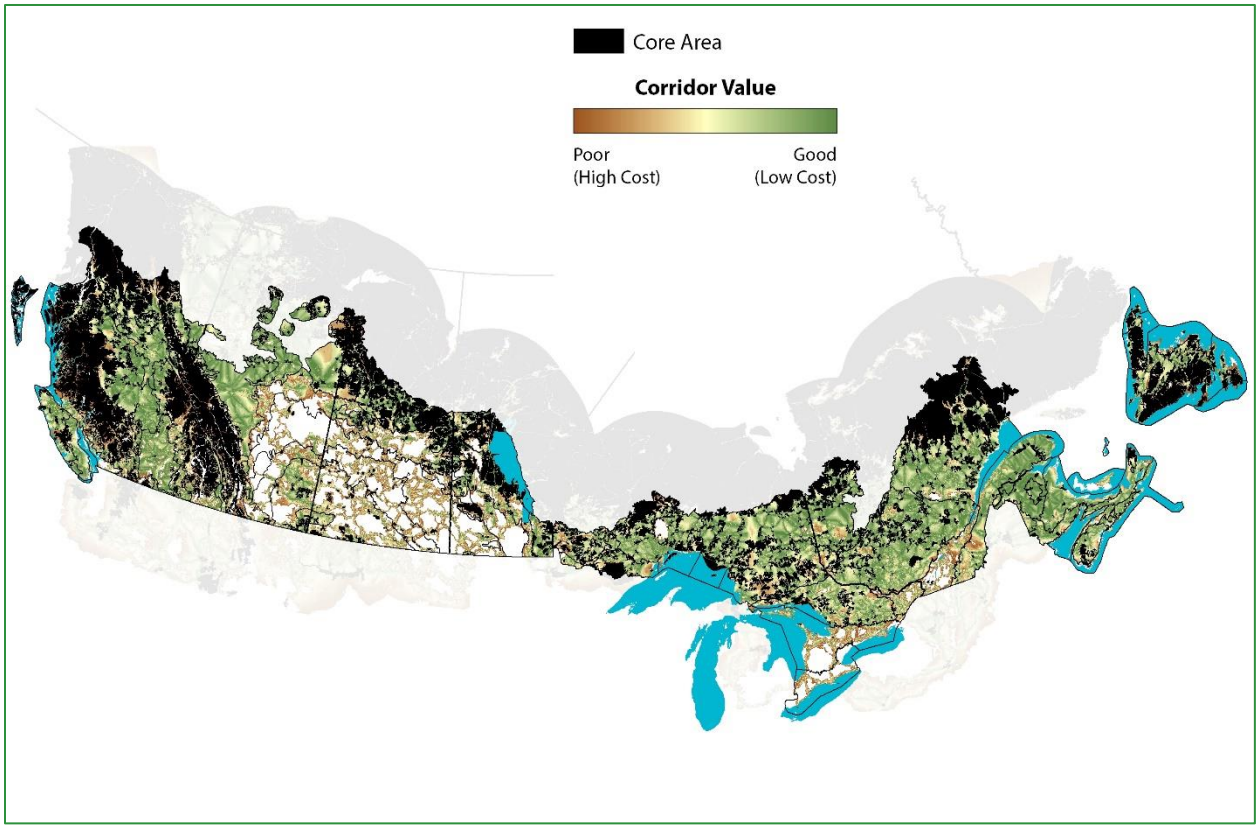

Figure E.3: Normalized least cost corridors after removing linkages >300 km truncated to a maximum cost-weighted width of 200 km

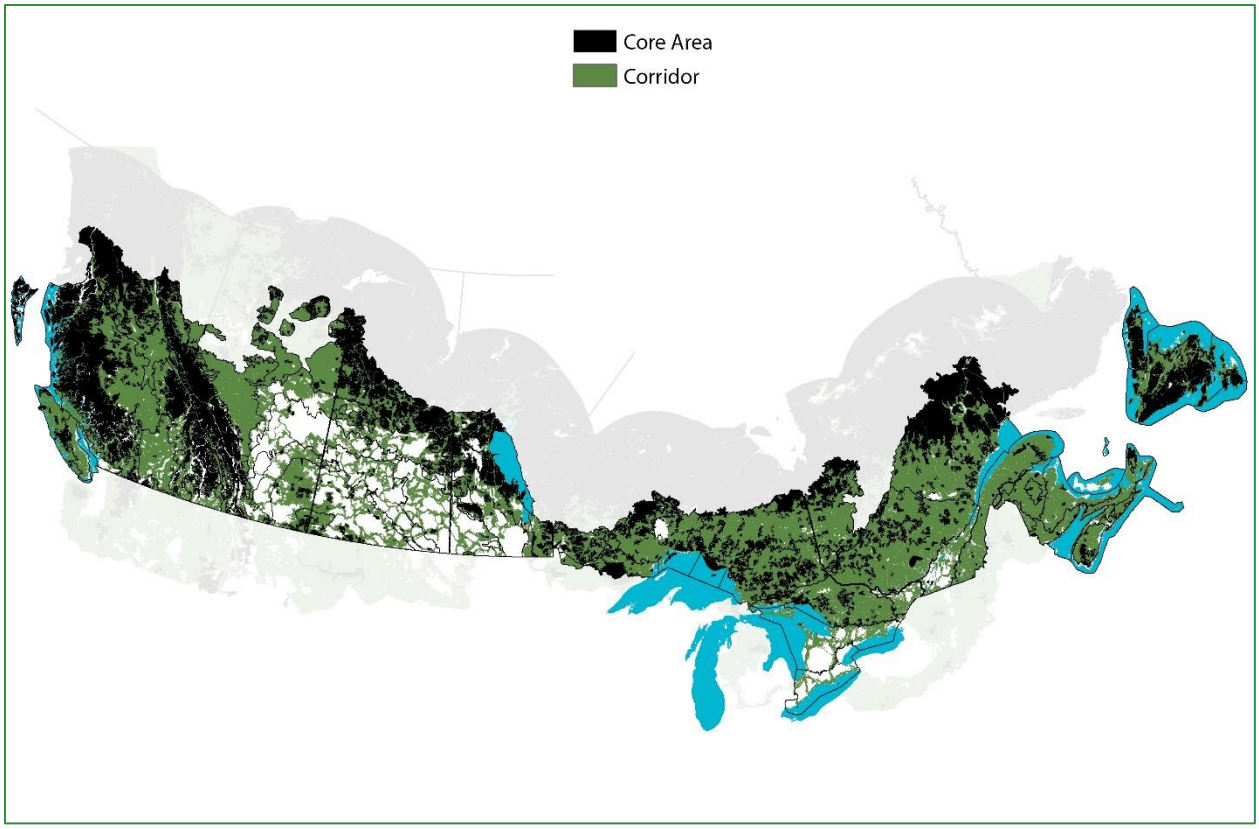

Figure E.4: Final corridor map

APPENDIX F – CORRELATION MATRICES

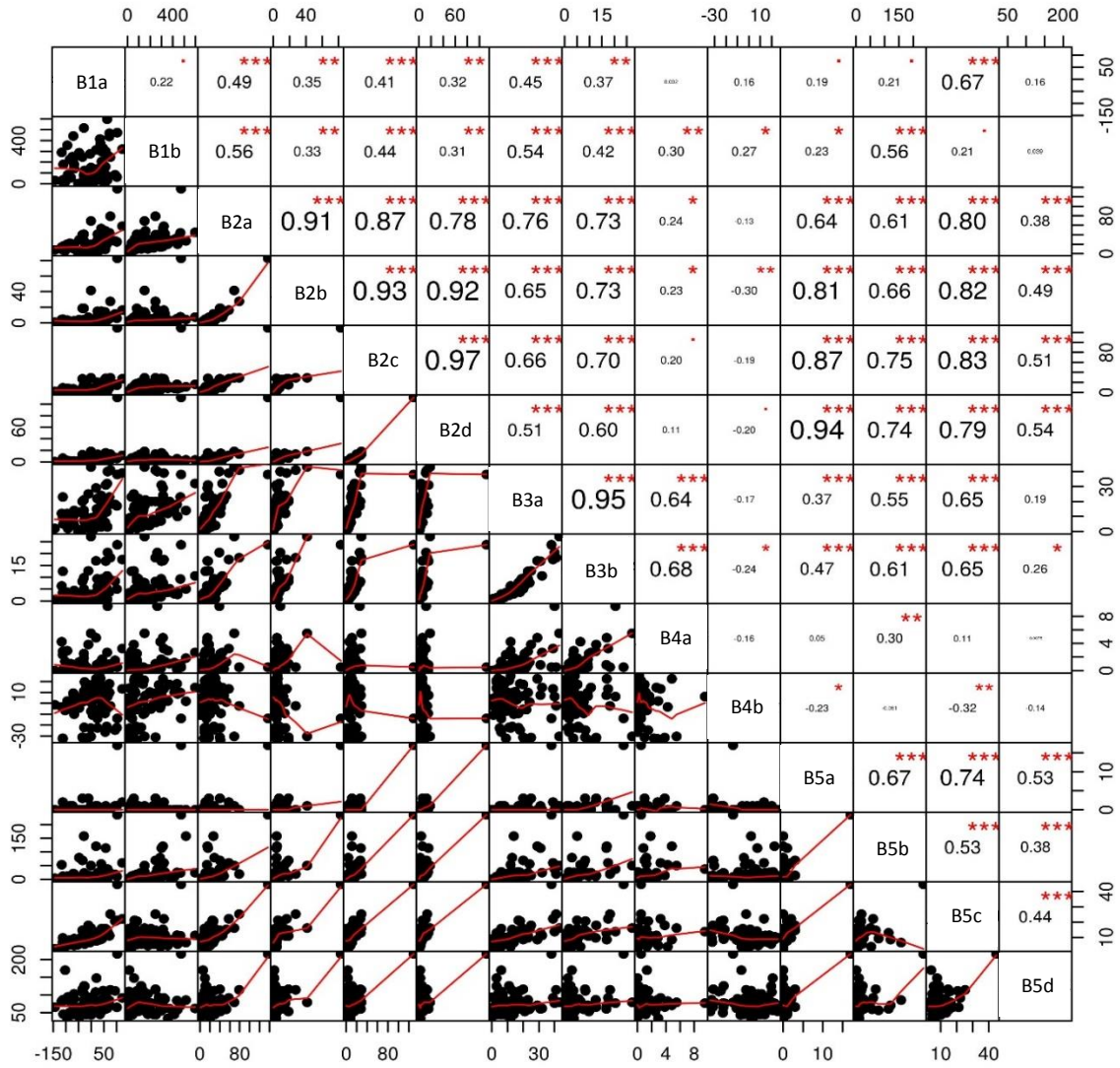

Figure F.1: Correlation matrix for species-related biodiversity measures. The axes represent untransformed values. The left side of the diagonal shows each measure's correlation with all other measures with a smoothing spline represented by the red line. The right side of the diagonal shows the strength of the correlation (adjusted R^2). The asterisks in red indicate the level of significance between two given species measures. Note that this significance only relates to whether the direction of the relationship between two species measures departs from zero (e.g. positive or negative relationship). Significance codes: *** P < 0.001; ** P < 0.01; * P < 0.05; . P < 0.1. The smoothing splines show trends in some relationships, but most are flat with a reduction in variation as the values increase.

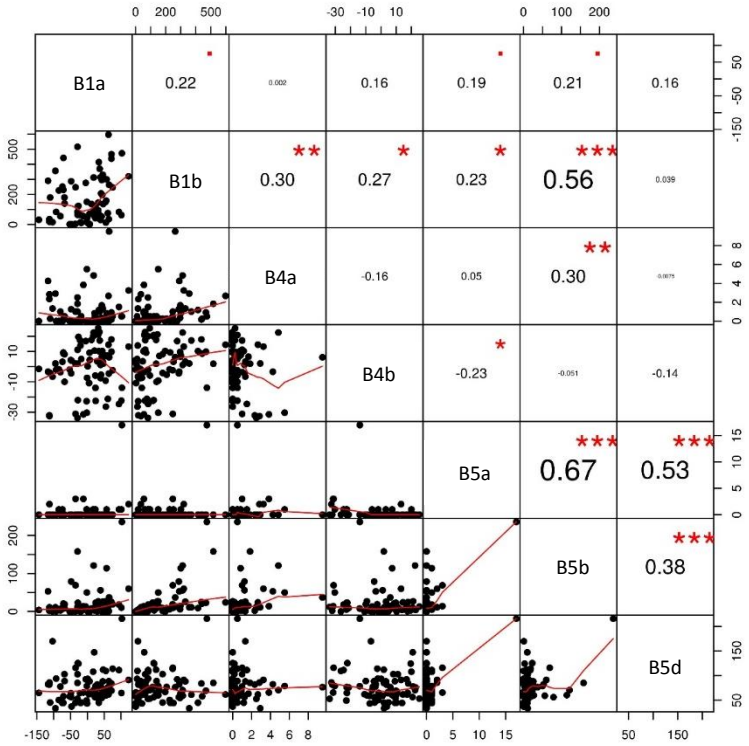

Figure F.2: Correlation matrix for non-redundant species-related biodiversity measures as in Figure F.1. The smoothing splines are mainly flat suggesting no additive effects and in most cases steep inclines are heavily influenced by a few outliers.

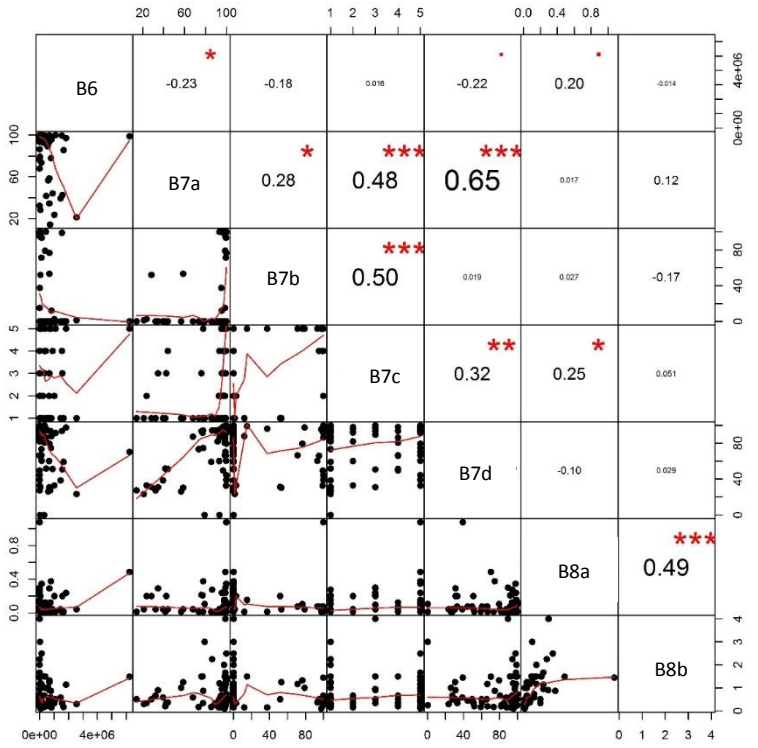

Figure F.3: Correlation matrix for landscape-related biodiversity measures. The smoothing splines tend not to have any consistent trends and none of the R^2 exceed the cut off value.

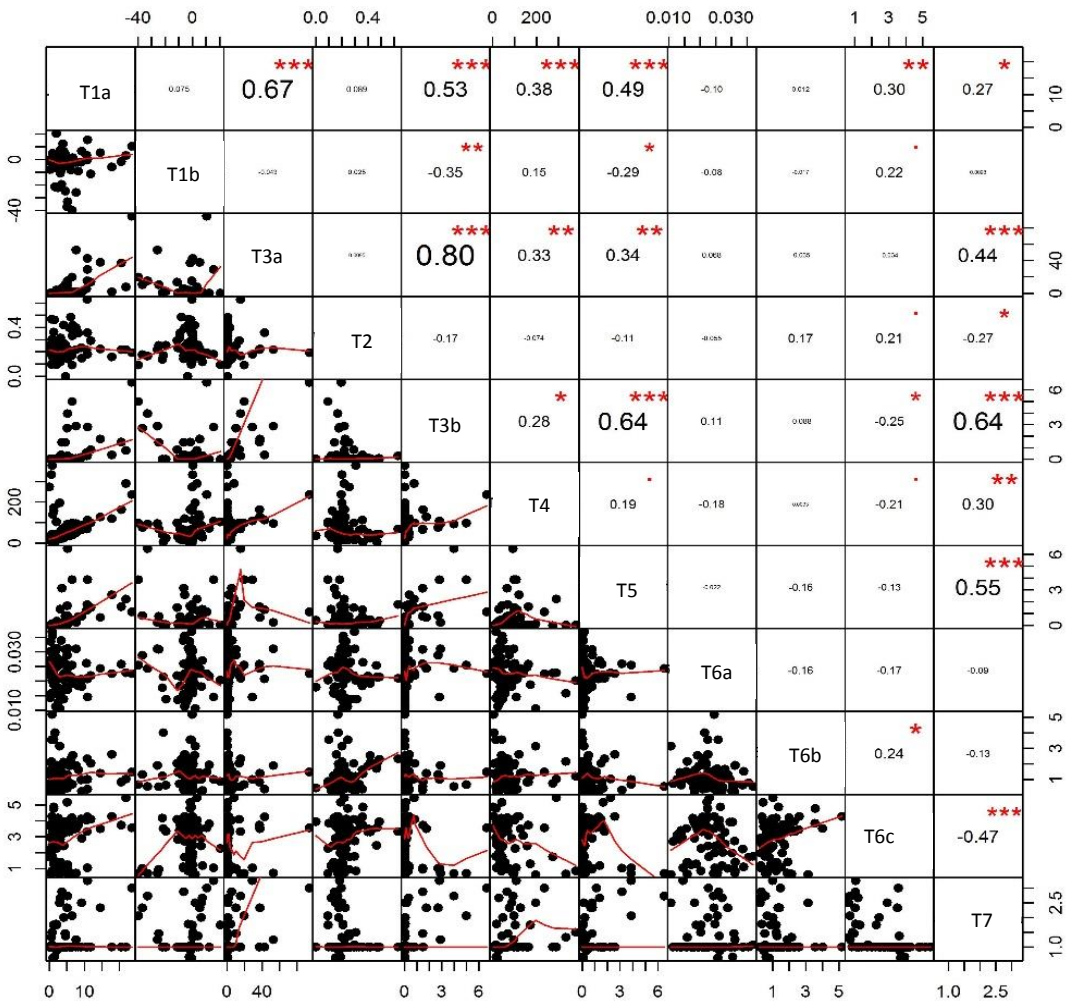

Figure F.4: Correlation matrix for threat measures. The smoothing splines show trends in some relationships, but most are flat with a reduction in variation as the values increase

APPENDIX G – RESULTS BY CRITERIA

Biodiversity, Threat and Conservation Response Criteria and Measures

This assessment analyzed 17 criteria and developed 34 maps that display and depict the relative ranks of biodiversity, threat and conservation response in southern Canada. Data sources and confidence levels are noted for each of the measures on the associated maps as follows: high (), medium-high (), medium (), medium-low () and low ().

Biodiversity

Species Richness (Criterion B1)

Species richness in Canada is generally driven by latitudinal gradients. The decline in species richness from the Equator to northern regions occurs around the world for almost all taxa (lichens and conifers are two notable exceptions). In addition to a latitudinal gradient, there are differences in the number of species across southern Canada with the greatest richness of breeding birds in western ecoregions (several ecoregions in the Prairies and the Eastern Continental Ranges and the Columbia Mountains and Highlands ecoregions) (Figure G.1). Mammal diversity is also greatest in the west and includes the Prairie ecoregions and most of the ecoregions in southern and central Alberta and British Columbia. The greater richness in the west results from a higher diversity of habitat types over larger altitudinal gradients and in the mountain regions, reflects lower rates of local extirpation. Mammal richness is lowest in ecoregions that are islands (e.g. Prince Edward Island, Vancouver Island) because of dispersal limitations. Richness of amphibians and trees is greatest in eastern Canada, particularly in southern Ontario and Quebec. Greater richness in these species groups in the eastern part of North America also occurs in the United States (Jenkins et al. 2015), and is partly a result of moisture gradients (i.e. drier climate and fewer trees in the Prairies ecozone). This region of Canada has the greatest richness of trees and amphibians because many such species reach their northern range limits here where Canada is at its lowest latitude.

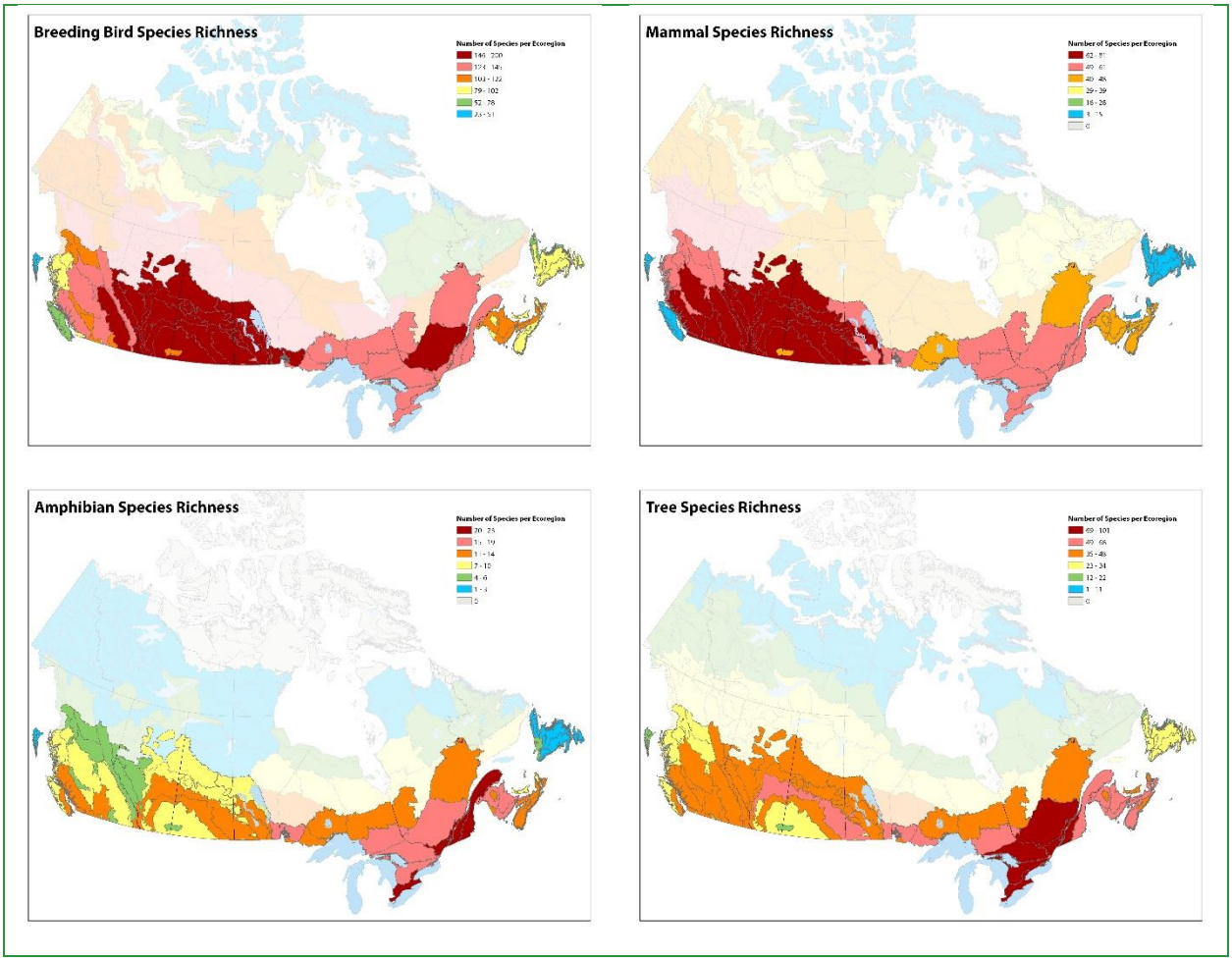

Figure G.1: Richness of breeding birds, mammals, amphibians and trees in Canada (Birdlife International and NatureServe 2014, IUCN 2017a, 2017b, USGS 1999)

When the total counts of birds, mammals, amphibians and trees are adjusted for area and log transformed (Figure G.2), the areas with very high species richness scores (5) are ecoregions in south-central Ontario and Quebec including Fundy Coast and Southern New Brunswick Uplands and British Columbia's coastal mountains (Pacific Ranges).

Species richness in Canada can be assessed further by examining the abundance of all species that are tracked by provincial and territorial CDCs (Figure G.3). These tracked species include species that are of provincial (S1-S3), national (N1-N3) and global (G1-G3) conservation concern. However, there are differences in how species are tracked and progress of CDCs in ranking species and adding them to the NatureServe database (see Datasets Caveats and Limitations in Appendix B).

This analysis highlights some ecoregions of very high species richness including the Aspen Parkland, three of the four ecoregions in the Mixedwood Plains ecozone, the Appalachians, Maritime Lowlands, Fundy Coast and Southern New Brunswick Uplands. Additional ecoregions of very high species richness include the Nova Scotia Highlands, Mid-Boreal Uplands, Eastern Continental Ranges and Northern Continental Divide.

