



Atlantic Maritime Ecozone⁺ **evidence for key findings summary**

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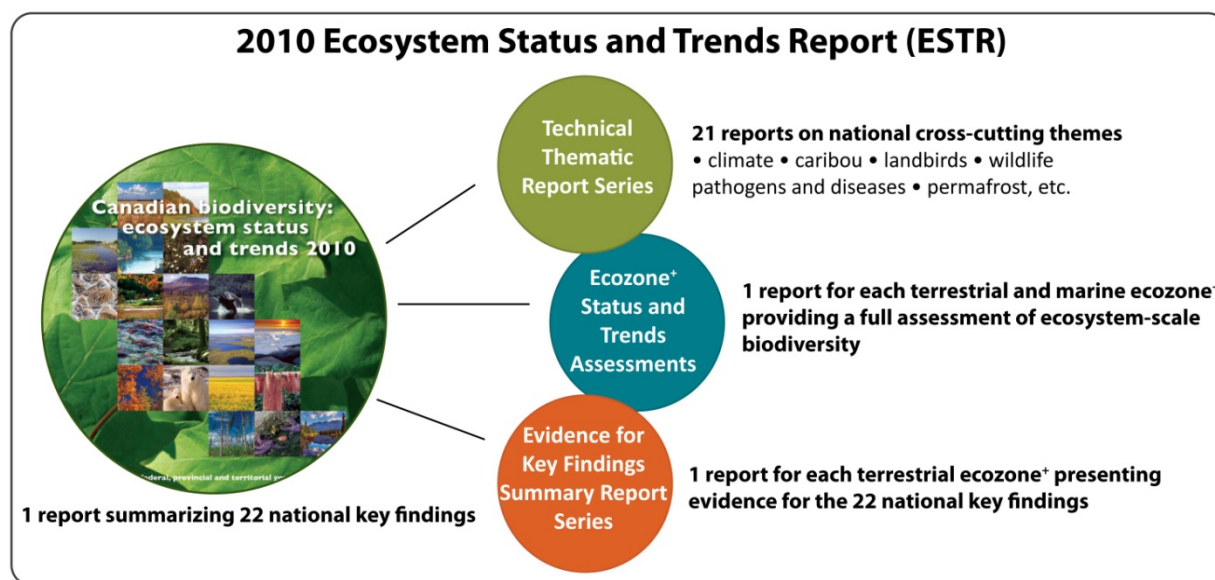
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PREFACE