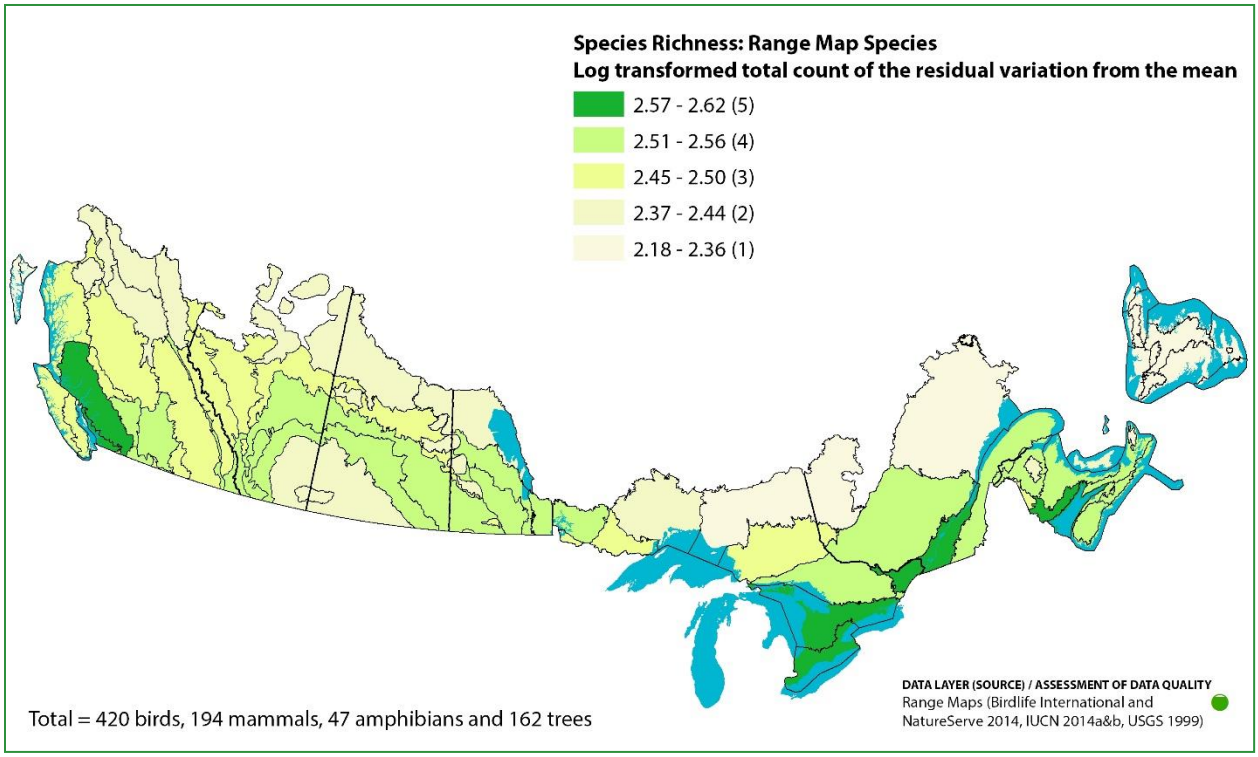

Figure G.2: B1a Species Richness: Range Map Species

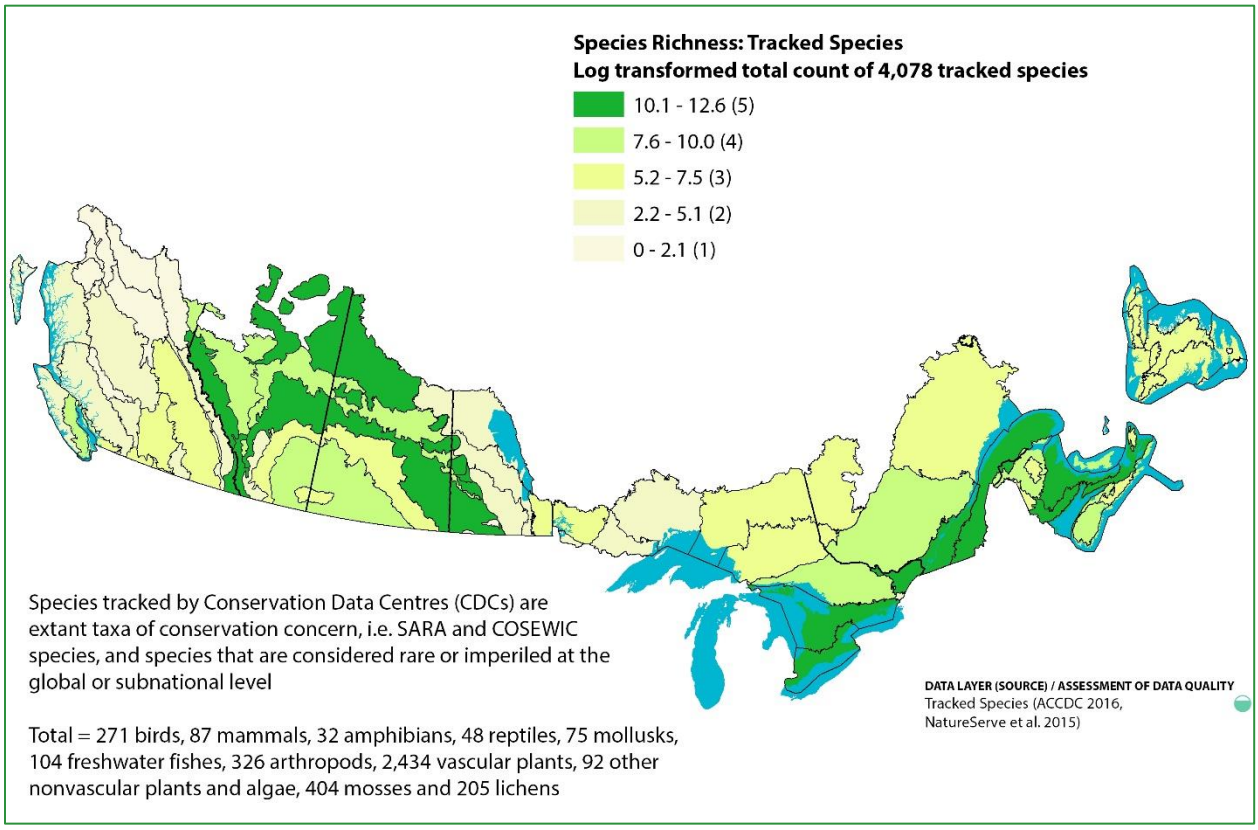

Figure G.3: B1b Species Richness: Tracked Species

Species at Risk (Criterion B2)

The greatest concentrations of SAR occur in three regions of the study area: southern Ontario and Quebec (Lake Erie Lowland, Manitoulin-Lake Simcoe, St. Lawrence Lowlands, Algonquin-Lake Nipissing), the Prairies (Mixed Grassland and Aspen Parkland) and southern British Columbia (Eastern Vancouver Island, Okanagan Highland, Thompson-Okanagan Plateau, Lower Mainland, Pacific Ranges and Georgia-Puget Basin). On Eastern Vancouver Island the richest areas of SAR occur in remnant Garry Oak habitats. In southern Ontario and Quebec, areas of very high richness are often associated with areas near the Great Lakes or St. Lawrence River. Sixteen other ecoregions have high richness scores (4) for SAR (Figure G.4).

The Lake Erie Lowland also has a very high score for numbers of SAR when the species are weighted by the number of ecoregions they occur in as a means of accounting for such rarity or irreplaceability. This ecoregion has species that do not occur in other ecoregions because of southern latitude and unique physical environments (e.g. species associated with Great Lakes coast, Figure G.5).

COSEWIC candidate species richness is also very high in the Lake Erie Lowland reflecting the high number of species that occur in this ecoregion. Ten other ecoregions have high scores for numbers of candidate species (Figure G.6). The most unique candidate species, based on rarity weighting or irreplaceability, occur in the Lake Erie Lowland (Figure G.7).

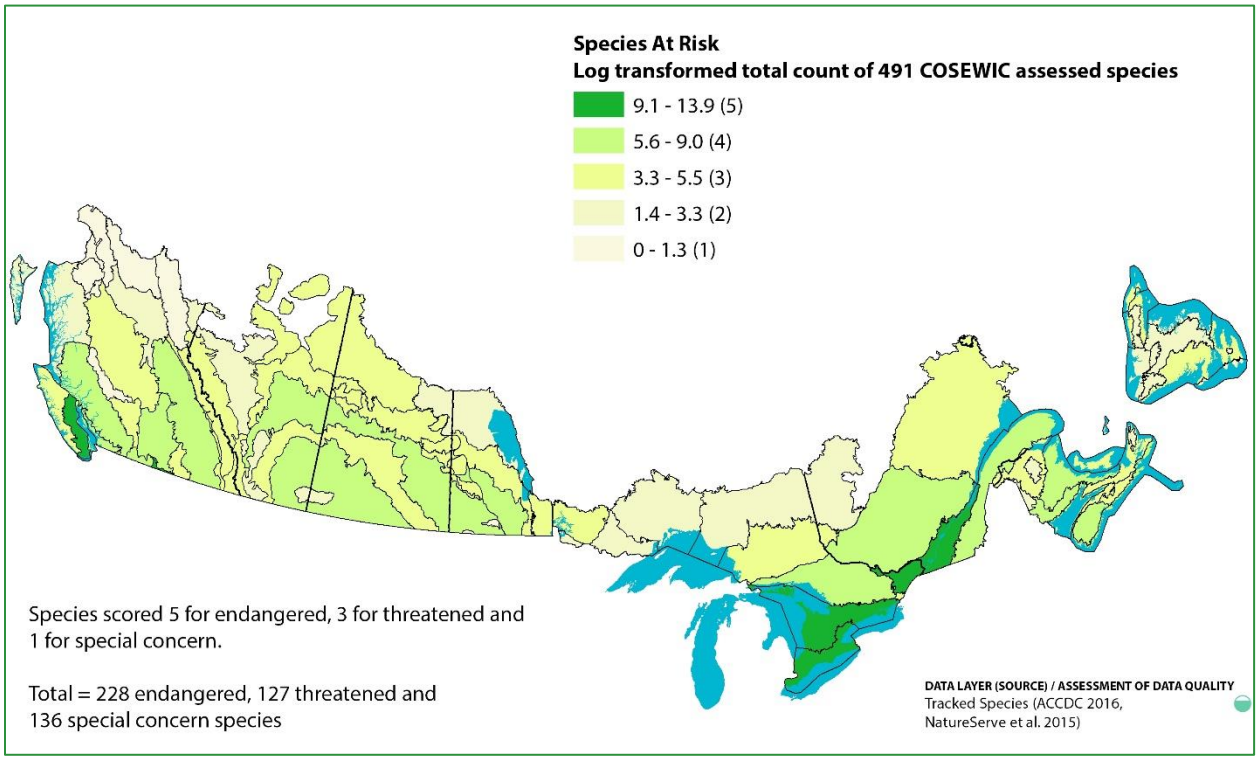

Figure G.4: B2a Richness of COSEWIC assessed wildlife species

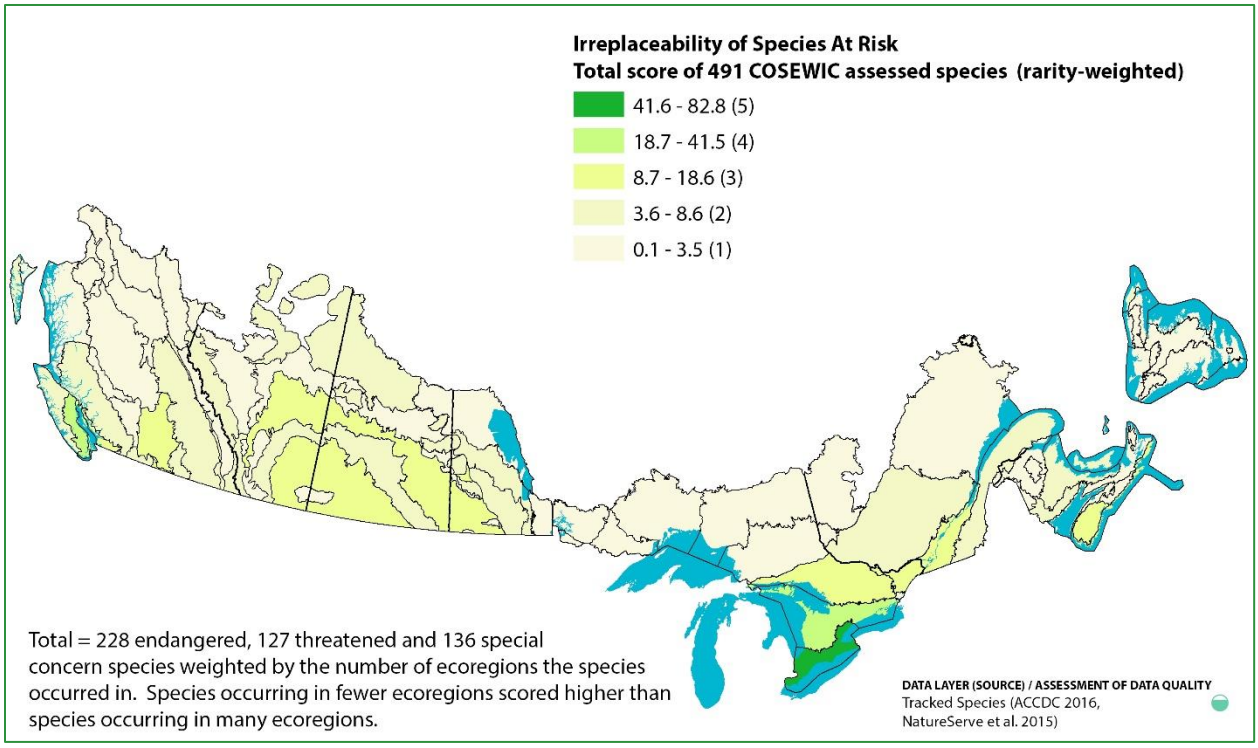

Figure G.5: B2b Irreplaceability of COSEWIC assessed wildlife species

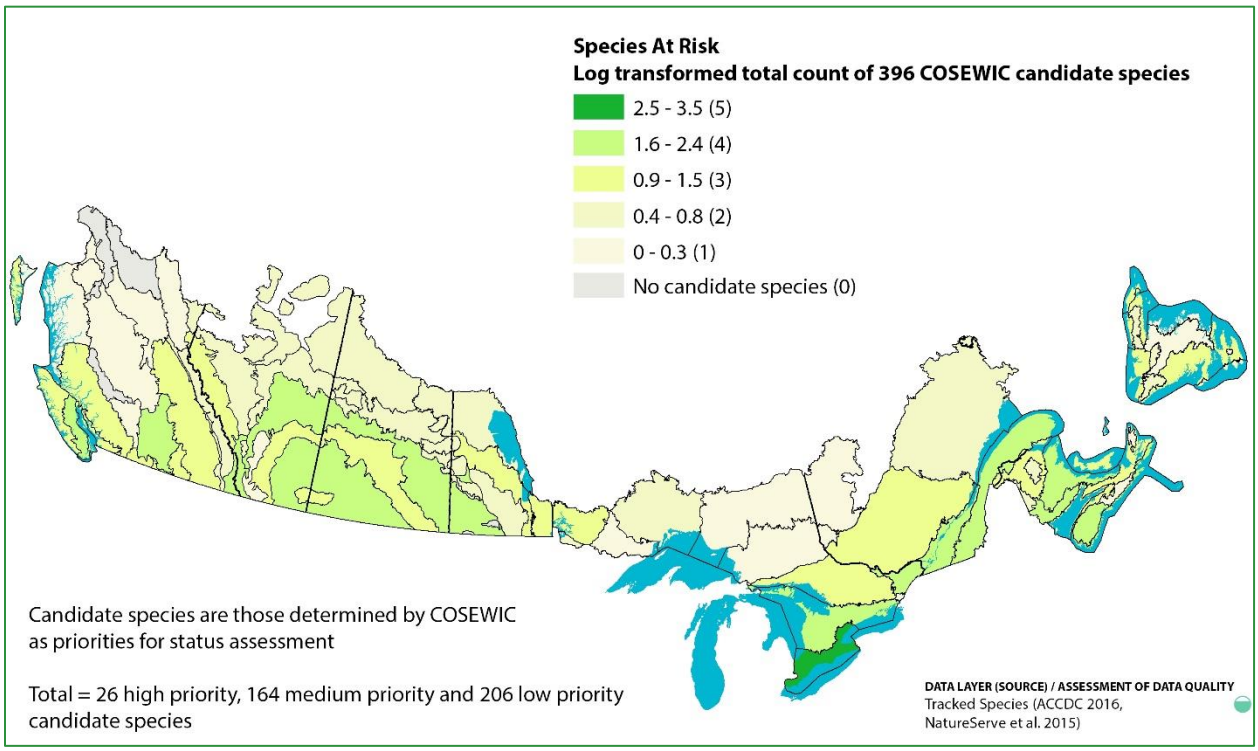

Figure G.6: B2c Richness of COSEWIC candidate wildlife species

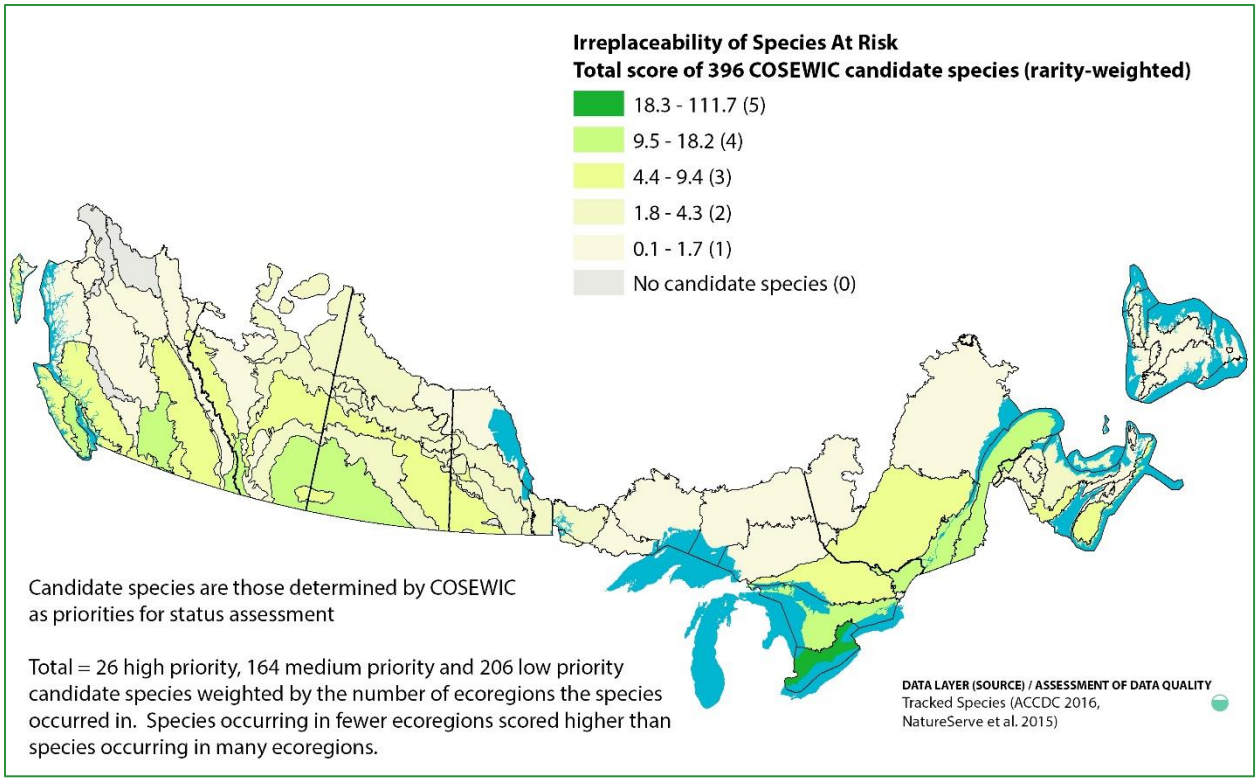

Figure G.7: B2d Irreplaceability of COSEWIC candidate wildlife species

Globally Rare Species (Criterion B3)

The ecoregions with very high scores for numbers of globally rare species are Western Vancouver Island, Eastern Vancouver Island, Columbia Mountains and Highlands, Eastern Continental Ranges, Manitoulin-Lake Simcoe, Lake Erie Lowland, St. Lawrence Lowlands, Appalachians, Maritime Lowlands and Fundy Coast (Figure G.8). In addition, Canada does have a large number of globally rare species that are associated with regions outside of the study area including marine regions, the Yukon and Lake Athabasca.

The ecoregions with the greatest number of unique globally rare species (i.e. rarity weighted by ecoregions where they occur) are Eastern Vancouver Island, and the Lake Erie Lowland (Figure G.9).

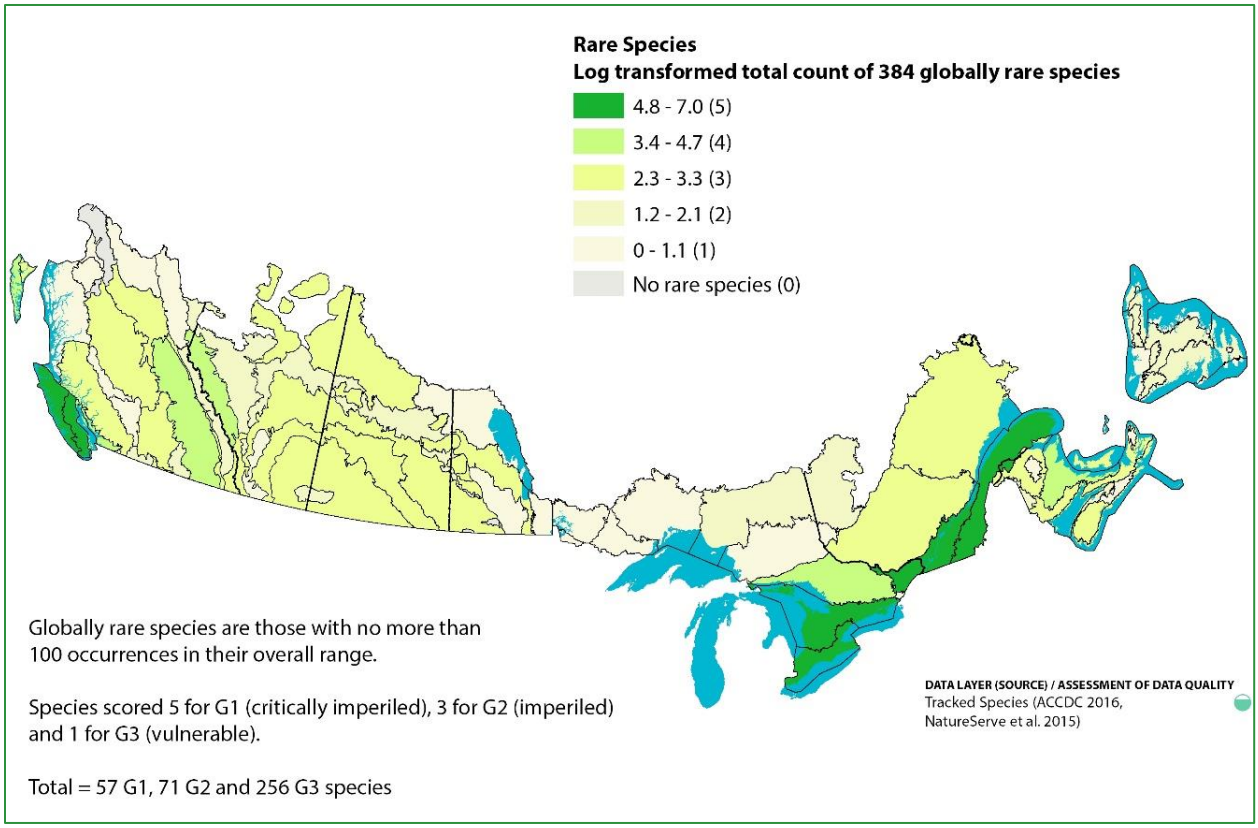

Figure G.8: B3a Richness of globally rare species

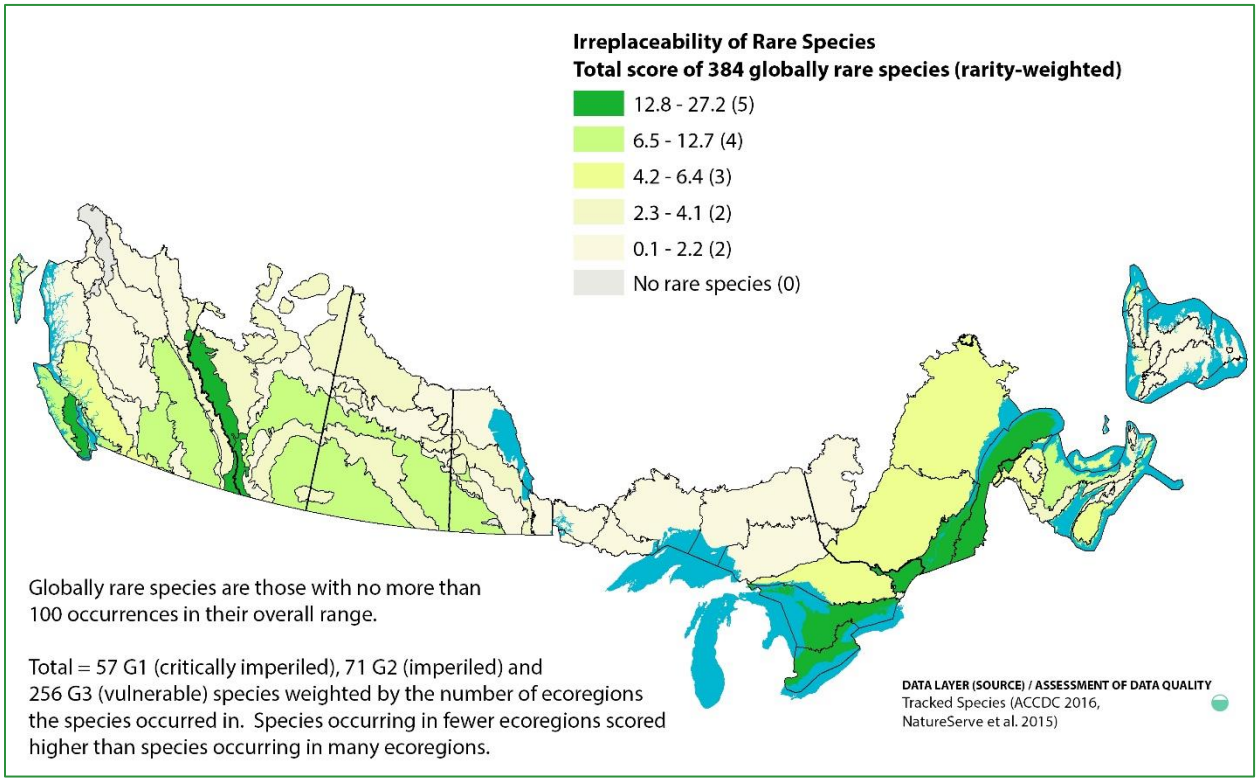

Figure G.9: B3b Irreplaceability of globally rare species

Species of High Conservation Responsibility (Criterion B4)

The only ecoregion with a very high score for richness of national endemic species is the Appalachians. This is driven by the high number of endemic species that occur in the estuaries of the St. Lawrence River and Gulf of St. Lawrence such as Maritime Ringlet (*Coenonympha nipisiquit*). Five other ecoregions have high scores for numbers of endemic species (Figure G.10).

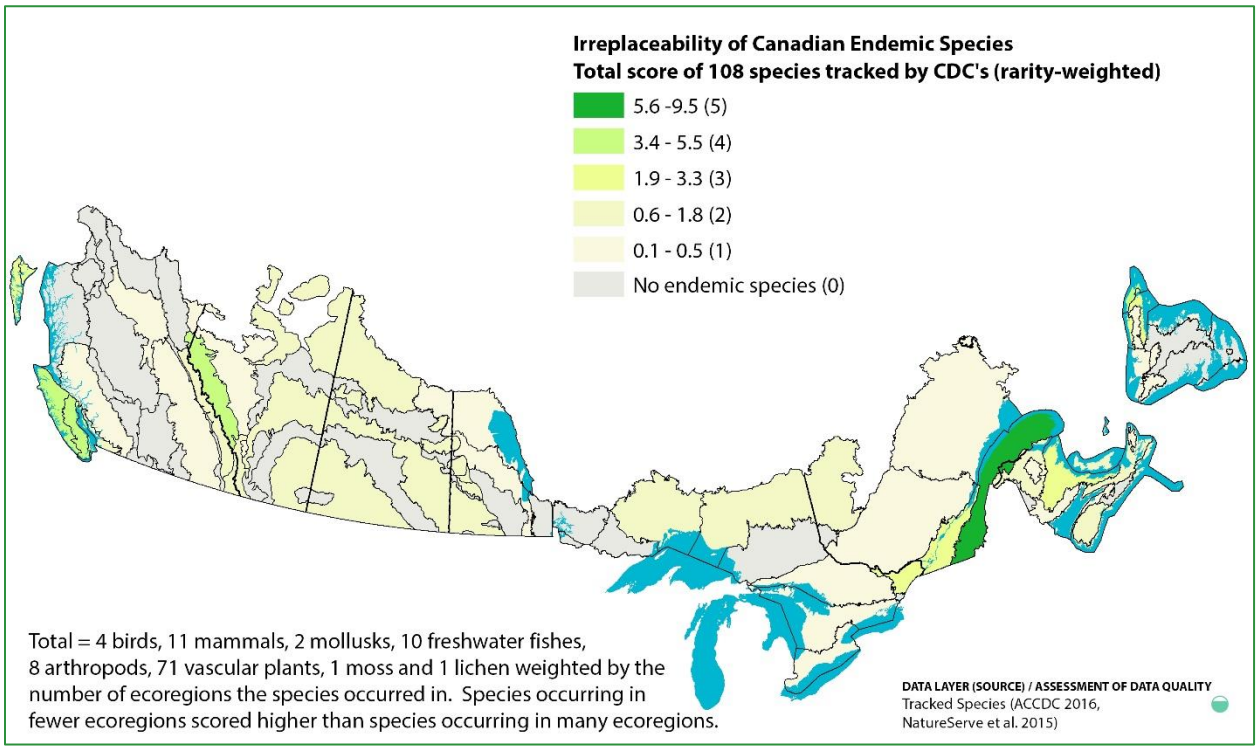

Figure G.10: B4a Irreplaceability of Canadian endemic species

The analysis also examined ecoregional responsibility for species that have at least 75% of their range in Canada (Figure G.11). Accounting for the effect of area on species counts, the greatest number of these species occur in 13 ecoregions along the southern edge of the boreal and are primarily boreal species such as White Spruce (*Picea glauca*), Jack Pine (*Pinus banksiana*) and Tennessee Warbler (*Oreothlypis peregrina*). Although these ecoregions have the highest number of species with predominately Canadian ranges compared to other ecoregions in the study area, most of these species also occur in ecoregions north of the study area.

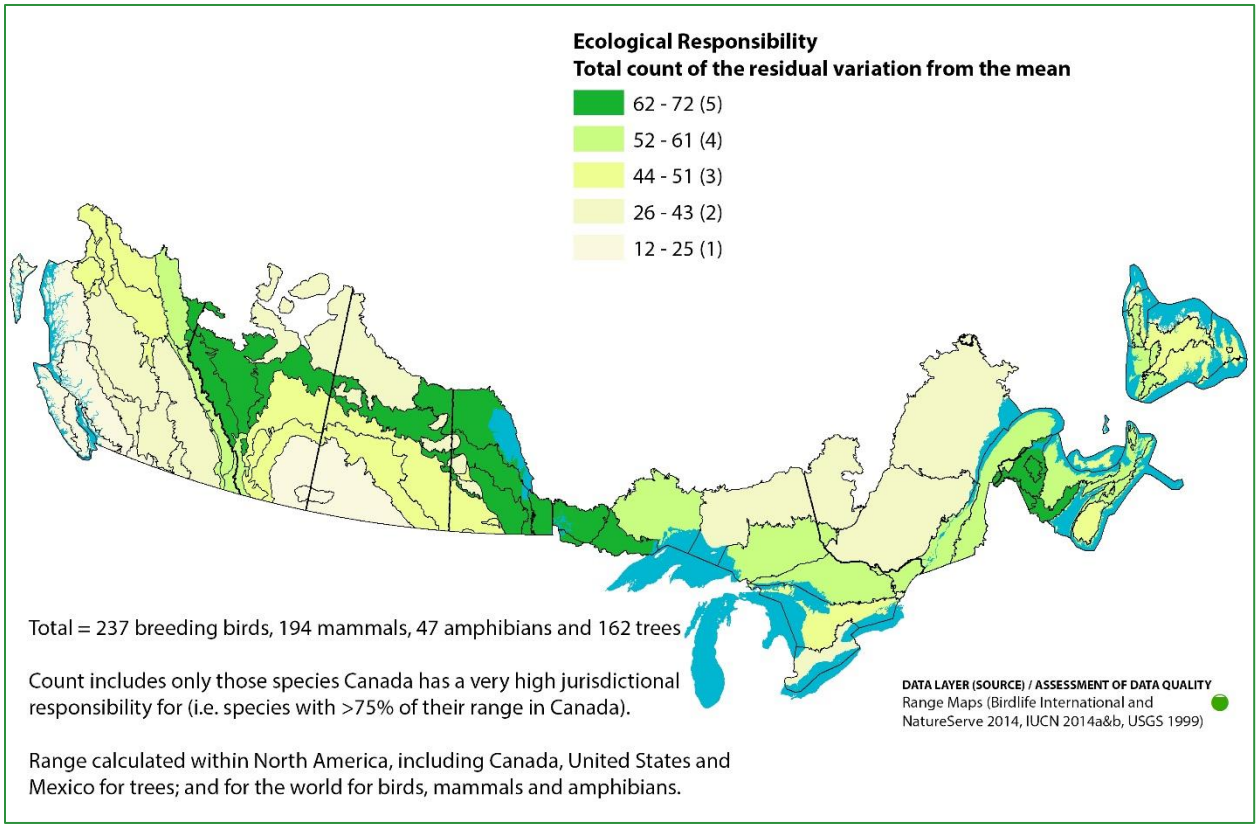

Figure G.11: B4b Ecoregional Responsibility

Unique and Distinctive Species (Criterion B5)

The results of these four measures highlight ecoregions that have distinct flora and fauna when compared to other ecoregions in the study area. The Lake Erie Lowland has very high scores for all four measures (Figure G.12 to 19). In the analysis of unique species by species ranges, Lake Erie Lowland scored very high because many species (primarily trees) reach their northern range limits in this ecoregion. Scores for the number of unique CDC tracked species by ecoregion are very high for Prince Edward Island, St. Lawrence Lowlands, Lake Erie Lowland, Mid-Boreal Uplands, Aspen Parkland, Mixed Grassland, Eastern Continental Ridges and Northern Continental Divide (Figure G.13). These are generally ecoregions that have a high diversity of species and habitat types and conditions that are not widespread in the study area.

Very high scores for rarity-weighting or irreplaceability of species based on range highlights the uniqueness of the Lake Erie Lowland (Figure G.14). This is directly related to the higher number of species in this ecoregion (Figure G.1). For the analysis on beta-diversity based on species ranges, the Lake Erie Lowland again had a very high score (Figure G.15). This is a combination of the high number of species and the low number of ecoregions that are directly adjacent (i.e. fewer neighbours

to compare beta-diversity). Îles-de-la-Madeleine also had a very high beta-diversity score based on species range.

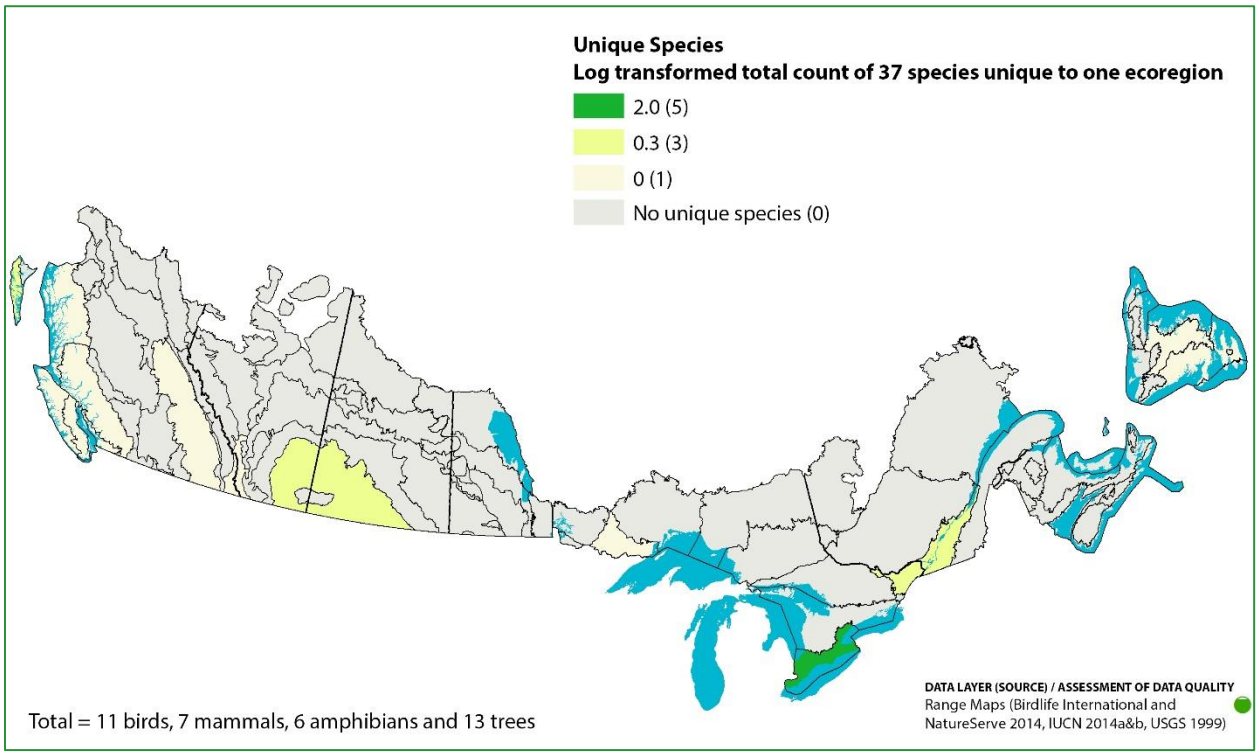

Figure G.12: B5a Unique Species: Species Range

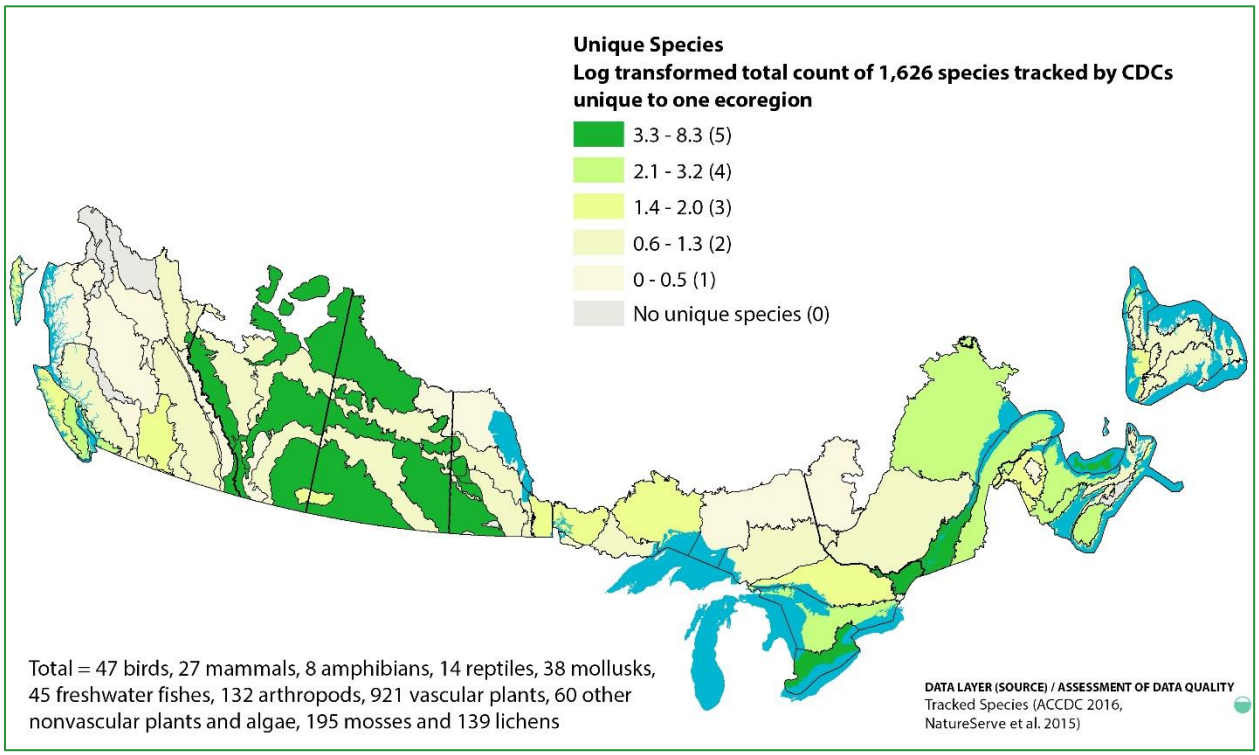

Figure G.13: B5b Unique Species: Tracked Species

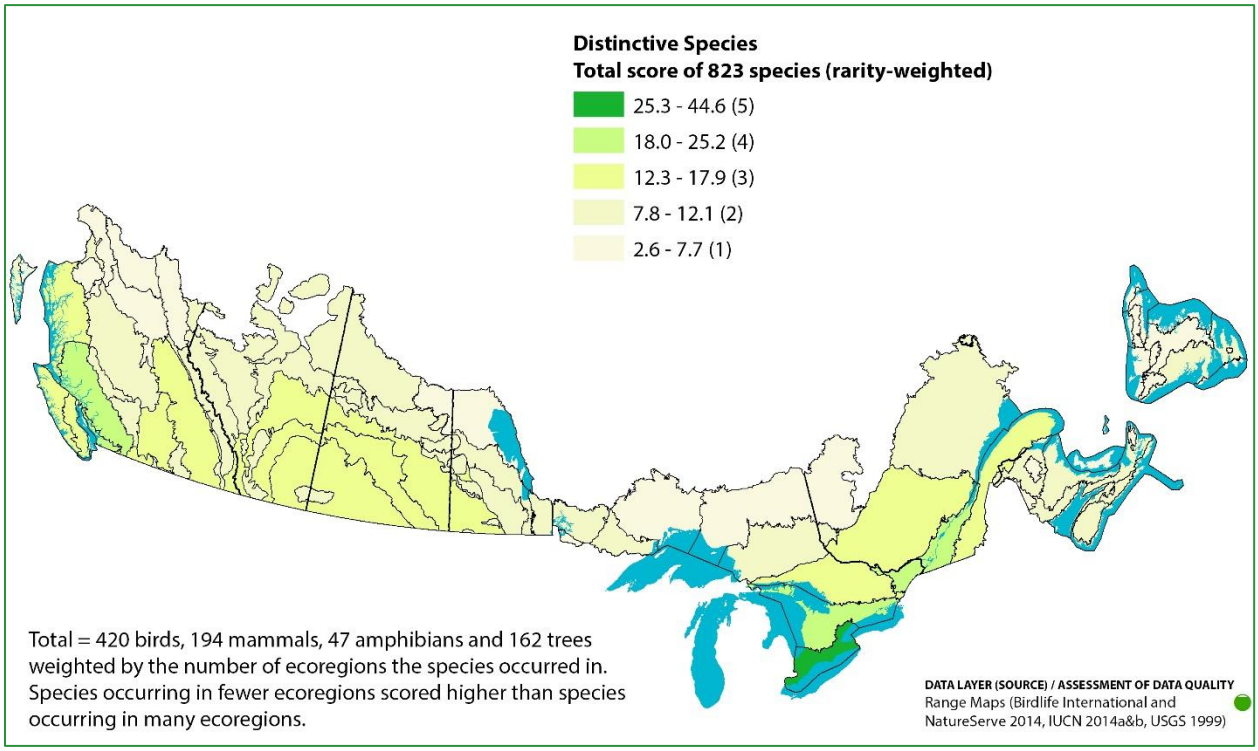

Figure G.14: B5c Distinctive Species: Species Range

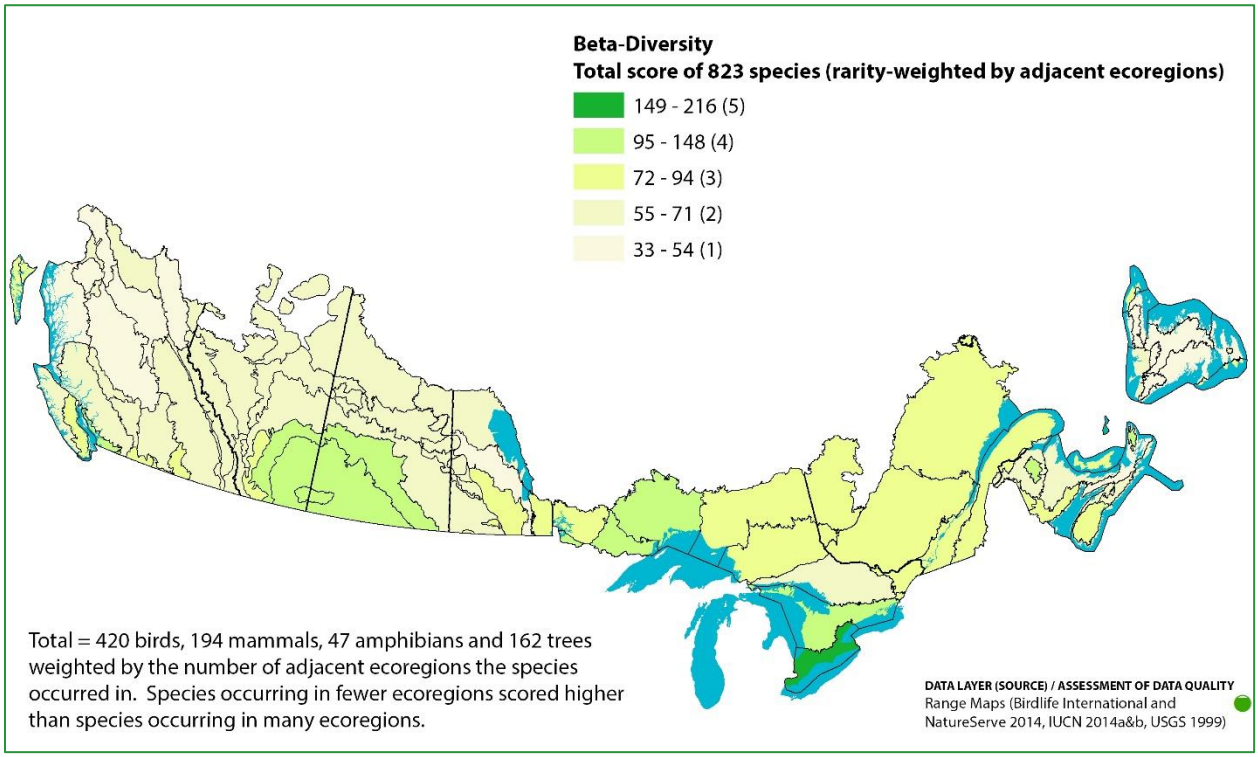

Figure G.15: B5d Beta-Diversity: Species Range (based on adjacent ecoregions)

Key Biodiversity Areas (Criterion B6)

Central Canada has the most KBAs for congregatory birds, and these are primarily associated with large wetlands and shallow lakes. The Mid-Boreal Lowland ecoregion scores very high for this criterion because two very large KBAs, Cumberland Marshes (4,934 km^2) and Saskatchewan River Delta (7,262 km^2) occupy a large portion of this ecoregion.

Six other ecoregions also have high scores for congregatory bird KBAs that are of national, continental and global significance (Figure G.16).

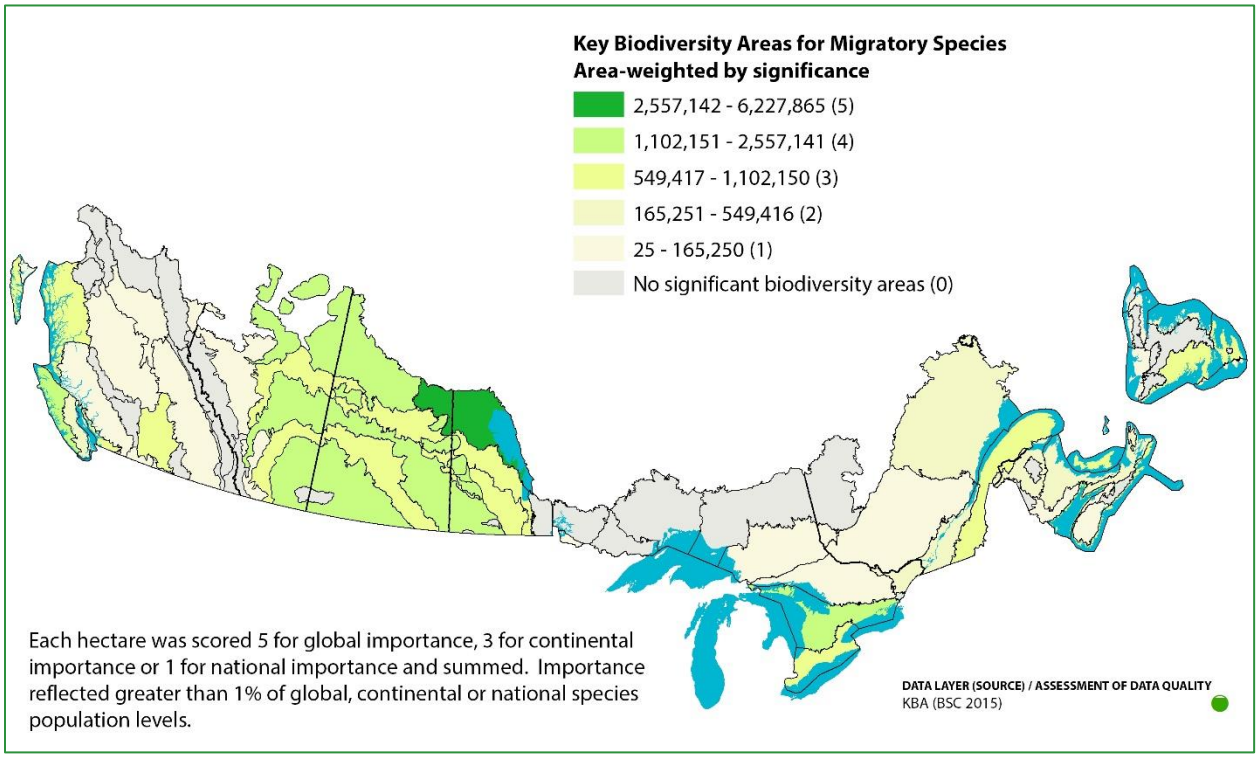

Figure G.16: B6 Key Biodiversity Areas

Intactness (Criterion B7)

Natural cover in the study area generally follows patterns of human settlement, which are largely based on latitude and agricultural suitability. Regions with greater than 90% natural cover include most of British Columbia, the southern boreal and Atlantic provinces (with the exception of Prince Edward Island). It is important to note that while natural cover may be high in these regions, there may still be a high degree of disturbance from forestry, although land conversion is limited. Some ecoregions including those in the Mixedwood Plains ecozone and parts of the Prairies have very low amounts of remaining natural cover (Figure G.17).

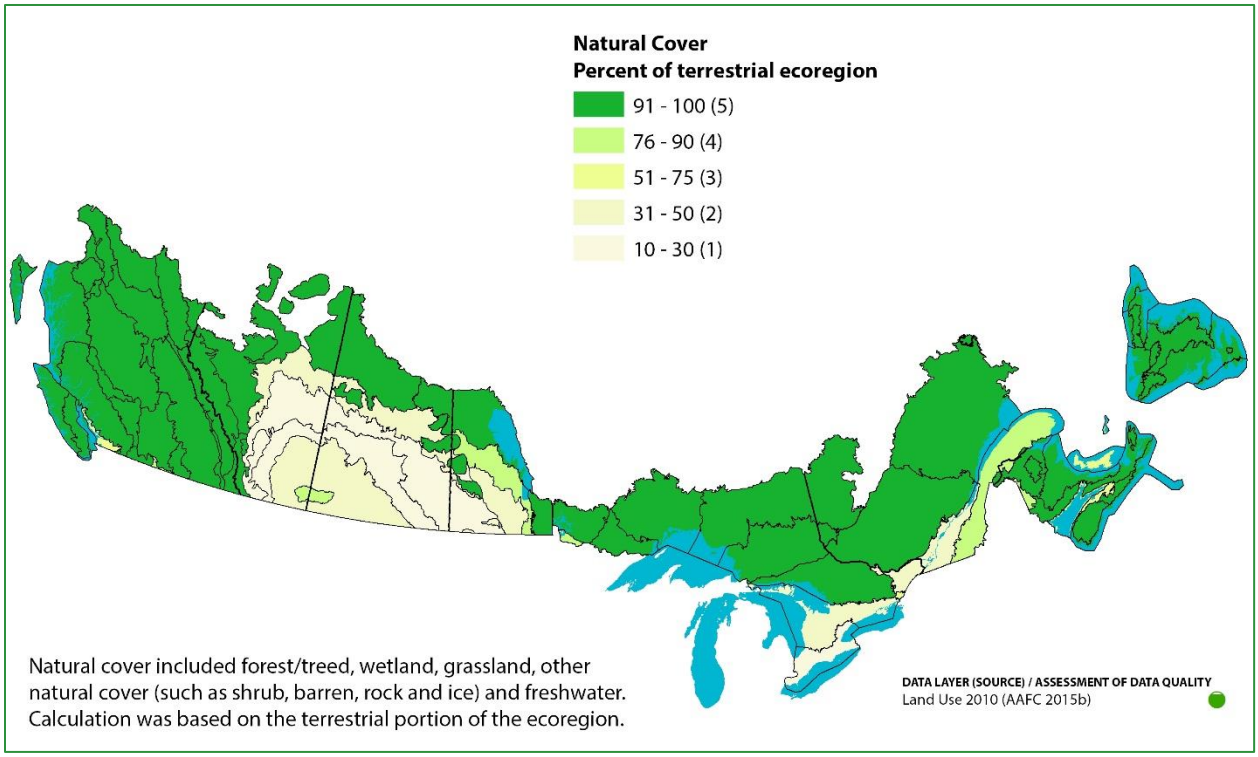

Figure G.17: B7a Natural Cover

The amount of disturbance (e.g. forestry) within these intact regions varies widely and is reflected in the changes in mammal composition (Figure G.18), and the number and size of intact habitat blocks (Figure G.19). These two measures refine the picture of habitat intactness. For example, Atlantic Canada scores in the lower categories for these two measures reflecting that while there is abundant natural cover, it is fragmented and some large mammals have become locally extinct (e.g. Eastern Cougar) or are regionally rare (e.g. Moose in Nova Scotia). Ecoregions with high amounts of natural cover that occur in large blocks, and have not lost any of their original mammals only occur in western Canada along the continental divide up into northern British Columbia including the Central Canadian Rocky Mountains, Omineca Mountains, Fraser Basin, Skeena Mountains, Nass Basin, Nass Ranges, Bulkley Ranges, Chilcotin Ranges, Western and Eastern Continental Ranges, and Vancouver Island. In the eastern part of the study area, only the Central Laurentians retain some (score of 3) of their intact mammalian fauna. Vancouver Island is the only region that scores in the highest category for intact mammalian fauna, but does not score in the highest category for habitat block size and number.

Intactness is also reflected by the numbers and size of the largest blocks of habitat that are not fragmented by roads or other human uses. Scoring thresholds for the number and size of these blocks varies depending on the size and major habitat type within each ecoregion (see Appendix E). The ecoregions with the highest scores for this criterion are generally located in the northern parts of the study area. Several ecoregions in the southern part of the study area that have a high amount of natural cover also have widespread disturbances scores. For example, most of the ecoregions in Atlantic Canada are dominated by natural cover, but have few large habitat blocks because of habitat fragmentation.

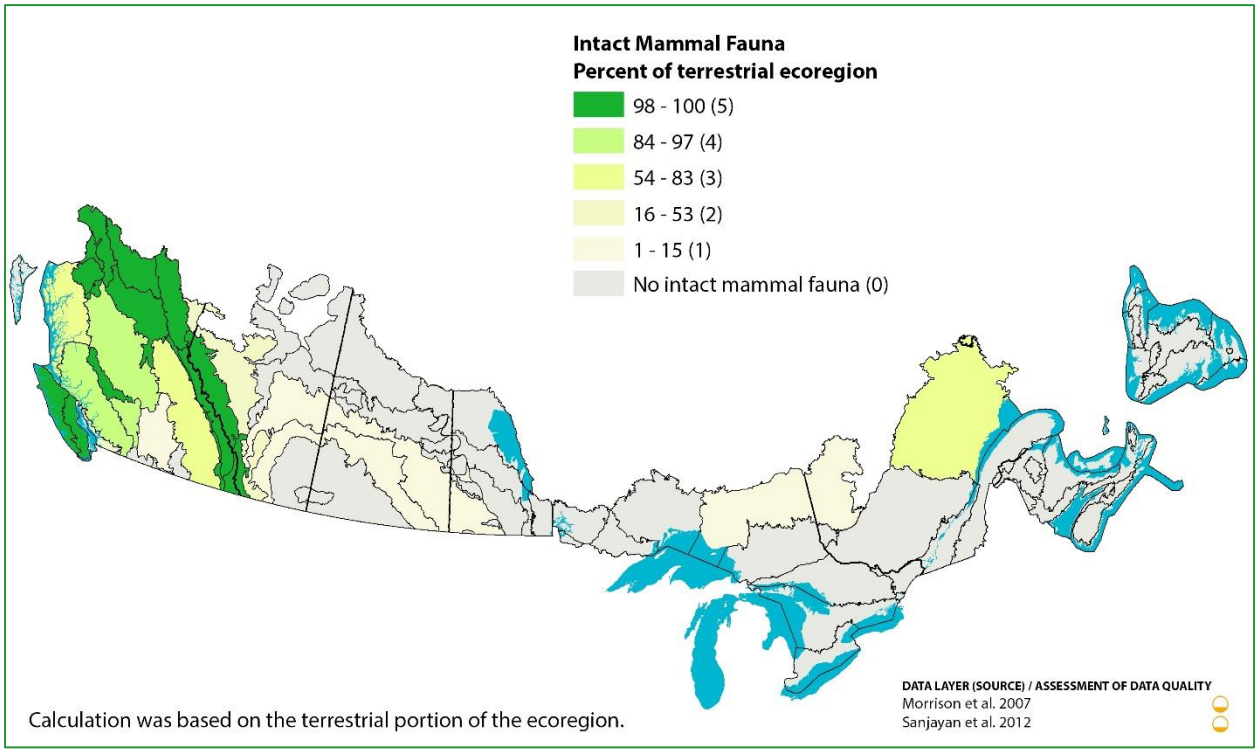

Figure G.18: B7b Intact Mammal Fauna

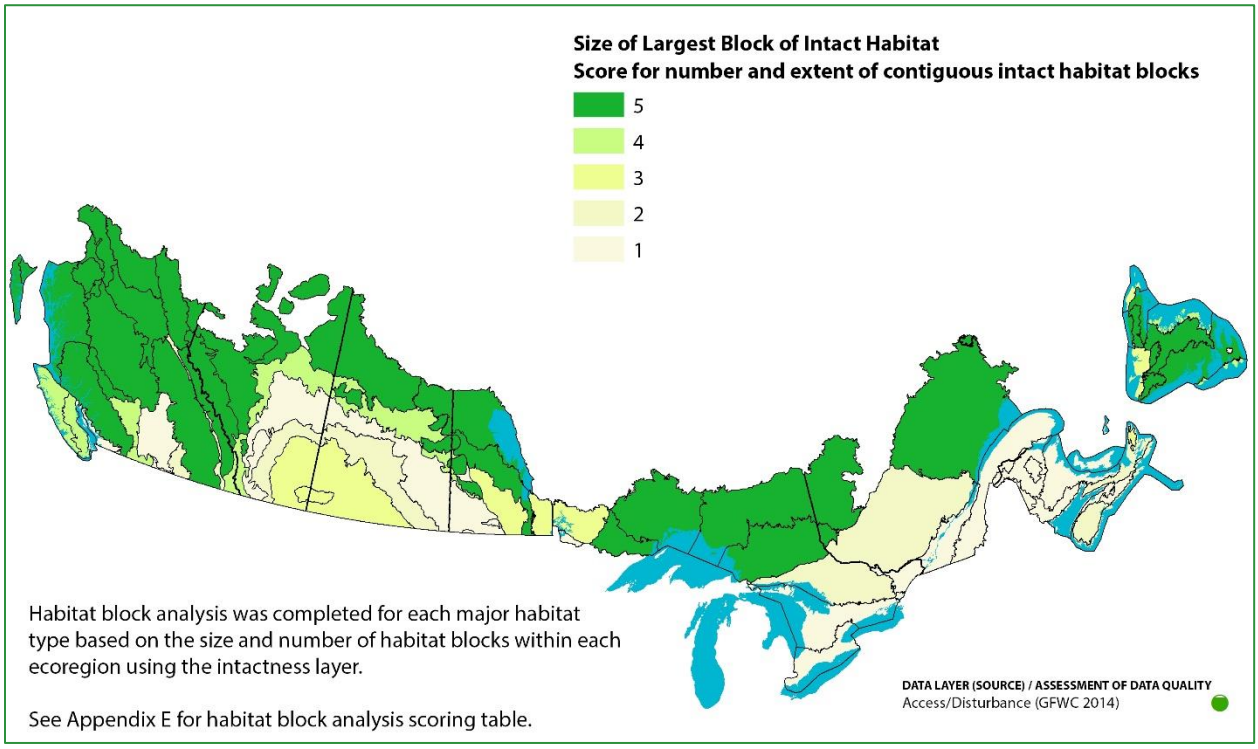

Figure G.19: B7c Size of largest block of intact habitat by major habitat type (see Appendix E for detailed explanation)

Finally, intactness is assessed by examining connectivity between core areas of intact habitat and protected areas. Ecoregions with higher levels of connectivity coincide with ecoregions that have higher levels of natural cover, greater numbers of large intact areas, and fewer anthropogenic (e.g. roads) and natural (e.g. high elevation, large water bodies) barriers. These include ecoregions on Vancouver Island and in central British Columbia; the Western Alberta Upland and Mid-Boreal Uplands; most of the Boreal Shield and Atlantic Highlands ecozones in eastern Canada; and parts of the Atlantic Maritime ecozone (Figure G.20). These ecoregions generally have several corridors between core areas, while ecoregions with lower connectivity have fewer linkage options or core areas that have very low connectivity. Ecoregions with lower connectivity generally have high resistance values (see Criterion T4). The connectivity analysis did not incorporate models of potential species movements and habitat shifts due to climate change (e.g. Lawler et al. 2013). These may also represent important areas for connectivity.

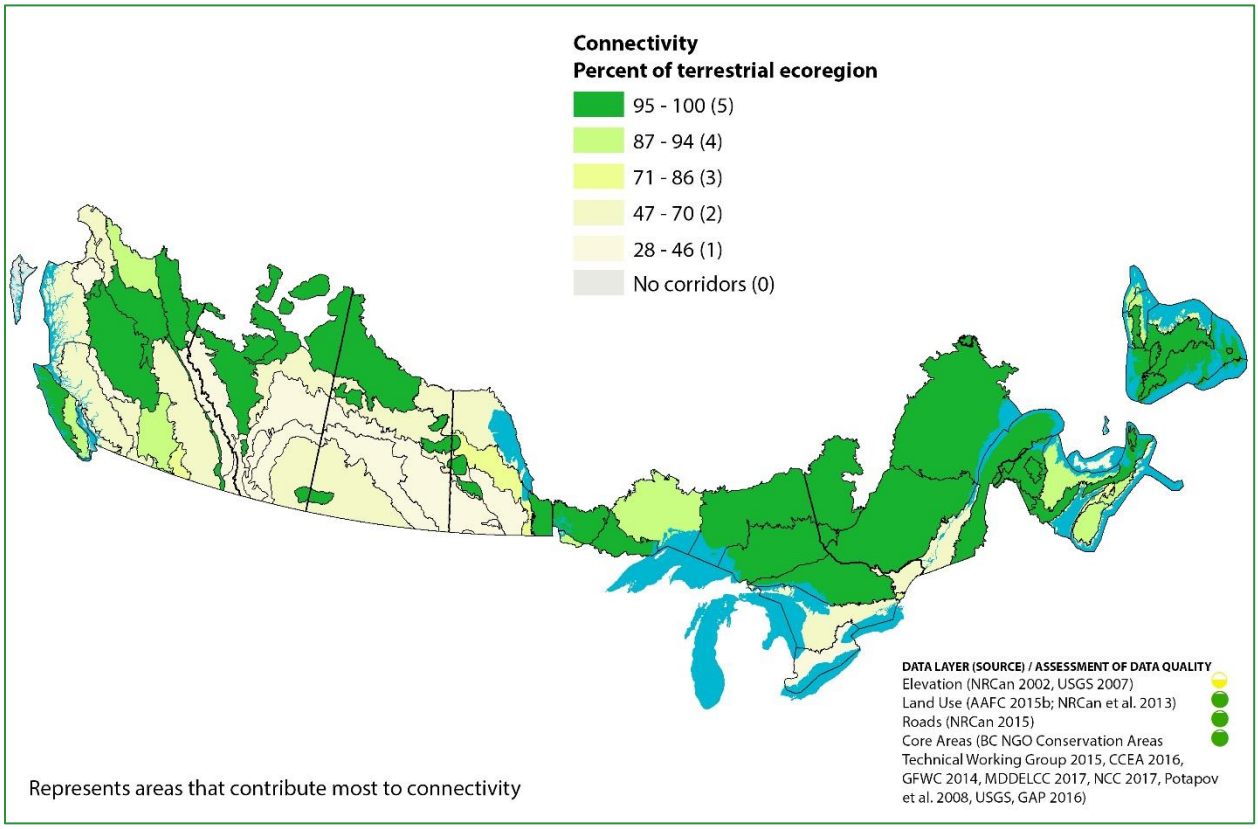

Figure G.20: B7d Connectivity

Ecosystem Distinctiveness (Criterion B8)

Ecosystem distinctiveness is based on the number of distinct natural land cover types within each ecoregion. This was compared to the entire study area (distinctiveness; Figure G.21) and just neighbouring ecoregions (beta-diversity; Figure G.22). Very high and high scoring distinctive land cover types occur in the Chilcotin Ranges, Mid-Boreal Lowland, Interlake Plain and Queen Charlotte Lowland. Beta-diversity scored very high in Îles-de-la-Madeleine, likely due to their marine isolation, Queen Charlotte Lowland and Okanagan Highland; another nine ecoregions have high scores.

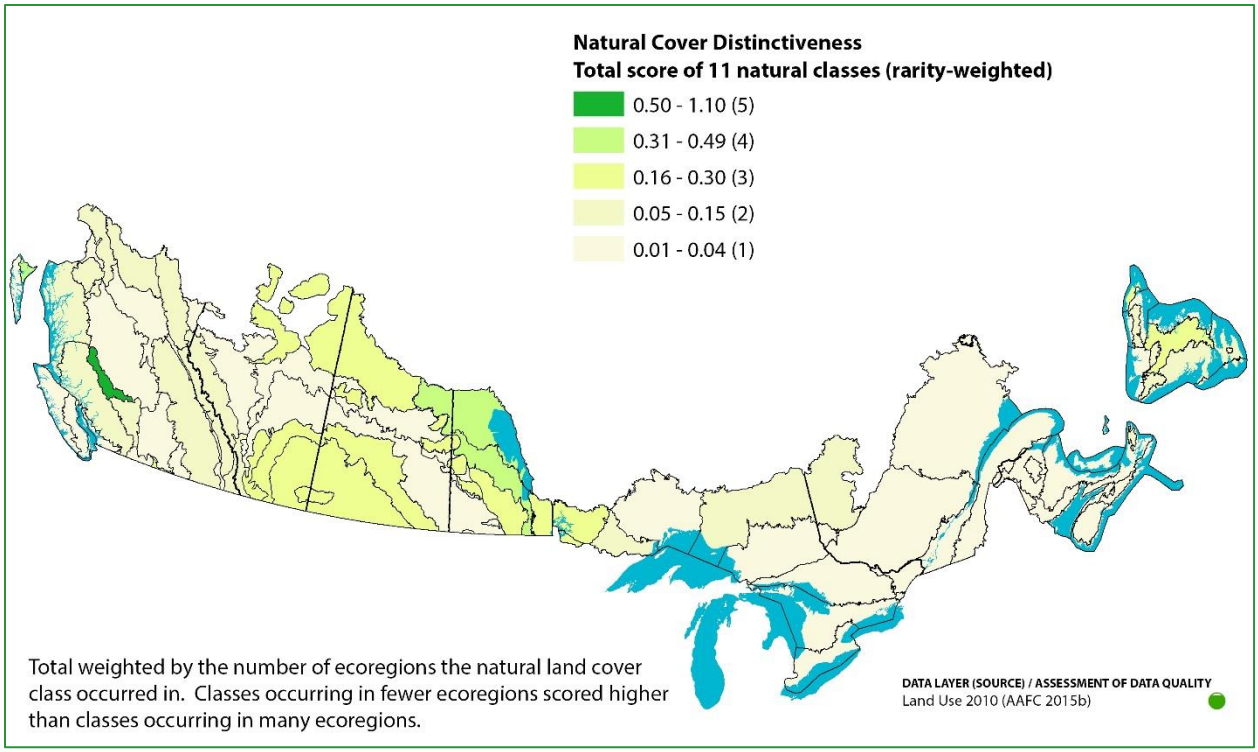

Figure G.21: B8a Natural Cover Distinctiveness

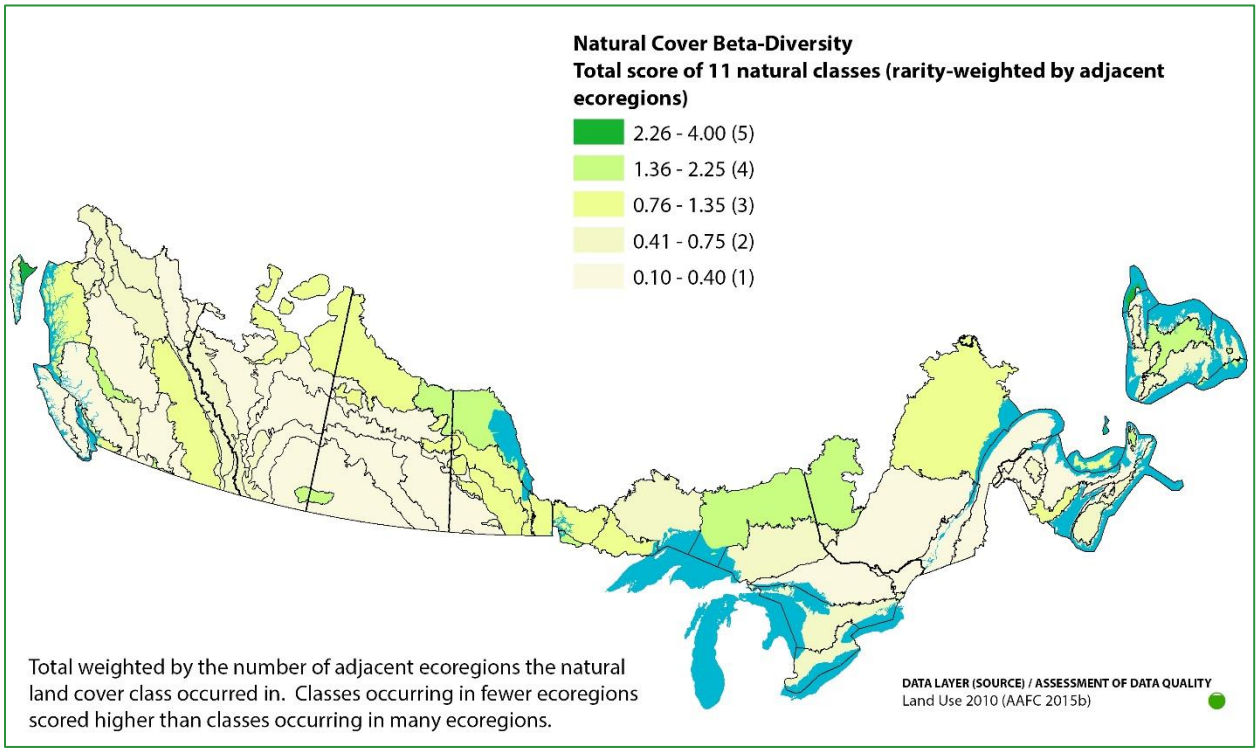

Figure G.22: B8b Natural Cover Beta-Diversity

Threat

Human Footprint (Criterion T1)

The human footprint in the study area is tightly linked to settlement patterns and population with the highest mean scores in British Columbia's Lower Mainland, the Lake Erie Lowland, St. Lawrence Lowlands and Îles-de-la-Madeleine (Figure G.23). These are all smaller ecoregions with large population centres and/or intensive agricultural conversion.

The analysis also looked at human footprint change from 1993 to 2009 (Figure G.24). The greatest change in the human footprint occurs in the Okanagan Range. This ecoregion is rapidly changing due to expanding agriculture (primarily vineyards) and urban development. Other ecoregions experiencing rapid change include the Cascade Ranges, Alberta's Fescue Grassland and southern Ontario's Lake Erie Lowland.

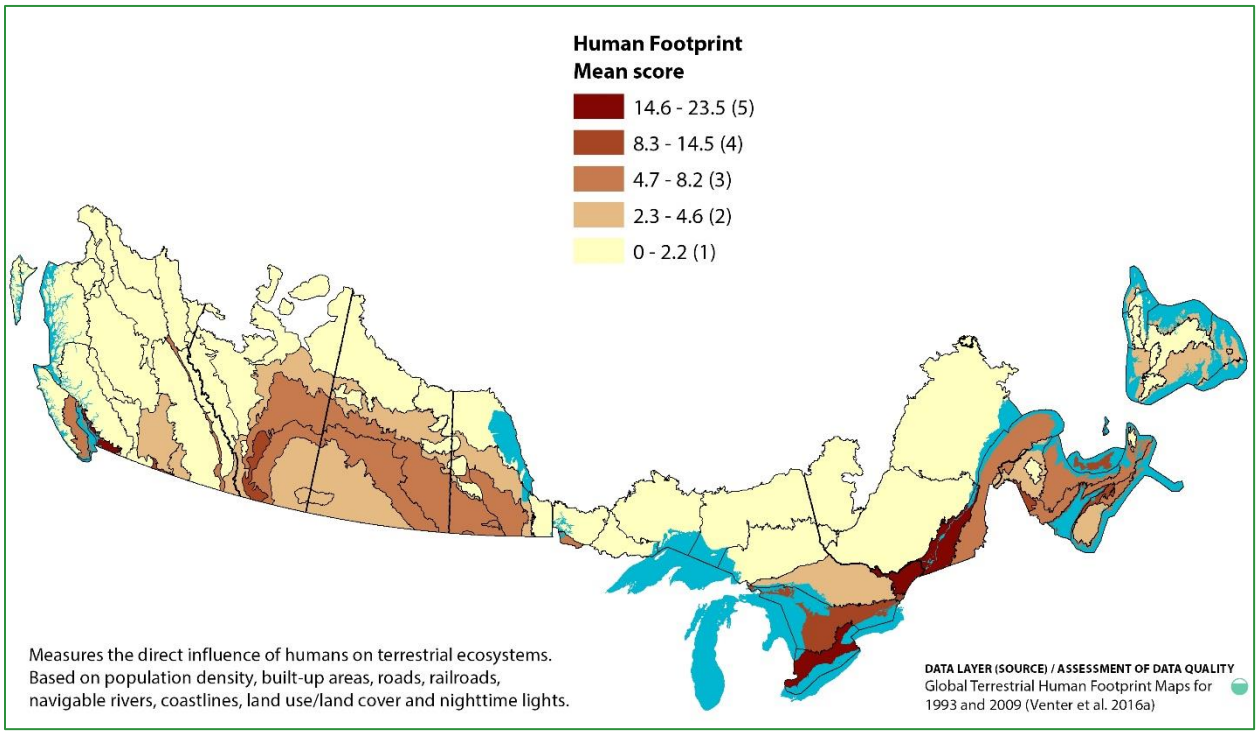

Figure G.23: T1a Human Footprint

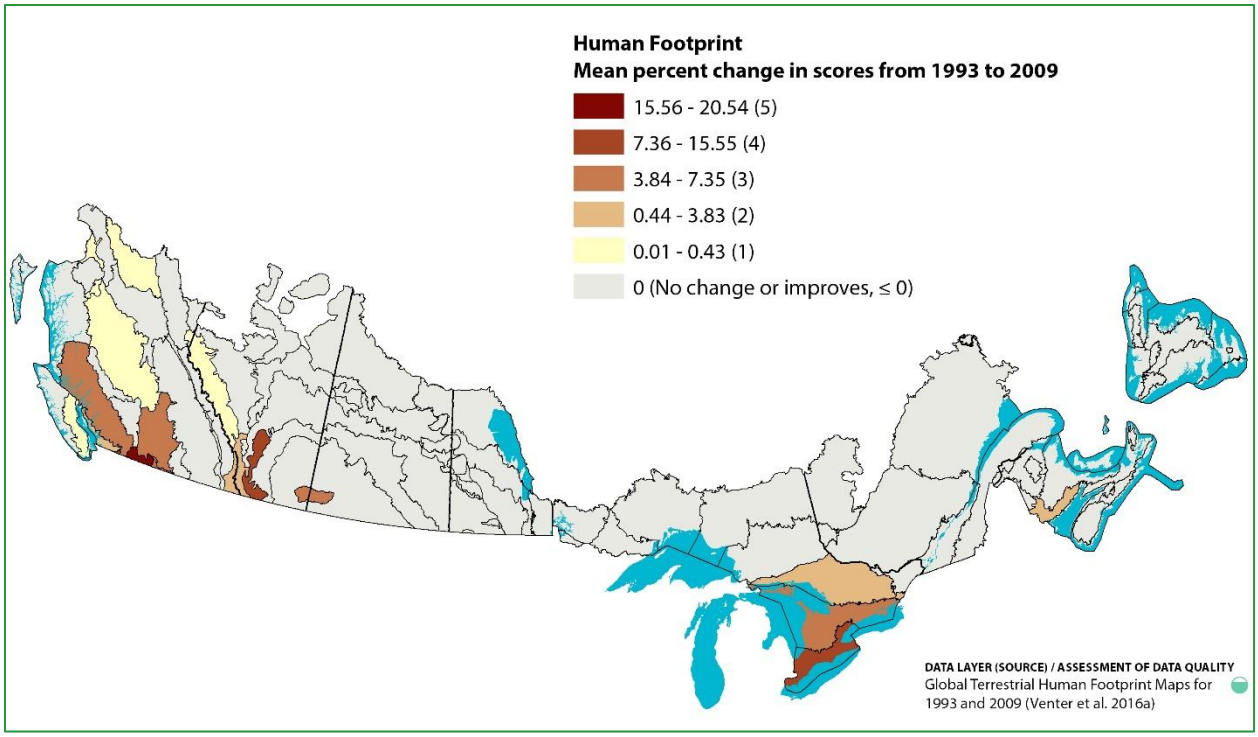

Figure G.24: T1b Human Footprint Change

Watershed Stress (Criterion T2)

The highest watershed stresses in the study area are associated with the Cascade Ranges, Lake Erie Lowland and ecoregions of Nova Scotia (Figure G.25). The very high ecoregion score in the Lake Erie Lowland is due to the high amount of urban and agricultural land cover, and industrial activities. The very high scores in ecoregions in Nova Scotia are driven by their relatively small size in comparison to a high density of roads (primarily for forestry) and industrial facilities (such as mills and refineries).

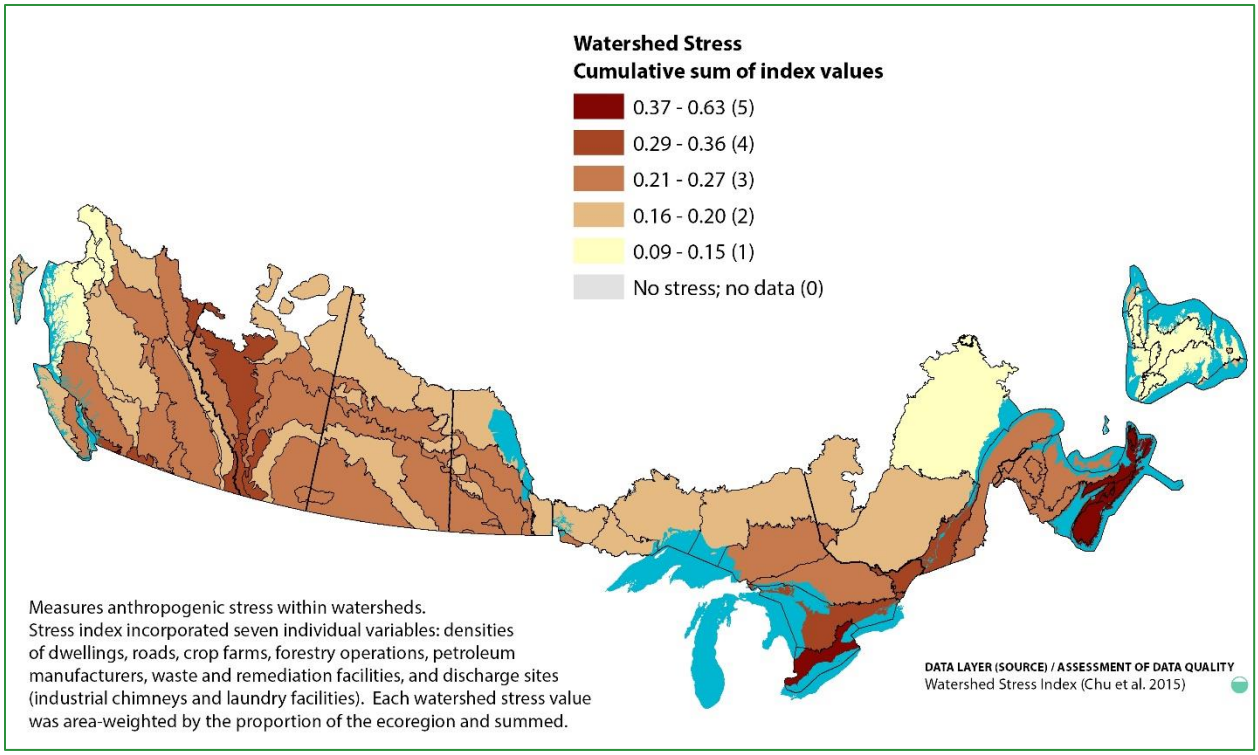

Figure G.25: T2 Watershed Stress

Conservation and Habitat Risk Index (Criterion T3)

The CRI is generally highest in settled regions where agriculture is the dominant land use. The Lake Erie Lowland and Lake Manitoba Plain ecoregions have the highest CRI scores in the study area. Three other ecoregions score high (Figure G.26). These five ecoregions generally have high or very high rates of conversion compared to natural cover as well (Habitat Risk Index, Figure G.27), and have relatively few protected areas (see **Error! Reference source not found.**). These risk indices re likely conservative, and would be higher across the study area if altered ecosystems are incorporated into the analysis (Swaty et al. 2011).

The highest rates of conversion of natural habitats to farmland and urban land uses are in the Aspen Parkland, Moist Mixed Grassland and Lake Erie Lowland ecoregions (Figure G.27).

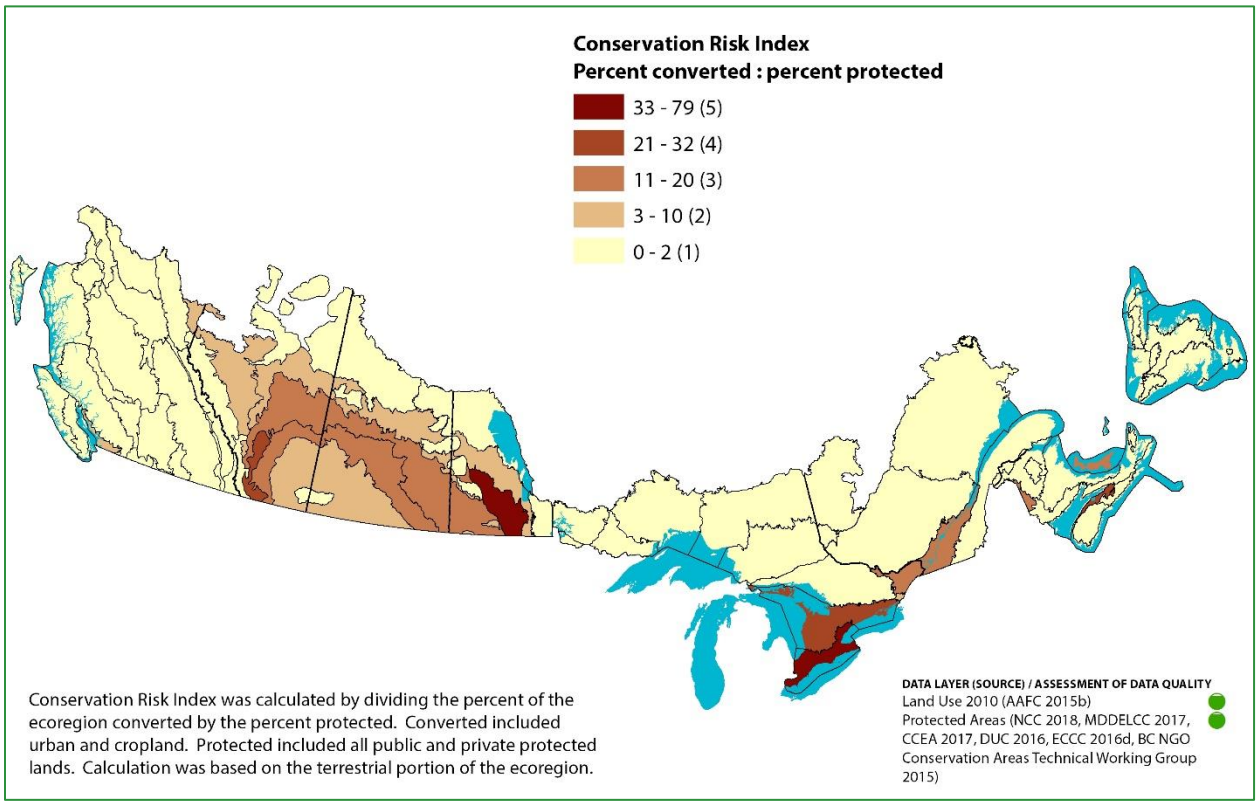

Figure G.26: T3a Conservation Risk Index

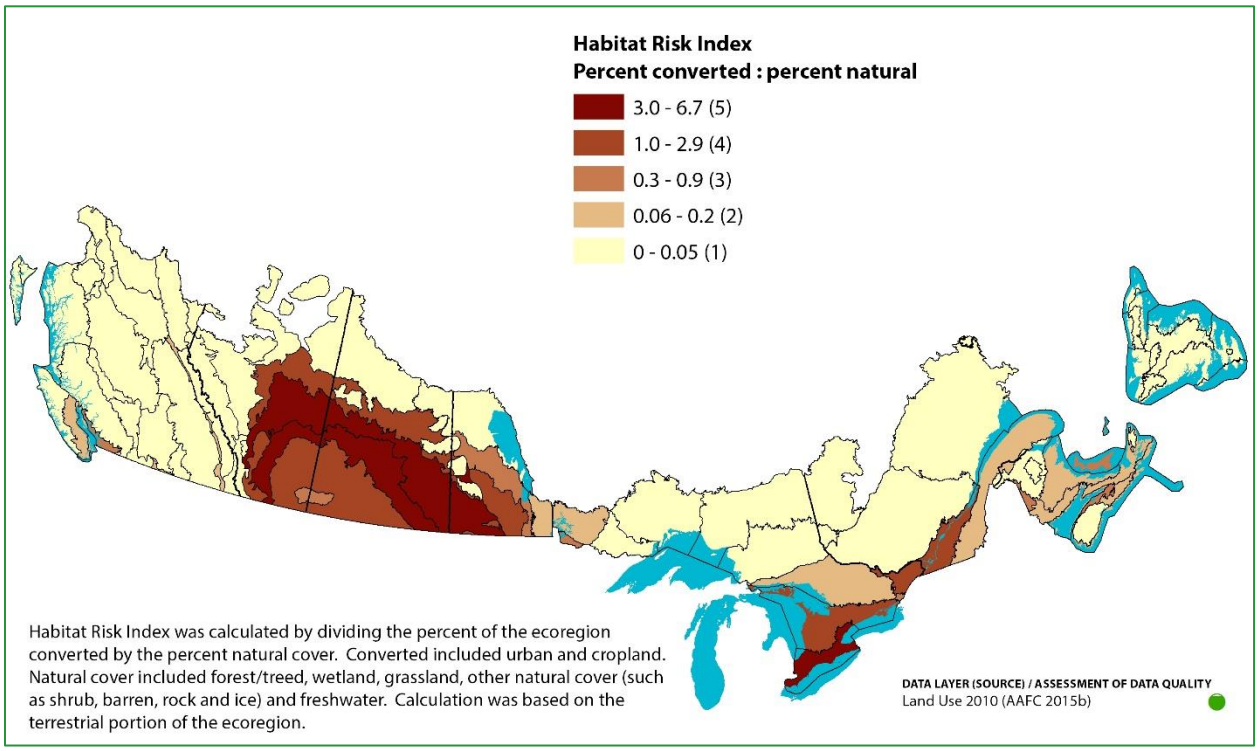

Figure G.27: T3b Habitat Risk Index

Fragmentation (Criterion T4)

Fragmentation is generally highly correlated with human activity and land conversion. Ecoregions with the highest overall resistance values are the Eastern and Western Continental Ranges (Figure G.28). These ecoregions have higher fragmentation values because of naturally-occurring high elevations and steep slopes. High or very high resistance values occur in nine other ecoregions – St. Lawrence Lowlands, Lake Erie Lowland, Manitoulin-Lake Simcoe, Chilcotin Ranges, Columbia Mountains and Highlands, Interior Transition Ranges, Northern Continental Divide, Pacific Ranges and Lower Mainland.

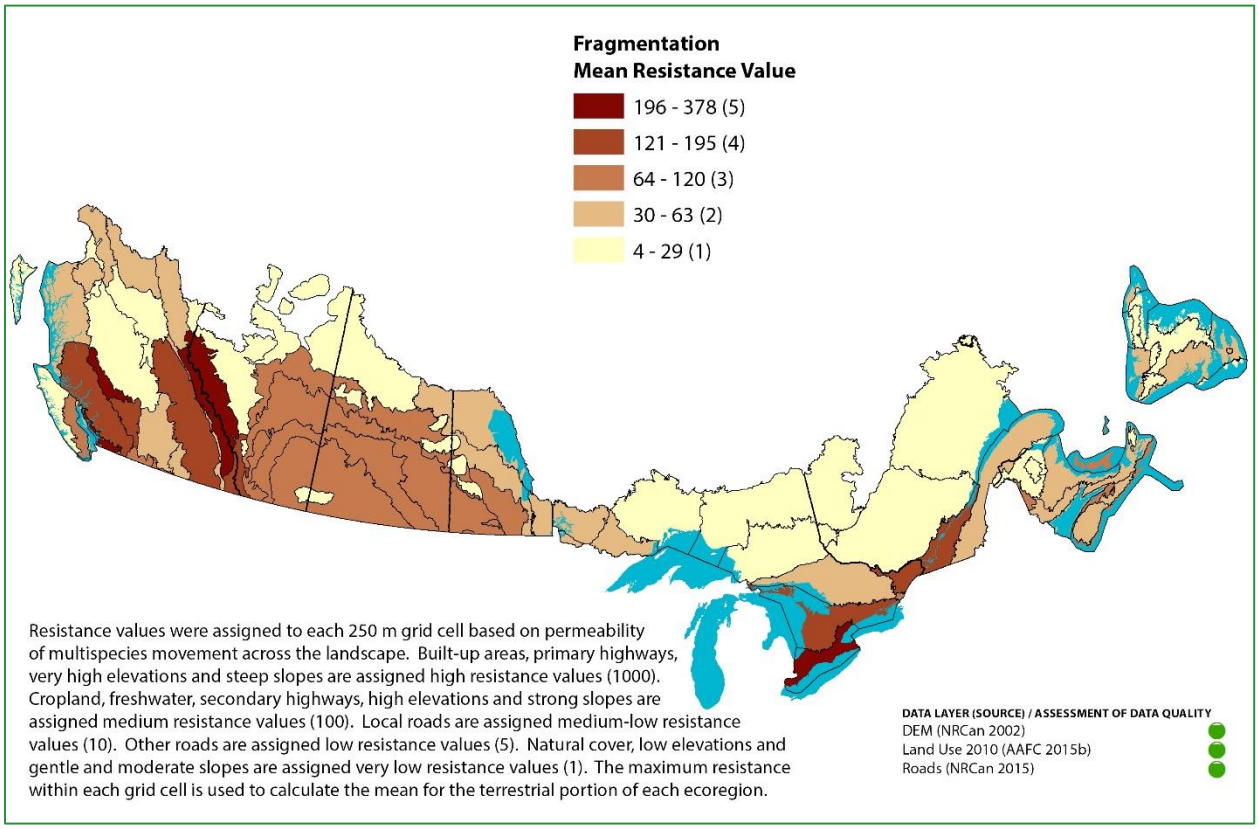

Figure G.28: T4 Lack of Connectivity

Land Use Change (Criterion T5)

Loss of natural habitats to agricultural and urban land uses generally occurs in ecoregions that have already experienced significant conversion, particularly in the Prairies ecozone (Figure G.29). In some ecoregions with low amounts of natural cover, low rates of conversion could be the result of urban areas expanding into agricultural areas. The high and very high scores for rates of conversion in the Prairies, in particular the Moist Mixed Grasslands, Aspen Parkland, Fescue Grassland and Mixed Grassland ecoregions, illustrate the relatively high level of current threat these ecoregions are experiencing as native grasslands (often with ranching) are converted to crops and urban areas. Îles-de-la-Madeleine also scores high for land cover change.

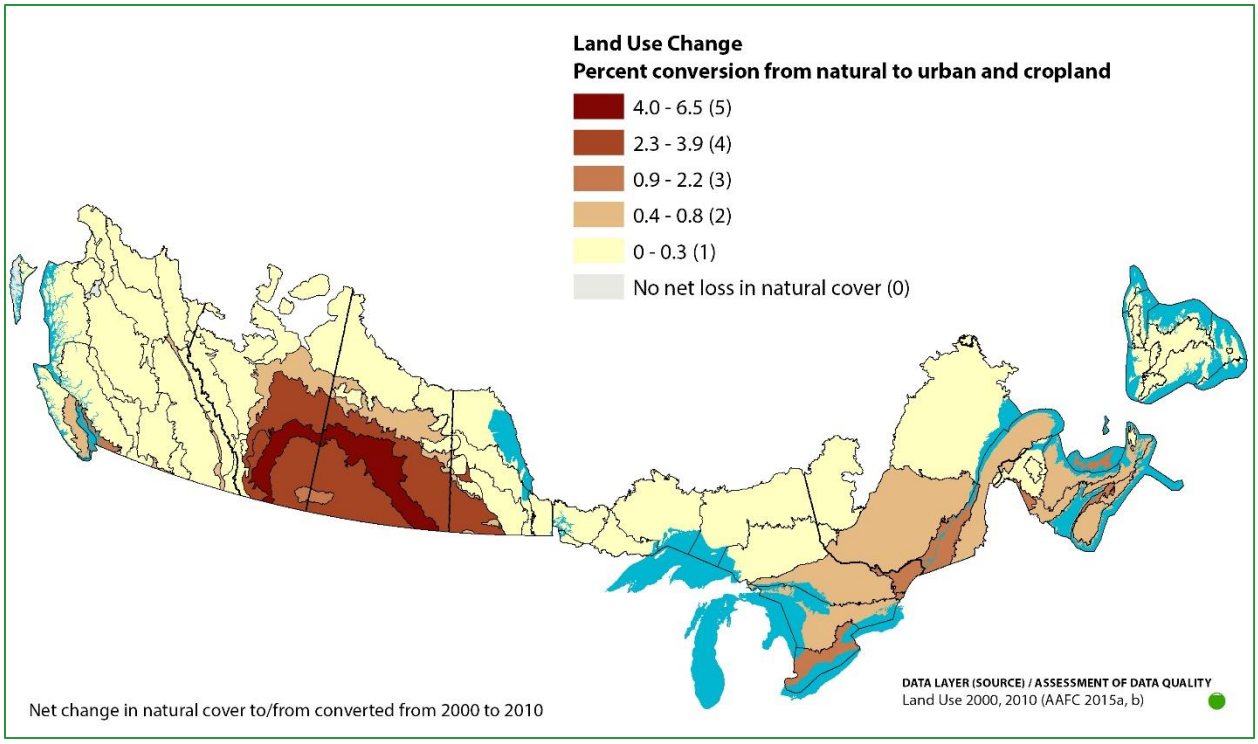

Figure G.29: T5 Land Use Change

Rate of Climate Change (Criterion T6)

The pattern in the study area is consistent with the pattern across Canada, with temperatures warming more quickly in the north (Warren & Lemmen 2014) (Figure G.30). The rate of temperature change has been highest in the most northerly ecoregions of the study area.

Observed changes in precipitation are more variable across the study area, and do not show the same patterns or gradients as temperature. Changes in precipitation include both observed increases and decreases from the climate normal. The observed rate of precipitation change is highest for the British Columbia's Queen Charlotte Ranges, Western Vancouver Island, Coastal Gap, and also in Northern Continental Divide and Cape Breton Highlands (Figure G.31). These changes in precipitation do not account for regional changes in the timing and frequency of precipitation events, such as extreme storms.

Observed changes in growing degree days also vary across the study area, with less variation in the interior of the continent. The greatest change is observed in the Lower Mainland, Georgia-Puget Basin, Queen Charlotte Lowland and Western Vancouver Island (Figure G.32). Ecoregions in Ontario, Quebec and the Maritimes also score high.

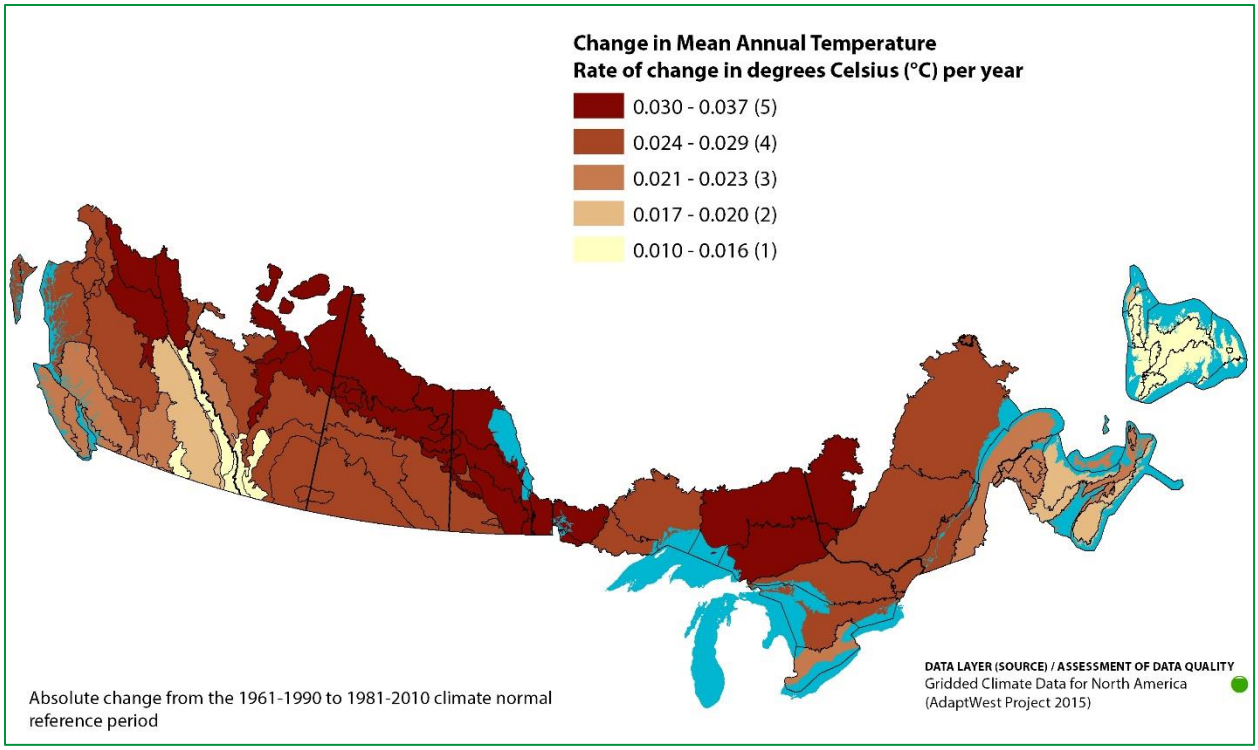

Figure G.30: T6a Mean Temperature Change

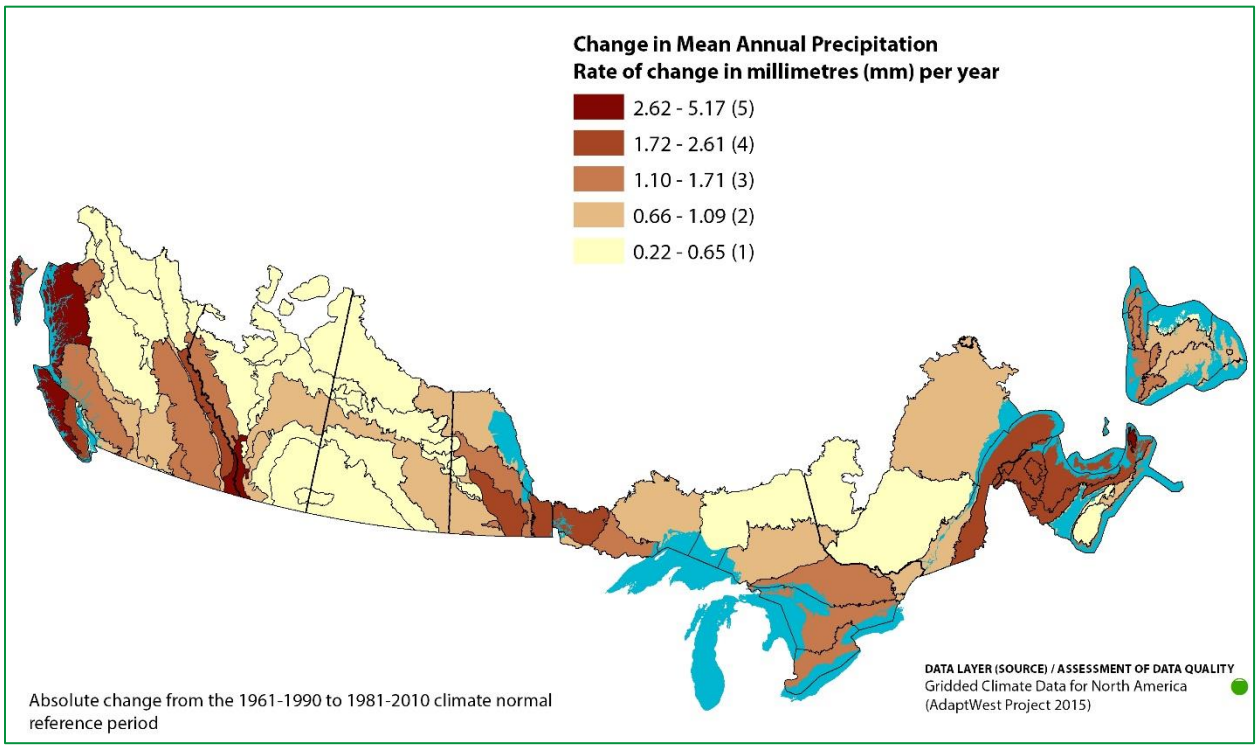

Figure G.31: T6b Mean Precipitation Change

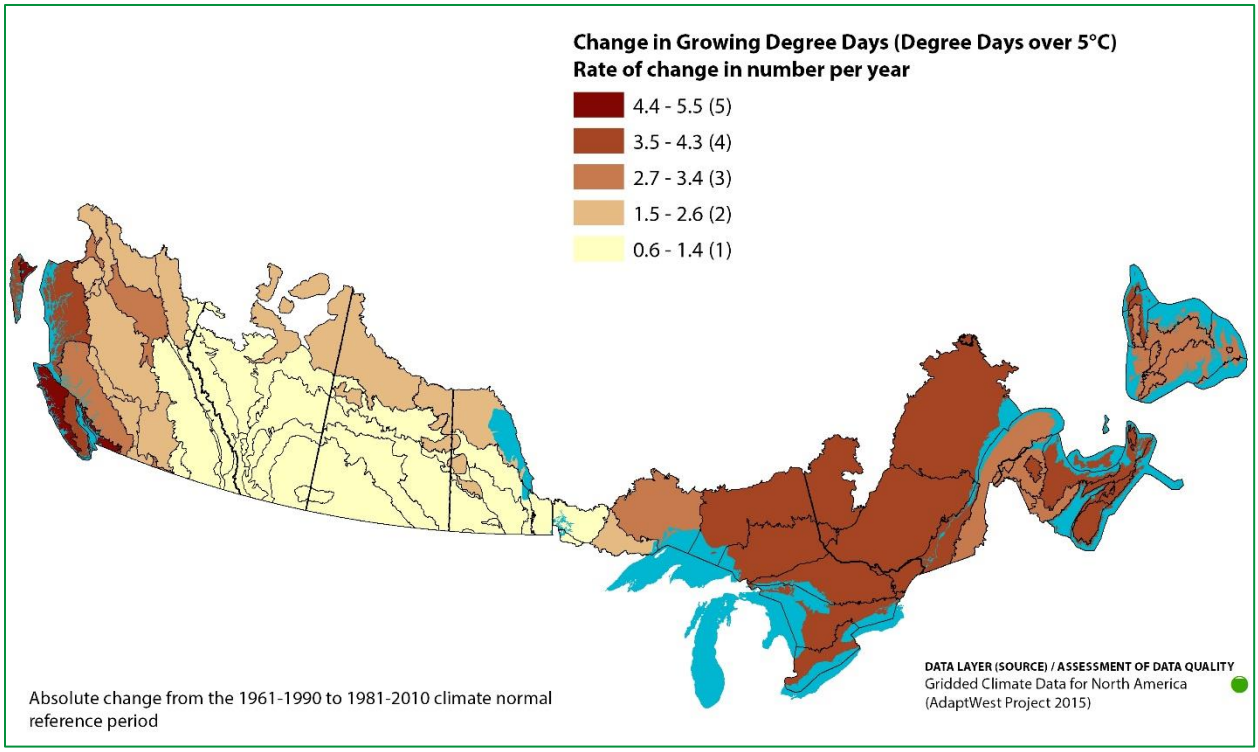

Figure G.32: T6c Growing Degree Days above 5°C

Lack of Water (Criterion T7)

Potential water availability for freshwater ecosystems is lower in ecoregions where there are competing demands for water from agricultural and municipal users. The highest scores for lack of water are in the Fescue Grasslands, Lake Erie Lowland and Mixed Grassland. These three ecoregions are some of the most intensively farmed areas of Canada resulting in higher water demands. In the Mixed Grassland ecoregion, several large communities rely on surface water from rivers for municipal drinking water. Other ecoregions with lower potential water availability are also found in southern Ontario and grassland regions of central British Columbia and the prairies that also have more intensive agriculture and municipal water uses. These include the Moist Mixed Grassland, Cypress Upland, Okanagan Highland, Northern Continental Divide, Manitoulin-Lake Simcoe and Southwest Manitoba Uplands (Figure G.33). Ecoregion size does influence the final scoring of this measure. For example, Southwest Manitoba Uplands, although it has similar water demands as surrounding ecoregions, scored higher because of its small size relative to the watershed data used to generate this measure.

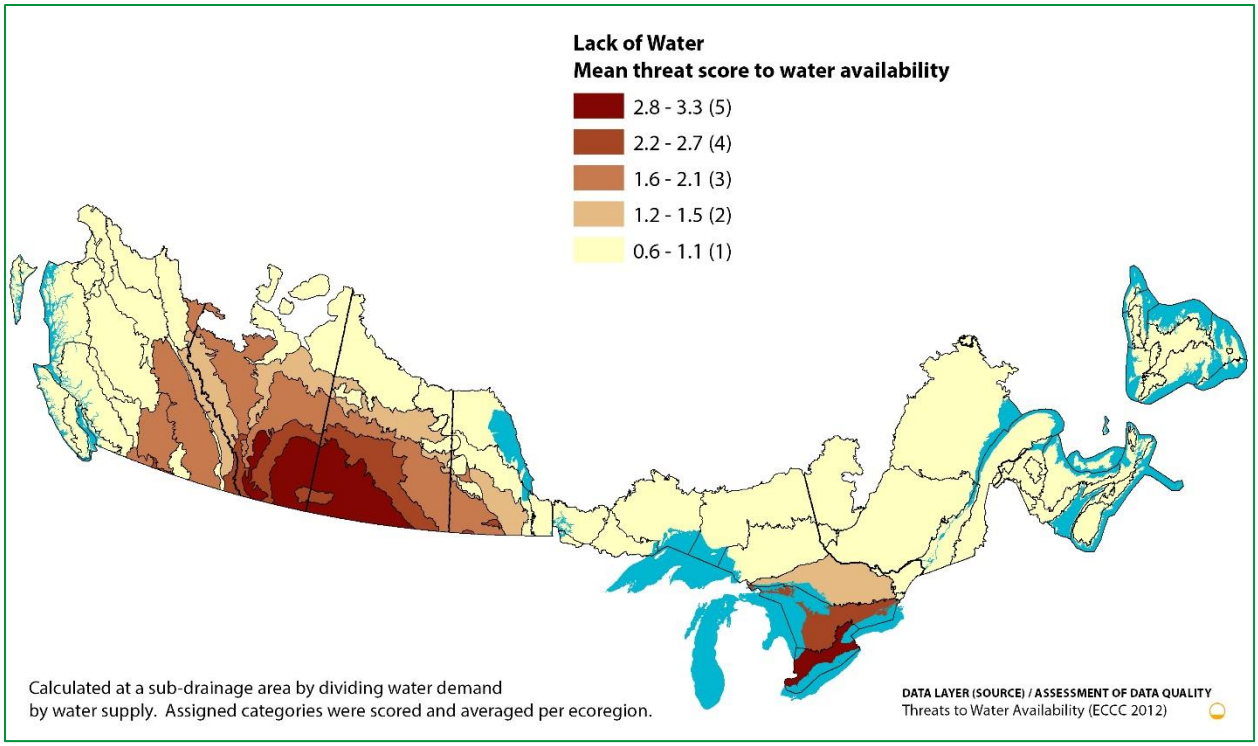

Figure G.33: T7 Lack of Water

APPENDIX H – ECOREGION SCORING TABLE WORKBOOK

The accompanying Ecoregion Scoring Table Workbook includes the raw values and scores for the individual measures and criteria for the three assessment categories (biodiversity, threat and conservation response) and approaches (Measures, Critieria and Combined). The workbook also includes base information relevant to each ecoregion, such as ecozone, major habitat type and area, and further describes the ecoregion based on other global and continental ERAs.

APPENDIX I – ADDITIONAL ECOREGION INFORMATION

Table I.1: Higher biodiversity/higher threat ecoregion profiles

Ecoregion Name and Identification Number	Prince Edward Island	St. Lawrence Lowlands	Manitoulin -Lake Simcoe	Lake Erie Lowland	Aspen Parkland	Mixed Grassland	Eastern Vancouver Island	Lower Mainland	Northern Continental Divide
	130	132	134	135	156	159	194	196	214
Total Terrestrial Area (ha)	589,323	4,182,092	4,626,437	2,372,347	17,518,350	13,345,784	1,331,491	473,245	1,555,421
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	18,441	155,796	88,591	25,662	698,574	1,416,016	183,803	24,466	451,535
% Protected	3.1	3.7	1.9	1.1	4.0	10.6	13.8	5.2	29.0
Natural Habitat (ha)	333,709	1,742,433	1,825,554	336,152	3,715,264	5,678,177	1,244,082	277,489	1,504,616
% Natural Habitat	56.6	41.7	39.5	14.2	21.2	42.5	93.4	58.6	96.7
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	1/1	10/13	8/9	3/3	15/17	4/9	1/1	1/1	5/6
% Area of NACP (terrestrial only) as of Dec 31, 2017	100.0	60.7	23.1	9.3	44.7	31.6	36.6	83.4	73.9
Corridor (ha; includes core areas)	170,861	2,595,892	2,481,900	776,155	5,718,260	7,497,771	1,187,135	247,064	628,899
Corridor in NACP (ha) as of Dec 31, 2017	152,657	1,067,946	490,474	110,415	2,813,305	2,389,727	322,831	111,730	687,846
Number of NCC fee simple properties as of Feb 28, 2018	23	140	99	89	103	36	8	4	58
Total area of NCC fee simple properties (ha)	642	11,100	18,962	3,360	12,463	12,235	268	93	19,718
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$3,732	$8,069	$9,134	$32,380	$3,152	$843	$8,324	$-	$16,072
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	64.8	32.0	26.0	19.9	22.8	35.4	25.4	18.7	15.5
% P1 and P2 ha in NACPs that are natural habitat	43.0	13.9	3.8	0.8	5.9	10.3	7.5	10.6	10.1
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	6	47	60	95	33	34	16	2	18
# COSEWIC SAR (terrestrial, freshwater) in NACP	6	43	56	85	33	34	16	2	18
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	4	4	10	-	-	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	6	38	59	88	27	29	8	2	12
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	-	9	1	7	6	5	8	-	6
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	6	36	55	79	27	29	8	2	12
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	-	7	1	6	6	5	8	-	6
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	2	4	9	-	-	-	-	-

Table I.2a: Higher biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Lake of the Woods	Rainy River	Thunder Bay-Quetico	Central Laurentians	Strait of Belle Isle	Appalachians	Southern New Brunswick Uplands	Maritime Lowlands
	91	92	93	101	106	117	121	122
Total Terrestrial Area (ha)	4,288,499	288,806	2,546,453	20,898,966	252,636	6,631,340	1,278,395	2,930,435
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	354,171	25,751	586,568	467,683	4,357	258,754	79,616	116,632
% Protected	8.3	8.9	23.0	2.2	1.7	3.9	6.2	4.0
Natural Habitat (ha)	4,093,584	222,797	2,496,696	20,642,369	250,136	5,916,678	1,194,450	2,685,534
% Natural Habitat	95.5	77.1	98.0	98.8	99.0	89.2	93.4	91.6
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	3/4	1/1	1/2	0/2	0/0	6/8	3/3	5/7
% Area of NACP (terrestrial only) as of Dec 31, 2017	43.8	100.0	26.6	0.2	-	42.0	63.4	64.8
Corridor (ha; includes core areas)	4,152,914	270,000	2,503,395	20,391,881	228,736	6,461,746	1,223,556	2,670,847
Corridor in NACP (ha) as of Dec 31, 2017	1,796,586	256,290	628,703	10,522	-	2,461,886	747,571	1,362,247
Number of NCC fee simple properties as of Feb 28, 2018	15	1	1	1	-	91	14	94
Total area of NCC fee simple properties (ha)	1,367	49	1,012	31	-	12,227	851	4,222
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$1,172	$-	$32,370	$-	$-	$8,577	$-	$1,784
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	24.0	3.3	3.5	19.1	-	57.1	38.2	66.8
% P1 and P2 ha in NACPs that are natural habitat	9.9	3.3	0.9	0.0	-	22.2	23.5	41.6
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	13	5	-	-	-	25	7	17
# COSEWIC SAR (terrestrial, freshwater) in NACP	13	5	-	-	-	25	1	16
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	-	-	-	-	6	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	12	5	-	-	-	19	7	17
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	1	-	-	-	-	6	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	12	5	-	-	-	19	1	16
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	1	-	-	-	-	6	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-	-	6	1

Table I.2b: Higher biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Fundy Coast	Southwest Nova Scotia Uplands	Atlantic Coast	Nova Scotia Highlands	Cape Breton Highlands	Mid-Boreal Uplands	Western Alberta Upland	Mid-Boreal Lowland
	123	124	125	128	129	139	145	148
Total Terrestrial Area (ha)	436,864	1,572,289	678,236	1,494,093	229,359	20,214,883	7,582,884	9,201,622
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	35,665	271,546	73,755	127,262	114,734	2,229,950	90,884	574,566
% Protected	8.2	17.3	10.9	8.5	50.0	11.0	1.2	6.2
Natural Habitat (ha)	373,859	1,519,731	631,740	1,385,431	228,228	19,621,419	7,214,466	9,110,043
% Natural Habitat	85.6	96.7	93.1	92.7	99.5	97.1	95.1	99.0
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	2/3	1/1	2/3	2/2	1/1	1/2	2/2	1/1
% Area of NACP (terrestrial only) as of Dec 31, 2017	43.0	99.4	47.6	47.2	32.1	2.6	4.3	1.7
Corridor (ha; includes core areas)	367,503	1,482,844	462,309	1,432,504	228,939	19,693,501	7,309,105	6,440,946
Corridor in NACP (ha) as of Dec 31, 2017	124,382	1,438,387	121,023	631,931	62,724	467,858	291,347	112,103
Number of NCC fee simple properties as of Feb 28, 2018	73	12	50	15	-	24	3	-
Total area of NCC fee simple properties (ha)	3,269	2,974	2,266	957	-	2,195	454	-
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$9,306	$-	$3,175	$714	$-	$1,249	$-	$-
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	62.9	31.3	43.5	39.6	3.8	89.5	37.1	84.8
% P1 and P2 ha in NACPs that are natural habitat	25.5	30.2	19.5	17.5	1.2	1.9	1.1	1.3
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	10	15	14	5	-	15	4	-
# COSEWIC SAR (terrestrial, freshwater) in NACP	8	15	14	5	-	15	4	-
# COSEWIC SAR (terrestrial, freshwater) outside NACP	2	-	-	-	-	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	9	11	13	3	-	12	-	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	1	4	1	2	-	3	4	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	7	11	13	3	-	12	-	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	1	4	1	2	-	3	4	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	2	-	-	-	-	-	-	-

Table I.2c: Higher biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Interlake Plain	Queen Charlotte Ranges	Western Vancouver Island	Columbia Mountains and Highlands	Eastern Continental Ranges
	155	188	193	205	207
Total Terrestrial Area (ha)	3,990,720	715,682	1,948,781	8,880,639	3,920,952
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	150,597	374,741	260,784	1,635,796	2,654,252
% Protected	3.8	52.4	13.4	18.4	67.7
Natural Habitat (ha)	3,111,175	715,338	1,941,864	8,833,038	3,911,044
% Natural Habitat	78.0	100.0	99.6	99.5	99.7
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	2/2	1/1	0/2	2/3	1/2
% Area of NACP (terrestrial only) as of Dec 31, 2017	26.9	100.0	0.9	14.9	1.7
Corridor (ha; includes core areas)	3,102,755	-	1,918,555	5,253,484	1,133,784
Corridor in NACP (ha) as of Dec 31, 2017	771,998	652,345	16,604	717,356	22,881
Number of NCC fee simple properties as of Feb 28, 2018	76	-	2	8	-
Total area of NCC fee simple properties (ha)	9,897	-	118	54,818	-
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$905	$-	$-	$6,248	
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	51.3	1.7	3.7	4.1	1.3
% P1 and P2 ha in NACPs that are natural habitat	9.6	1.7	0.0	0.5	0.0
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	24	-	1	15	-
# COSEWIC SAR (terrestrial, freshwater) in NACP	24	-	-	15	-
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	1	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	22	-	-	15	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	2	-	1	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	22	-	-	15	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	2	-	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-

Table I.3a: Lower biodiversity/higher threat ecoregion profiles

Ecoregion Name and Identification Number	Algonquin-Lake Nipissing	Saint John River Valley	Annapolis-Minas Lowlands	Frontenac Axis	Moist Mixed Grassland	Fescue Grassland	Cypress Upland
	98	120	126	133	157	158	160
Total Terrestrial Area (ha)	6,870,843	376,408	448,273	87,688	9,959,335	1,490,698	854,189
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	779,352	5,438	5,138	5,665	494,156	36,823	137,036
% Protected	11.3	1.4	1.1	6.5	5.0	2.5	16.0
Natural Habitat (ha)	6,550,141	292,603	329,870	59,587	2,359,931	421,332	650,443
% Natural Habitat	95.3	77.7	73.6	68.0	23.7	28.3	76.1
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	2/7	1/2	1/2	1/2	4/11	4/5	3/5
% Area of NACP (terrestrial only) as of Dec 31, 2017	1.7	100.0	17.3	97.9	37.6	33.3	100.0
Corridor (ha; includes core areas)	6,658,071	363,710	383,887	73,949	3,918,828	457,479	819,309
Corridor in NACP (ha) as of Dec 31, 2017	108,687	353,931	68,208	72,604	1,107,216	361,021	771,722
Number of NCC fee simple properties as of Feb 28, 2018	30	-	1	4	28	13	5
Total area of NCC fee simple properties (ha)	1,958	-	164	214	3,671	3,967	587
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$4,573	$-	$-	$11,313	$2,449	$-	$-
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	46.6	51.9	29.2	29.9	10.8	22.6	41.1
% P1 and P2 ha in NACPs that are natural habitat	0.7	44.9	4.4	22.1	3.2	6.0	38.8
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	36	1	4	19	24	17	14
# COSEWIC SAR (terrestrial, freshwater) in NACP	30	1	-	19	21	17	14
# COSEWIC SAR (terrestrial, freshwater) outside NACP	6	-	4	-	3	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	34	-	4	16	18	12	5
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	2	1	-	3	6	5	9
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	29	-	-	16	17	12	5
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	1	1	-	3	4	5	9
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	5	-	4	-	1	-	-

Table I.3b: Lower biodiversity/higher threat ecoregion profiles

Ecoregion Name and Identification Number	Lake Manitoba Plain	Southwest Manitoba Uplands	Pacific Ranges	Cascade Ranges	Okanagan Range	Okanagan Highland
	162	163	192	197	210	211
Total Terrestrial Area (ha)	3,265,434	215,613	5,963,895	31,543	451,621	120,916
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	40,326	14,337	796,527	3,584	176,523	16,537
% Protected	1.2	6.6	13.4	11.4	39.1	13.7
Natural Habitat (ha)	1,129,153	69,733	5,945,360	31,133	444,713	104,477
% Natural Habitat	34.6	32.3	99.7	98.7	98.5	86.4
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	3/4	0/1	3/4	0/1	1/1	1/1
% Area of NACP (terrestrial only) as of Dec 31, 2017	23.6	0.4	24.5	42.8	19.0	64.5
Corridor (ha; includes core areas)	1,155,190	84,367	3,898,721	29,036	273,936	113,472
Corridor in NACP (ha) as of Dec 31, 2017	414,596	-	952,161	12,271	54,554	69,212
Number of NCC fee simple properties as of Feb 28, 2018	12	-	5	-	-	7
Total area of NCC fee simple properties (ha)	2,503	-	461	-	-	1,481
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$2,679	$-	$13,037	$-		$11,658
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	54.4	44.7	0.7	1.3	60.2	72.2
% P1 and P2 ha in NACPs that are natural habitat	7.7	0.1	0.1	0.5	11.0	42.2
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	13	-	4	-	-	28
# COSEWIC SAR (terrestrial, freshwater) in NACP	13	-	4	-	-	28
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	-	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	13	-	3	-	-	28
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	-	-	1	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	13	-	3	-	-	28
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	-	-	1	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-	-

Table I.4a: Lower biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Lake Nipigon	Abitibi Plains	Lac Temiscamingue Lowland	Southern Laurentians	Northern Peninsula	Long Range Mountains	Southwestern Newfoundland	Central Newfoundland
	94	96	97	99	107	108	109	112
Total Terrestrial Area (ha)	8,221,692	17,772,480	8,364,481	16,742,865	819,981	1,602,568	1,048,710	2,988,756
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	1,362,149	956,012	850,771	742,601	46,779	139,033	91,118	85,943
% Protected	16.6	5.4	10.2	4.4	5.7	8.7	8.7	2.9
Natural Habitat (ha)	8,184,704	17,516,057	8,184,239	16,330,610	813,470	1,600,498	1,025,106	2,958,211
% Natural Habitat	99.6	98.6	97.8	97.5	99.2	99.9	97.7	99.0
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	1/1	1/1	1/1	4/7	1/1	1/1	1/1	1/2
% Area of NACP (terrestrial only) as of Dec 31, 2017	54.2	11.8	14.7	20.5	19.3	39.4	98.7	9.6
Corridor (ha; includes core areas)	7,749,090	17,592,432	8,248,734	16,516,085	768,467	1,598,271	1,010,000	2,949,355
Corridor in NACP (ha) as of Dec 31, 2017	3,801,873	2,047,967	1,160,492	3,151,750	152,292	628,916	936,033	269,550
Number of NCC fee simple properties as of Feb 28, 2018	5	-	1	58	-	1	21	1
Total area of NCC fee simple properties (ha)	5,268	-	12	10,027	-	1,577	636	882
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$2,639	$-	$-	$3,490	$-	$390	$6,237	$-
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	4.1	4.4	6.0	41.1	78.8	61.4	75.4	90.1
% P1 and P2 ha in NACPs that are natural habitat	2.2	0.5	0.9	8.1	15.1	24.2	73.0	8.5
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	1	-	-	27	-	4	3	1
# COSEWIC SAR (terrestrial, freshwater) in NACP	1	-	-	27	-	4	3	-
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	-	-	-	-	-	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	1	-	-	24	-	4	2	1
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	-	-	-	3	-	-	1	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	1	-	-	24	-	4	2	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	-	-	-	3	-	-	1	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-	-	-	1

Table I.4b: Lower biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Northeastern Newfoundland	Maritime Barrens	Avalon Forest	South Avalon-Burin Oceanic Barrens	Northern New Brunswick Uplands	New Brunswick Highlands	South-central Nova Scotia Uplands	Îles-de-la-Madeleine
	113	114	115	116	118	119	127	131
Total Terrestrial Area (ha)	593,388	3,566,687	48,477	203,715	2,371,502	496,771	618,786	23,363
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	4,152	364,900	1,870	9,723	83,707	52,078	75,509	2,628
% Protected	0.7	10.2	3.9	4.8	3.5	10.5	12.2	11.3
Natural Habitat (ha)	583,776	3,503,539	47,364	200,232	2,273,375	494,017	578,276	18,502
% Natural Habitat	98.4	98.2	97.7	98.3	95.9	99.4	93.5	79.2
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	0/0	1/2	1/1	1/1	3/5	1/2	1/2	0/1
% Area of NACP (terrestrial only) as of Dec 31, 2017	-	22.7	100.0	71.0	64.3	54.5	29.9	100.0
Corridor (ha; includes core areas)	474,658	3,382,842	48,057	199,497	2,311,263	496,182	580,469	-
Corridor in NACP (ha) as of Dec 31, 2017	-	695,355	47,778	142,010	1,257,383	231,227	168,919	-
Number of NCC fee simple properties as of Feb 28, 2018	-	5	2	-	-	-	11	3
Total area of NCC fee simple properties (ha)	-	99	82	-	-	-	657	15
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$-	$8,861	$618	$-	$-	$-	$1,094	$-
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	-	68.1	98.7	52.7	86.1	98.3	35.9	64.4
% P1 and P2 ha in NACPs that are natural habitat	-	14.6	96.6	36.7	54.2	53.3	10.6	58.7
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	-	4	1	-	-	-	7	1
# COSEWIC SAR (terrestrial, freshwater) in NACP	-	4	1	-	-	-	6	1
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	-	-	-	-	1	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	-	4	1	-	-	-	5	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	-	-	-	-	-	-	2	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	-	4	1	-	-	-	4	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	-	-	-	-	-	-	2	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-	-	1	-

Table I.4c: Lower biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Boreal Transition	Nass Basin	Queen Charlotte Lowland	Nass Ranges	Coastal Gap	Georgia-Puget Basin	Skeena Mountains	Omineca Mountains	Central Canadian Rocky Mountains
	149	187	189	190	191	195	198	199	200
Total Terrestrial Area (ha)	10,089,724	563,490	288,817	1,275,433	5,074,968	138,036	2,288,864	3,502,211	3,706,368
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	549,193	52,999	105,826	65,858	1,752,795	18,672	92,582	285,157	362,859
% Protected	5.4	9.4	36.6	5.2	34.5	13.5	4.0	8.1	9.8
Natural Habitat (ha)	4,453,110	560,354	288,766	1,267,184	5,068,247	128,907	2,287,791	3,498,862	3,698,976
% Natural Habitat	44.1	99.4	100.0	99.4	99.9	93.4	100.0	99.9	99.8
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	3/4	0/0	1/1	0/0	1/1	1/1	0/0	0/0	0/0
% Area of NACP (terrestrial only) as of Dec 31, 2017	24.8	-	100.0	-	35.5	100.0	-	-	-
Corridor (ha; includes core areas)	6,074,117	312,586	-	582,055	3,378,846	61,860	1,600,029	3,168,340	3,528,550
Corridor in NACP (ha) as of Dec 31, 2017	1,225,324	-	281,302	-	1,395,450	-	-	-	-
Number of NCC fee simple properties as of Feb 28, 2018	33	-	2	-	4	5	-	-	-
Total area of NCC fee simple properties (ha)	3,264	-	127	-	302	67	-	-	-
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$1,410	$-	$27,503	$-	$8,486	$7,263	$-	$-	$-
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	32.2	-	1.6	-	0.1	45.2	-	-	-
% P1 and P2 ha in NACPs that are natural habitat	5.3	-	1.6	-	0.0	43.1	-	-	-
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	14	-	5	-	7	6	-	-	-
# COSEWIC SAR (terrestrial, freshwater) in NACP	14	-	5	-	7	6	-	-	-
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	-	-	-	-	-	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	11	-	5	-	-	4	-	-	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	3	-	-	-	7	2	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	11		5		-	4	-	-	-
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	3	-	-	-	7	2	-	-	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	-	-	-	-	-	-	-	-

Table I.4d: Lower biodiversity/lower threat ecoregion profiles

Ecoregion Name and Identification Number	Bulkley Ranges	Fraser Plateau	Fraser Basin	Chilcotin Ranges	Western Continental Ranges	Interior Transition Ranges	Thompson-Okanagan Plateau	Selkirk-Bitterroot Foothills	Southern Rocky Mountain Trench
	201	202	203	204	206	208	209	212	213
Total Terrestrial Area (ha)	290,108	9,133,642	4,630,018	1,178,642	2,448,400	1,525,001	3,797,784	794,844	751,975
Protected Area (ha) as of Dec 31, 2017 (CARTS) and Feb 28, 2018 (NCC)	36,178	1,203,297	158,034	452,497	666,941	208,520	149,962	88,876	60,588
% Protected	12.5	13.2	3.4	38.4	27.2	13.7	3.9	11.2	8.1
Natural Habitat (ha)	289,330	8,980,714	4,511,110	1,178,412	2,443,589	1,511,160	3,628,140	783,343	713,632
% Natural Habitat	99.7	98.3	97.4	100.0	99.8	99.1	95.5	98.6	94.9
Number of NACPs (NACPs that cover >5% of ecoregion / all NACPs in ecoregion) as of Dec 31, 2017	0/0	3/5	0/0	2/3	2/2	2/2	3/3	2/2	2/2
% Area of NACP (terrestrial only) as of Dec 31, 2017	-	4.5	-	45.8	22.8	54.9	23.0	15.3	58.6
Corridor (ha; includes core areas)	283,420	8,711,022	4,577,211	451,440	898,077	974,056	3,341,255	654,300	716,745
Corridor in NACP (ha) as of Dec 31, 2017	-	379,247	-	226,895	291,496	444,548	737,196	104,941	418,510
Number of NCC fee simple properties as of Feb 28, 2018	-	9	-	4	2	-	5	2	12
Total area of NCC fee simple properties (ha)	-	1,596	-	374	1,289	-	1,615	48	1,797
Cost per hectare (total $/ha) of NCC fee simple properties secured from Apr 1, 2007 to Feb 28, 2018	$-	$554	$-	$1,916	$3,106		$4,134	$2,200	$14,020
% P1 and P2 ha in NACPs not owned by NCC as of Feb 28, 2018	-	1.3	-	0.4	2.1	2.1	19.5	25.1	18.7
% P1 and P2 ha in NACPs that are natural habitat	-	0.1	-	0.2	0.4	1.0	4.2	3.8	9.5
# COSEWIC SAR (terrestrial, freshwater) recorded on NCC lands as of Apr 30, 2018	-	14	-	2	5	-	17	4	13
# COSEWIC SAR (terrestrial, freshwater) in NACP	-	3	-	2	5	-	17	3	13
# COSEWIC SAR (terrestrial, freshwater) outside NACP	-	11	-	-	-	-	-	1	-
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties	-	10	-	2	5	-	8	4	12
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties	-	4	-	-	-	-	9	-	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties in NACP	-	3	-	2	5	-	8	3	12
# COSEWIC SAR (terrestrial, freshwater) NOT on NCC fee simple properties in NACP	-	-	-	-	-	-	9	-	1
# COSEWIC SAR (terrestrial, freshwater) on NCC fee simple properties outside NACP	-	7	-	-	-	-	-	1	-

APPENDIX J – EXAMPLE OF ECOREGION SUMMARY

St. Lawrence Lowlands Ecoregion (#132)

Total Area	*45,061 km^2 (0.45% of Canada)*
Total Terrestrial Area	*41,182 km^2*
Protected Areas	*3.7%*
National & International Designations	*5.7%*
NCC Natural Area	*60.7%*
Natural Cover	*41.7% (primarily forest)*
Dominant Land Ownership	*Private*
Population	*7,016,938*
Final Ecoregion Classification	*Higher biodiversity and higher threat*

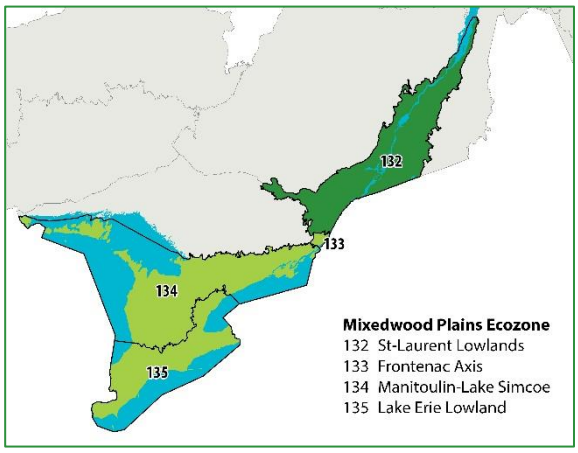

Figure J.1: Location Map

The St. Lawrence Lowlands ecoregion includes the lowlands centred on the Ottawa and St. Lawrence rivers stretching from Quebec City to the Frontenac Axis near Brockville, Ontario. It is bounded on the north by the hilly Laurentian Highlands on the Boreal Shield and the Eastern Quebec Uplands to the south (Figure J.1).

The ecoregion is marked by warm summers and cold snowy winters. Mixedwood forests of sugar maple, yellow birch, eastern hemlock, American beech and eastern white pine are the dominant forest type. Red pine and red oak occur on drier sites, and wet forests are characterized by red maple, black ash, white spruce, tamarack and eastern white cedar. Common wildlife species include white tailed deer, eastern coyote and red fox. Underlain by flat-lying Palaeozoic strata that are either faulted or lie upon the crystalline rocks of the Canadian Shield, the ecoregion is generally flat, except for the seven Monteregian Hills in the south, which are formed of intrusive igneous rocks. Gleysolic soils developed on level, poorly drained, clayey deposits are dominant in the ecoregion; with significant inclusions are Humo-Ferric Podzols and Dystric Brunisols on morainal uplands.

Most of the ecoregion is intensively cultivated farmland (46%) with corn being the dominant crop (Figure J.2). Dairy and mixed farming systems also occur. Urban development is extensive. The major communities include Quebec City, Montreal, Trois-Rivières, Saint-Hyacinthe, Cornwall, Brockville, Ottawa/Gatineau and Pembroke. Nature conservation is closely associated with the provision of local ecological services in this ecoregion due to the large human population and low amount of natural cover.

This ecoregion has very high biodiversity and threat scores. It also has a low number of protected areas. Although the ecoregion has approximately 42% natural cover, there is relatively low connectivity with the exception of larger habitat patches in the southern and northern sections (Figures J.4 and J.5). Both the human influence and watershed stresses are high throughout most of the ecoregion (Figures J.6 and J.7).

Key Facts

- Very high species richness, provincially rare species and globally rare species
- High richness of national species at risk
- Very high richness of unique species, including four endemic species
- Very high human footprint
- High watershed stress
- Moderate Conservation Risk Index due to 40% of the ecoregion remaining in natural cover
- Most of the natural cover is in small patches and the ecoregion has poor connectivity
- Only 3.7% of this ecoregion is currently protected, one of the lowest amounts in Canada
- The St. Lawrence River supports marine mammals such as Beluga
- Over 50% of Quebec's rare species occur in this ecoregion

Key Species for Conservation

- Copper redhorse: globally rare, endemic fish
- Victorin's gentian: globally rare, endemic plant
- Bogbean buckmoth: globally rare invertebrate
- Northern myotis: globally rare mammal
- 15 nationally endangered species

Protected Areas and Designations

Although only 3.7% of the St. Lawrence Lowlands ecoregion is protected, there are many small parks and protected areas (Figure J.3). There are only four protected areas in the ecoregion that are greater than 3,000 ha. Several large protected areas occur in adjacent ecoregions and extend into the St. Lawrence Lowlands. This ecoregion has three biosphere reserves and five RAMSAR wetlands. There are a large number of Important Bird Areas, mainly along the rich coastal areas of the St. Lawrence River. NCC has nine Natural Areas in this ecoregion and over half of the ecoregion has a NCC NACP. These Natural Areas include all of the sites with high numbers of nationally and globally rare species (Figures J.8 and J.9).

Protected Areas (top 10, by size)

1. Aire de concentration d'oiseaux aquatiques Îles de la Girodeau - Grande Île (4,398 ha)
2. Mer Bleue Conservation Area – National Capital Commission (3,605 ha)
3. Aire de concentration d'oiseaux aquatiques du Lac St-Louis (Centre du Lac) (3,183 ha)
4. Refuge de Nicolet - Habitat faunique (3,148 ha)
5. Nicolet Migratory Bird Sanctuary (2,939 ha)
6. Plaisance - Parc national du Québec (2,816 ha)
7. Upper Canada Bird Sanctuary (2,604 ha)
8. Cap Tourmente National Wildlife Area (2,319 ha)
9. Oka - Parc national du Québec (2,285 ha)
10. Aire de concentration d'oiseaux aquatiques du Fleuve Saint-Laurent (Îles de Verchères) (2,104 ha)

World Biosphere Reserves

Frontenac Arch, Lac-Saint-Pierre, Mont Saint-Hillaire

RAMSAR

Cap Tourmente, Lac Saint-François, Lac Sainte Pierre, Mer Bleue Conservation Area

Global IBAs

Anse de Saint-Vallier, Barrage de Beauharnois, Battures aux Loups Marins, Battures de Beauport and chenal de l'île d'Orléans, Canal de Beauharnois, Cap Tourmente, Kamouraska, L'Islet, Lac Deschenes-Ottawa River, Lac Saint-Louis and Iles-de-la-Paix, Montmagny, Nicolet et Baie-du-Febvre, Plaine Inondable de Saint-Barthelemy, Reserve faunique de Plaisance, Reserve nationale de faune des Iles de Contrecoeur, Reservoir Beaudet

NCC Natural Areas

- Bassin versant du Saint-Maurice
- Ceinture verte de Montréal
- Estuaire d'eau douce
- Frontenac Arch
- Haut-Saint-Laurent
- Îles du Fleuve Saint-Laurent
- Montagnes Vertes du Nord
- Ottawa Valley
- Richelieu-Yamaska

Potential Conservation Strategies (Goals)

- Increase natural cover from 42% to 50% by 2030
- Increase the cover of protected areas from 1.3% to 3% by 2030
- At least two SAR are downlisted based on recovery actions

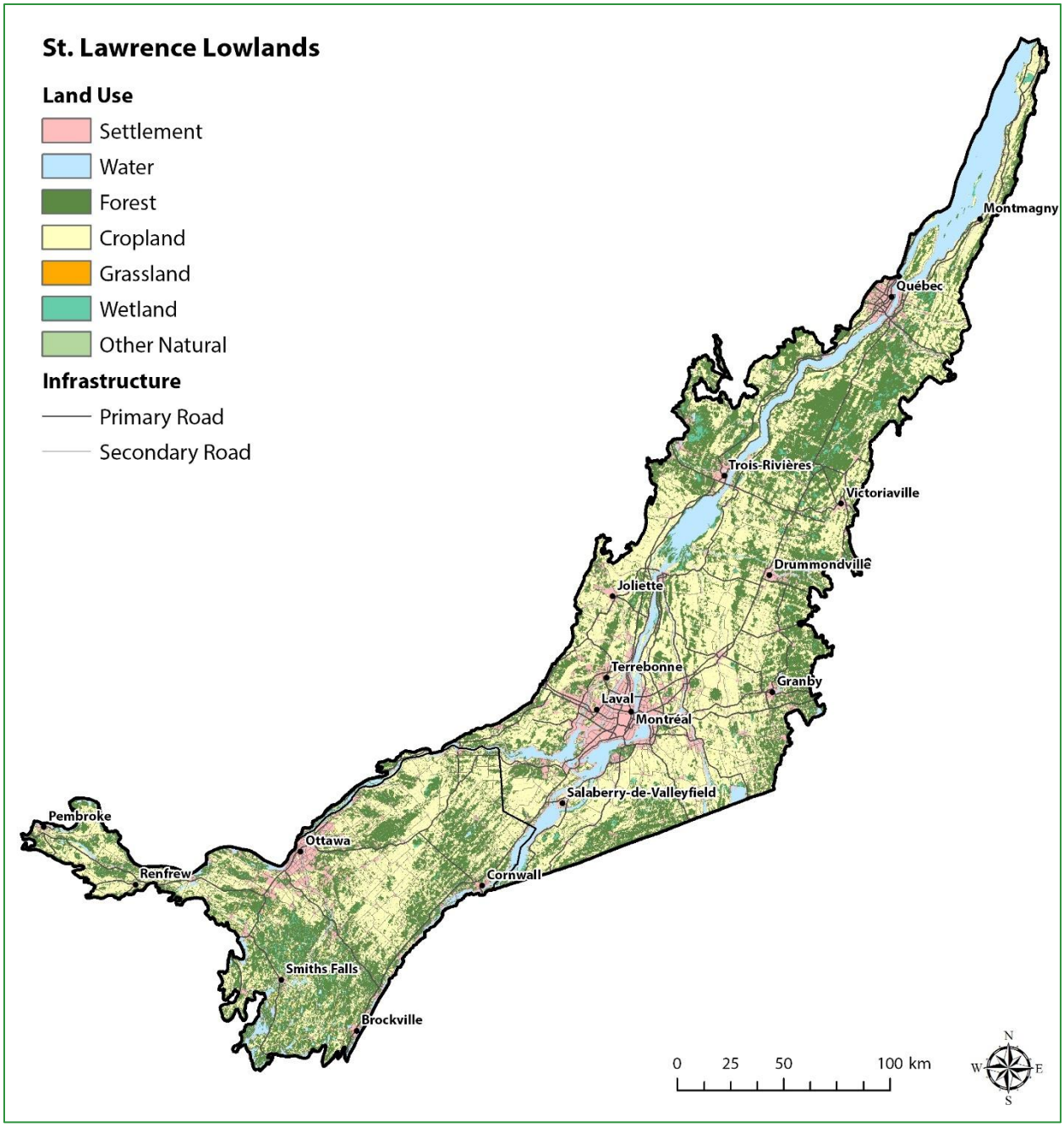

Figure J.2: Land Use

Approximately 42% of the ecoregion remains natural, primarily as deciduous and mixed forest. Natural land use is much higher in the southern portion of the ecoregion in Ontario on the limestone plain, and along the eastern edge where the St. Lawrence Lowlands borders the Appalachians.

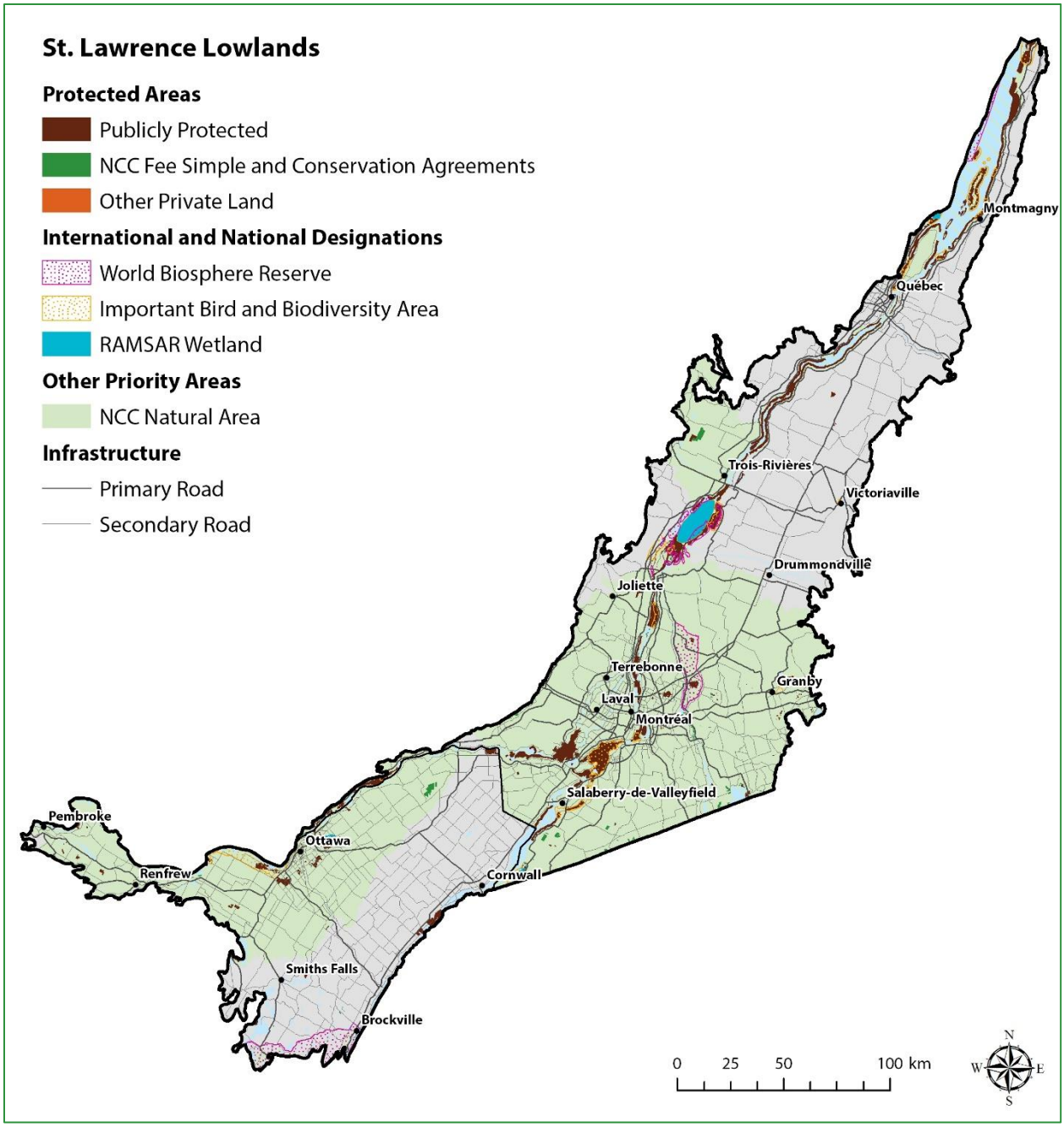

Figure J.3: Protected Areas

Only 3.7% of the ecoregion is protected. Most of the protected areas occur around the urban fringe of Montreal.

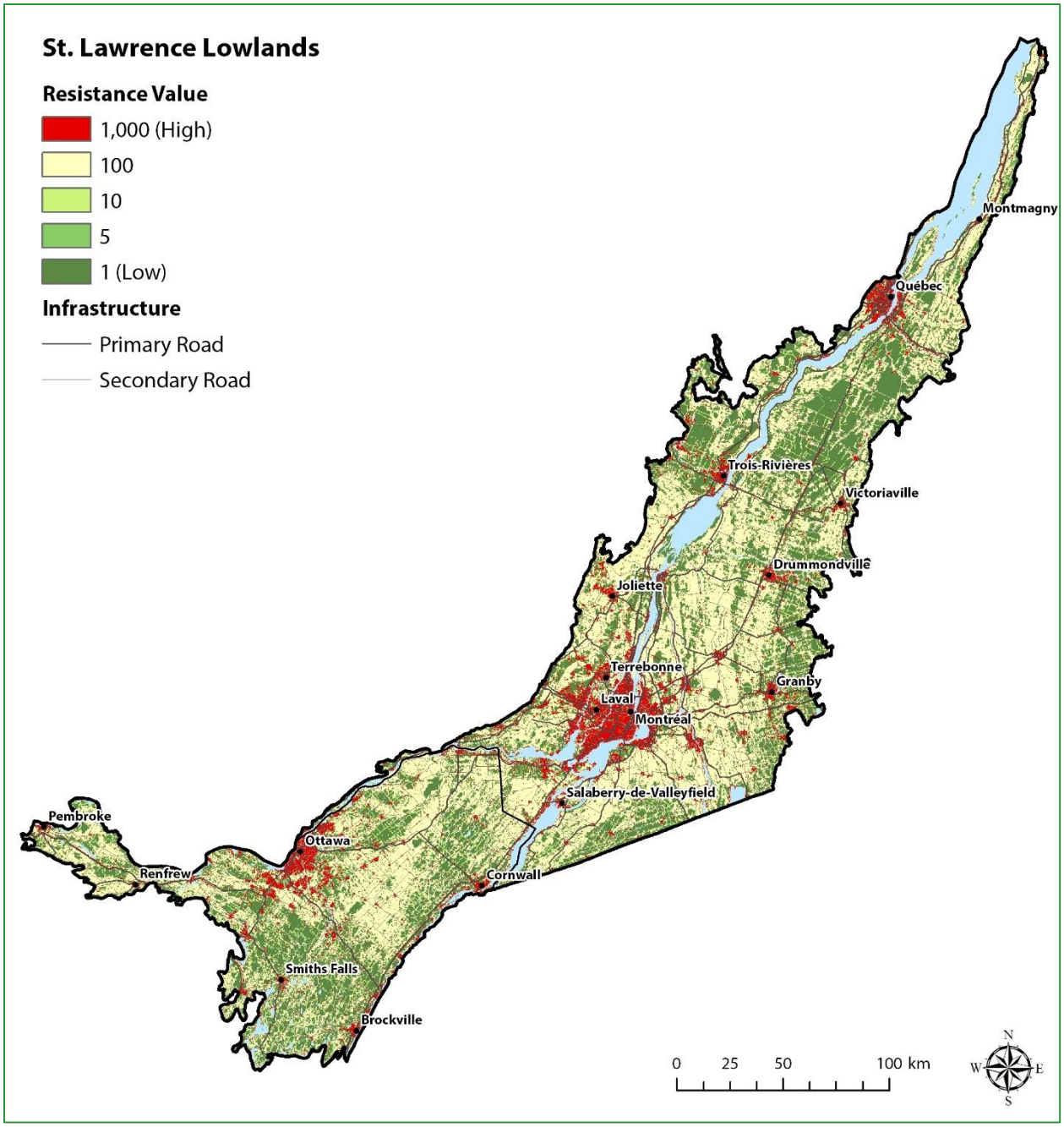

Figure J.4: Resistance values

Although this ecoregion has a relatively high resistance score (4), it does have areas of intact and connected habitat. Resistance values reflect land cover, and are lower in regions with more natural cover. Small, fragmented habitats characterize the regions along the St. Lawrence valley where deeper soils provide productive agricultural lands.

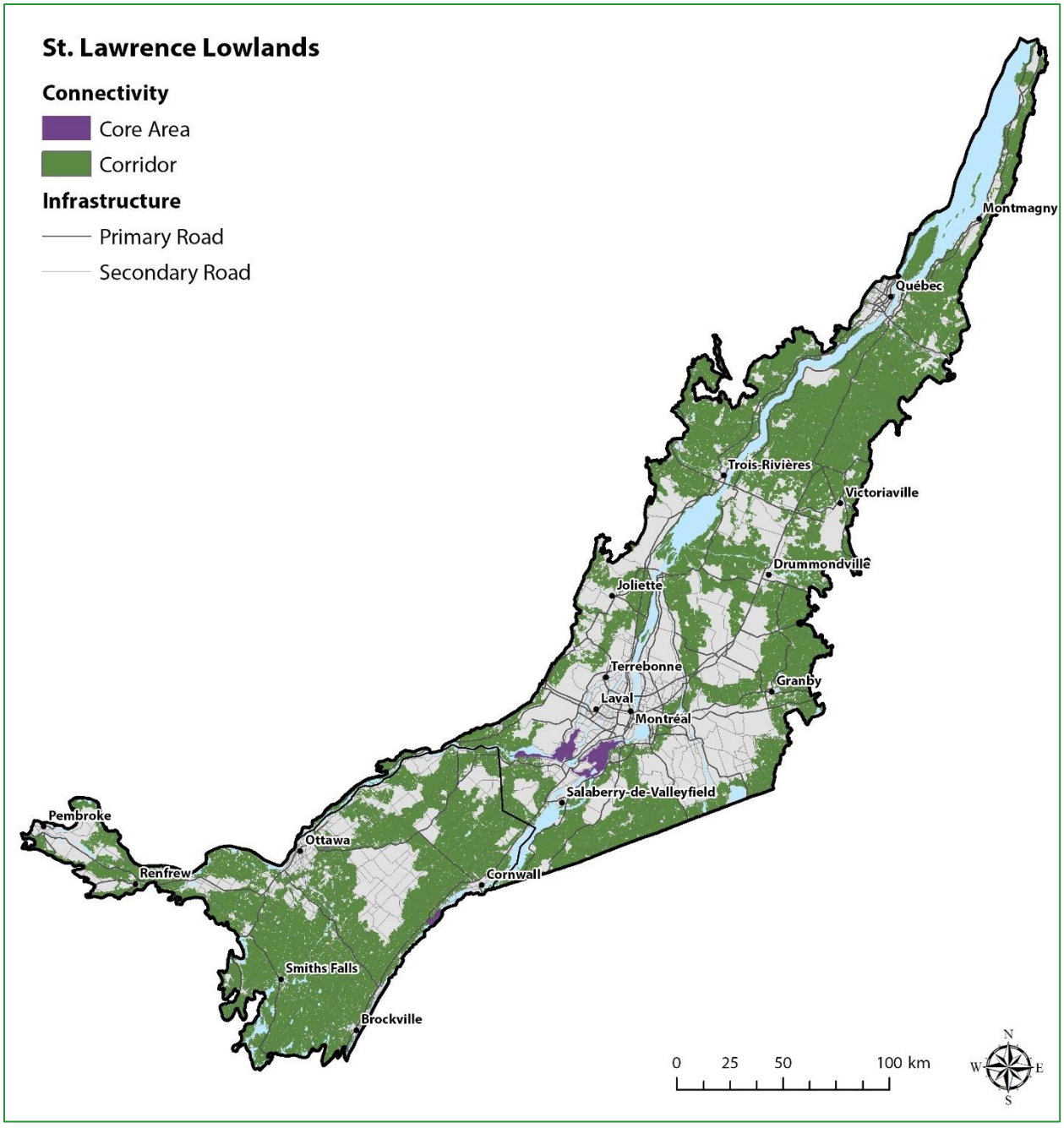

Figure J.5: Connectivity

Areas of higher connectivity in the southern portion near Brockville (part of the Algonquin to Adirondack corridor), near Cornwall and north of Victorville are important north-south linkages that provide corridors between the Canadian Shield and forests in New York State. There are limited corridors along the St. Lawrence River.

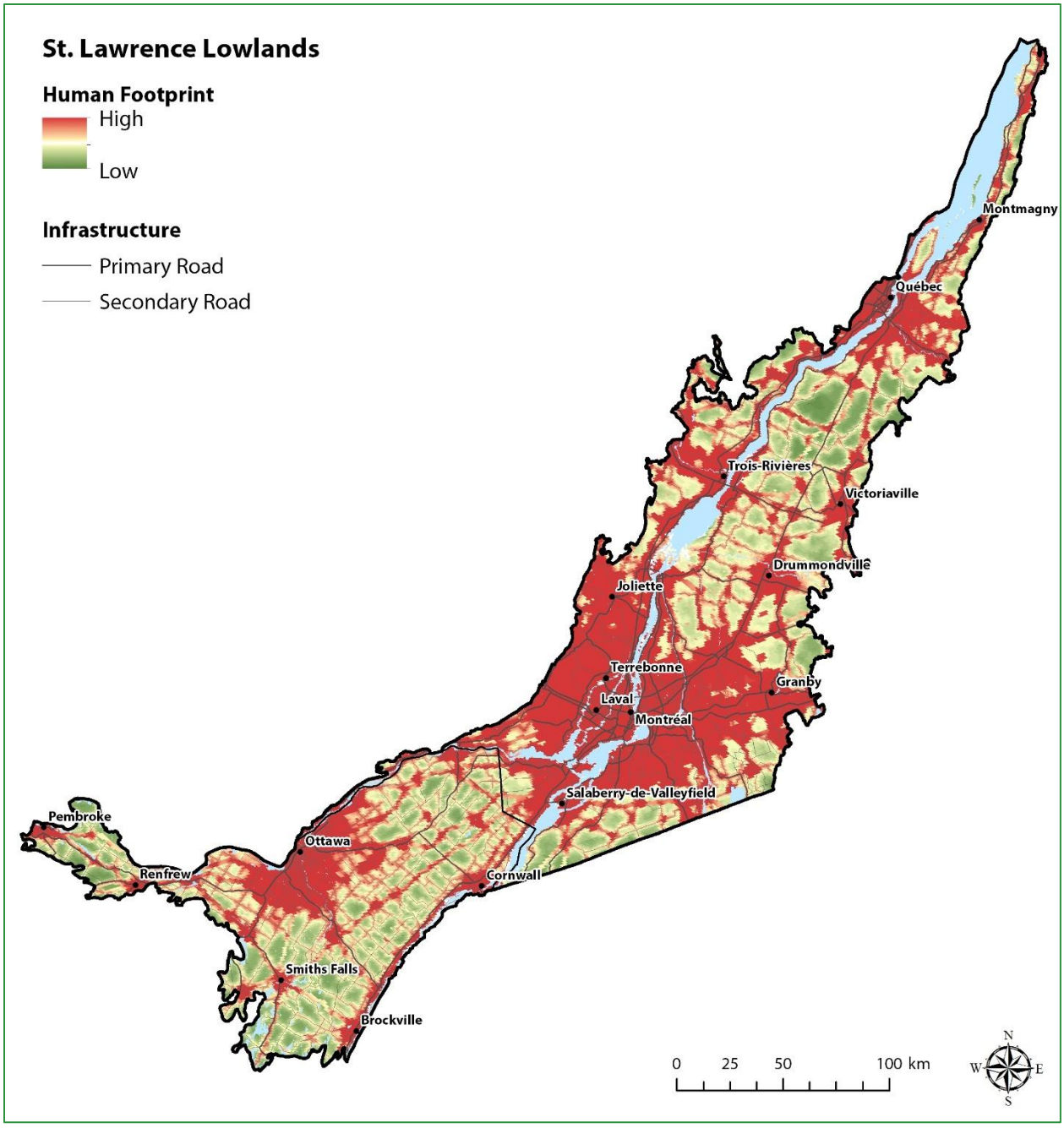

Figure J.6: Human Footprint

Much of this ecoregion is characterized by a high human footprint because of large urban areas and extensive agricultural lands. Many of the largest protected areas are in areas of higher human footprint. Some of the areas with a low human footprint may have impacts that are not depicted because of the scale of the analysis or because of impacts that could not be incorporated into the analysis (e.g. invasive species).

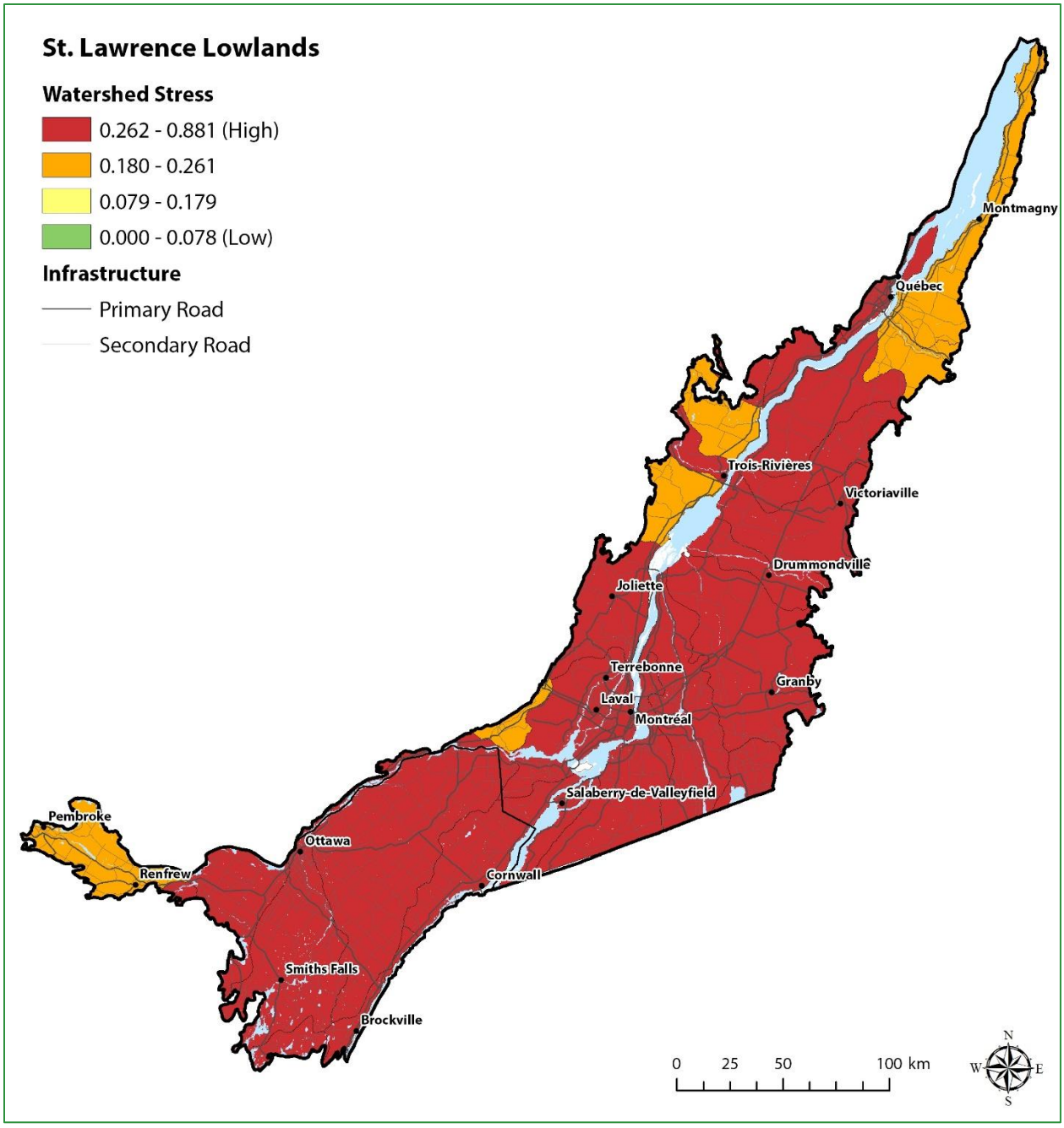

Figure J.7: Watershed Stress

This ecoregion has a very high watershed stress due to the extensive urban and agricultural areas.

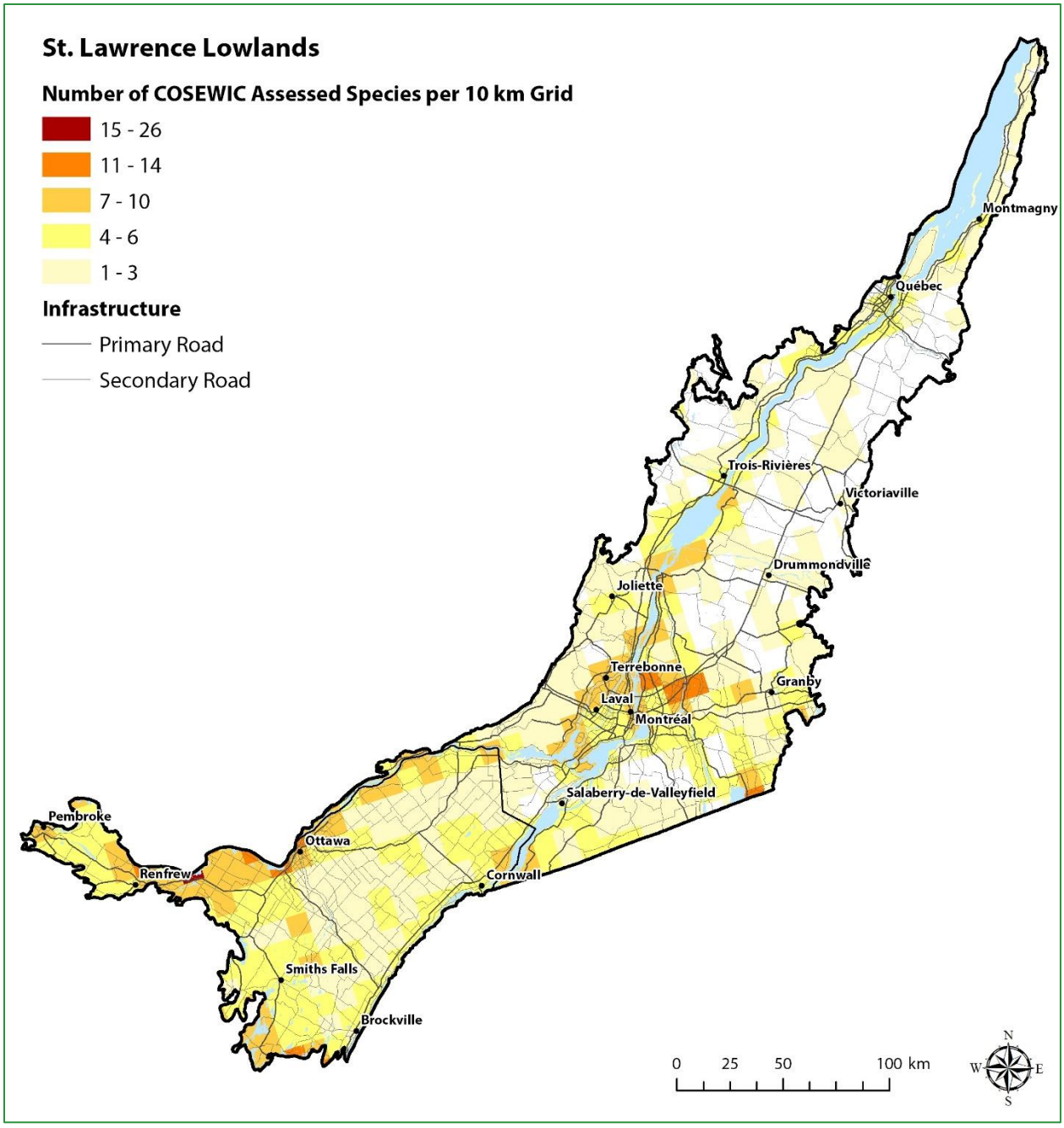

Figure J.8: Number of COSEWIC Assessed Species

The highest numbers of species assessed as at risk by COSEWC that occur along the St. Lawrence River corridor, with the highest concentration near the city of Montreal.

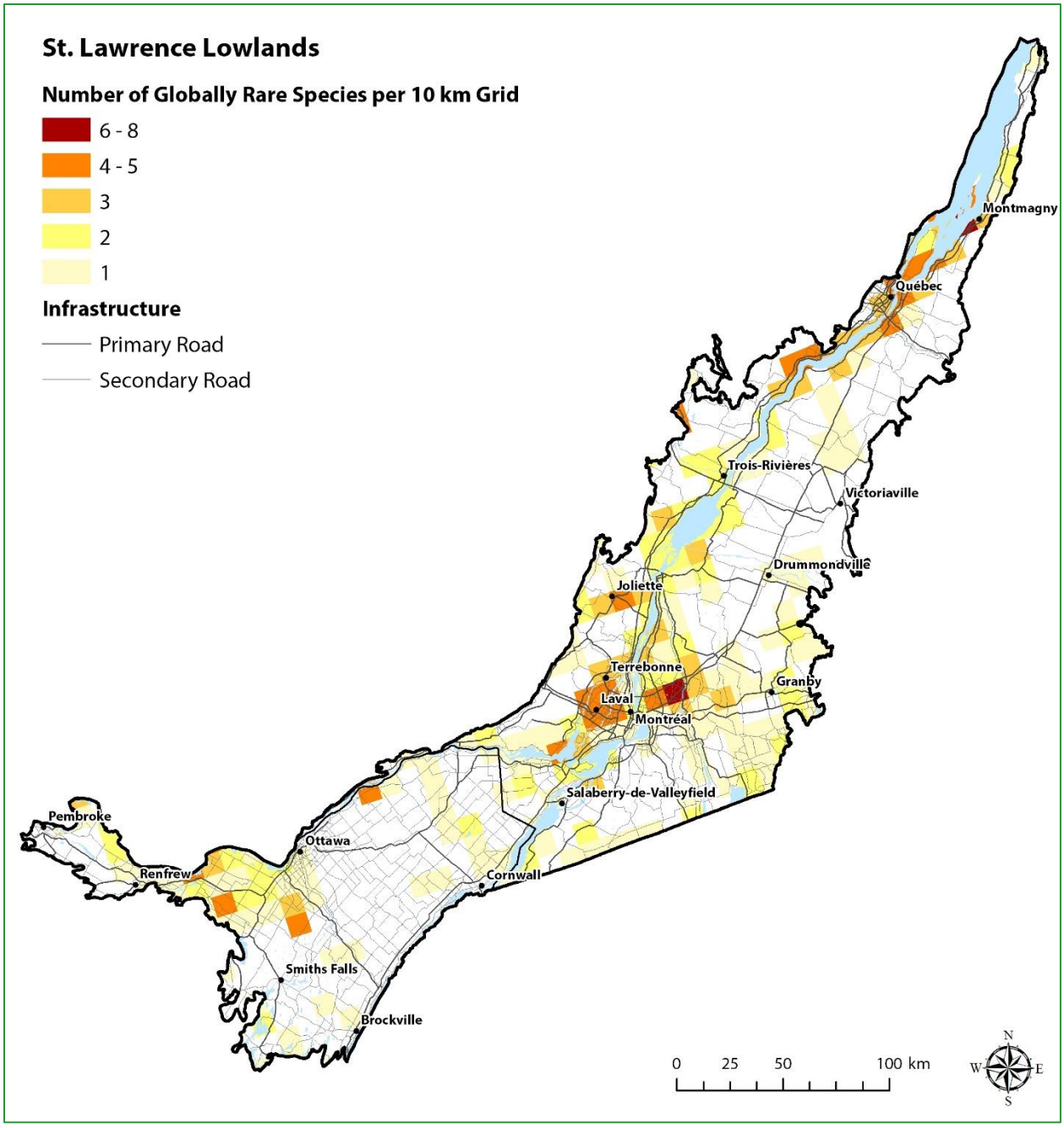

Figure J.9: Globally rare species

Globally rare species are generally concentrated along the St. Lawrence and Ottawa River corridors. The estuary region around Quebec City and Montmagmy has very high numbers of globally rare species. It is a Canadian hotspot for globally imperiled species, including several endemics.

Table J.1: Land use change matrix for the St. Lawrence Lowlands, 2000-2010

			Change To 2010 (km²)															Total (From)	Percent (%) of Total Change
	Land Use Class	Code	11	21	25	31	41	42	45	46	51	61	62	71	73	74	91		
Change From 2000 (km²)	Unclassified	11		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
	Settlement	21	0		402.8	17.4	93.0	1.4	8.4	1.3	185.9	0	1.2	3.1	2.1	1.0	3.5	721.07	*16.7*
	Roads	25	0	427.8		6.0	87.3	1.6	4.8	1.0	214.2	0	0.7	3.0	2.0	0.8	2.6	751.82	*17.4*
	Water	31	0	17.8	6.0		43.7	4.8	6.4	2.2	22.5	0	0.1	8.0	2.7	2.2	0.5	116.91	*2.7*
	Forest	41	0	242.4	142.7	44.6		47.9	3.7	11.9	428.8	0	7.4	44.8	22.5	6.0	5.4	1,007.98	*23.4*
	Forest Wetland	42	0	2.9	2.3	4.6	47.6		2.0	0.1	3.2	0	0.1	8.8	27.3	11.2	0.0	110.12	*2.6*
	Trees	45	0	20.0	6.7	6.1	0	2.0		1.0	44.1	0	0.9	3.0	1.3	0.8	0.4	86.14	*2.0*
	Treed Wetland	46	0	2.1	1.1	2.3	11.8	0.0	1.1		7.2	0	0.1	2.5	5.1	2.7	0.1	36.11	*0.8*
	Cropland	51	0	365.3	280.6	23.4	413.4	3.4	43.7	7.8		0	7.8	13.9	5.8	4.8	8.7	1,178.50	*27.3*
	Grassland Managed	61	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	*0*
	Grassland Unmanaged	62	0	2.0	0.9	0.1	7.1	0.1	0.8	0.1	8.4	0		0.5	0.2	0.1	0.4	20.57	*0.5*
	Wetland	71	0	6.0	4.4	8.1	44.6	8.1	2.9	2.4	15.0	0	0.7		12.1	3.0	0.4	107.50	*2.5*
	Wetland Shrub	73	0	4.3	2.4	2.8	22.8	27.4	1.3	5.2	6.0	0	0.2	12.1		15.2	0.2	99.85	*2.3*
	Wetland Herb	74	0	2.2	1.1	2.3	6.0	11.0	0.8	2.7	4.8	0	0.1	3.0	15.3		0.1	49.29	*1.1*
	Other	91	0	7.2	3.7	0.5	5.4	0.0	0.4	0.1	8.9	0	0.4	0.4	0.2	0.1		27.29	*0.6*
Total (To)			0	1,100.0	854.7	118.1	782.7	107.6	76.3	35.7	949.0	0	19.5	103.2	96.3	47.7	22.3	4,313.15	
Net Change (To-From)			0	378.9	102.9	1.2	-225.3	-217.7	-9.8	-0.4	-229.5	0	-1.0	-4.3	-3.5	-1.6	-5.0		
Percent (%) of Total Change			0	25.5	19.8	2.7	18.1	2.5	1.8	0.8	22.0	0	0.5	2.4	2.2	1.1	0.5		
Net Gain/Loss %			0	8.8	2.4	0.0	-5.2	-0.1	-0.2	-0.01	-5.3	0	-0.02	-0.1	-0.1	-0.04	-0.1		

** Diagonal represents unchanged land use*

LIST OF ACRONYMS

AAFC	Agriculture and Agri-Food Canada
CARTS	Conservation Areas Reporting and Tracking System
CBD	Convention on Biological Diversity
CCEA	Canadian Council on Ecological Areas
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRI	Conservation Risk Index
DEM	Digital Elevation Model
DUC	Ducks Unlimited Canada
ECCC	Environment and Climate Change Canada
ERA	Ecoregional Assessment
GFWC	Global Forest Watch Canada
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
MHT	Major Habitat Type
MODIS	Moderate Resolution Imaging Spectroradiometer
NACP	Natural Area Conservation Plan
NALCMS	North American Land Change Monitoring System
NCC	Nature Conservancy of Canada
NGO	Non-governmental Organization
SAR	Species at risk
SARA	*Species at Risk Act*
WWF	World Wildlife Fund