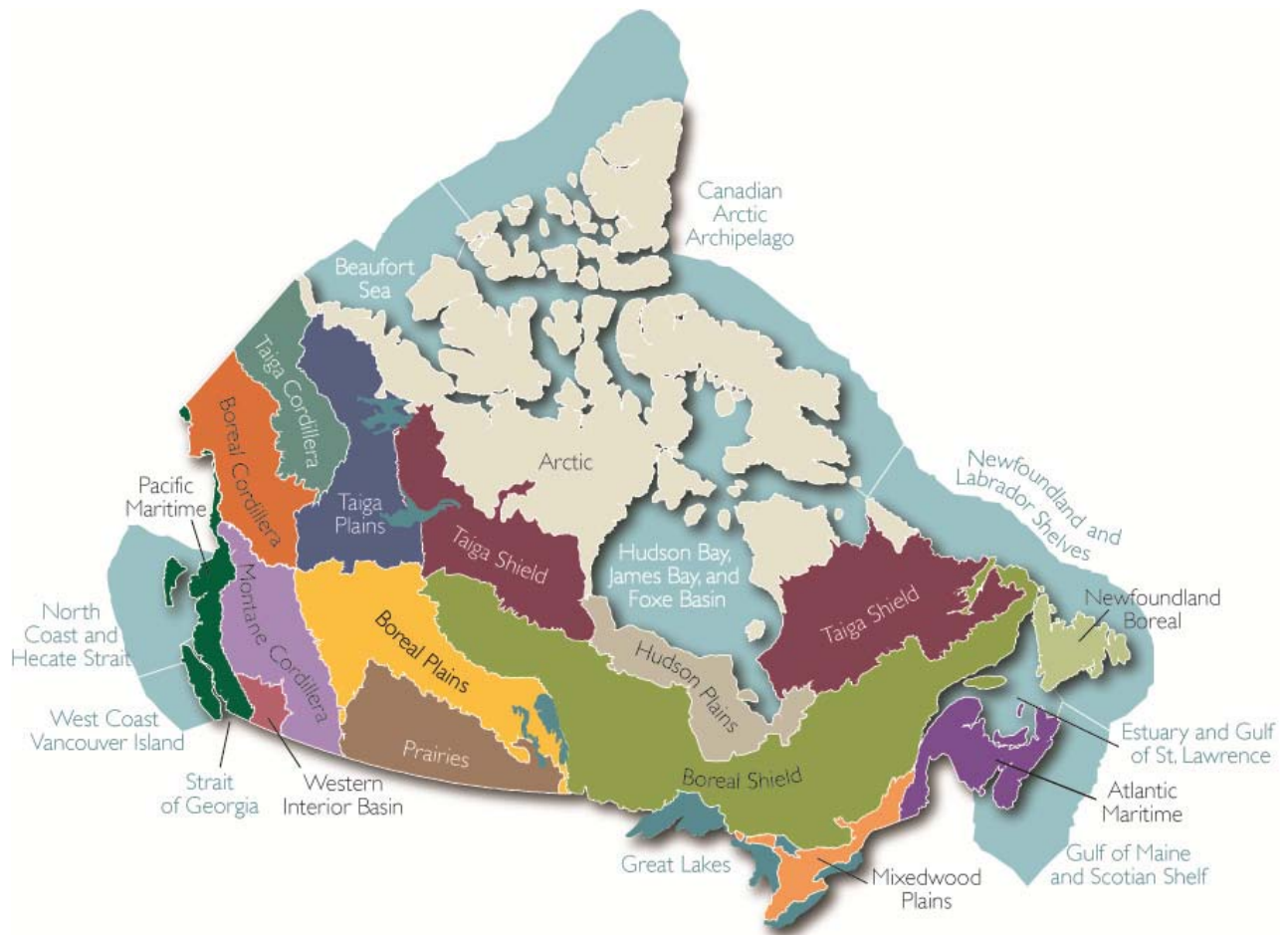
The Canadian Councils of Resource Ministers developed a Biodiversity Outcomes Framework¹ in 2006 to focus conservation and restoration actions under the *Canadian Biodiversity Strategy*.² *Canadian Biodiversity: Ecosystem Status and Trends 2010*³ was the first report under this framework. It presents 22 key findings that emerged from synthesis and analysis of background technical reports prepared on the status and trends for many cross-cutting national themes (the Technical Thematic Report Series) and for individual terrestrial and marine ecozones⁺ of Canada (the Ecozone⁺ Status and Trends Assessment Report Series). More than 500 experts participated in data analysis, writing, and review of these foundation documents. Summary reports were also prepared for each terrestrial ecozone⁺ to present the ecozone⁺-specific evidence related to each of the 22 national key findings (the Evidence for Key Findings Summary Report Series). Together, the full complement of these products constitutes the 2010 Ecosystem Status and Trends Report (ESTR).



This report, *Atlantic Maritime Ecozone⁺ Evidence for Key Findings Summary*, presents evidence from the *Atlantic Maritime Ecozone⁺ Status and Trends Assessment*⁴ related to the 22 national key findings and highlights important trends specific to this ecozone⁺. It is not a comprehensive assessment of all ecosystem-related information. The level of detail presented on each key finding varies and important issues or datasets may have been missed. Also, because of the report's timing or a lack of readily available ecozone⁺-specific information, some key findings were not addressed. Some emphasis has been placed on information from the national Technical Thematic Report Series. As in all ESTR products, the time frames over which trends are assessed vary—both because time frames that are meaningful for these diverse aspects of ecosystems vary and because the assessment is based on the best available information, which is over a range of time periods.

Ecological classification system – ecozones⁺

A slightly modified version of the Terrestrial Ecozones of Canada, described in the *National Ecological Framework for Canada*,⁵ provided the ecosystem-based units for all reports related to this project. Modifications from the original framework include: adjustments to terrestrial boundaries to reflect improvements from ground-truthing exercises; the combination of three Arctic ecozones into one; the use of two ecoprovinces—Western Interior Basin and Newfoundland Boreal; the addition of nine marine ecosystem-based units; and, the addition of the Great Lakes as a unit. This modified classification system is referred to as “ecozones” throughout these reports to avoid confusion with the more familiar “ecozones” of the original framework.⁶ The boundary for the Atlantic Maritime is the same in both frameworks.



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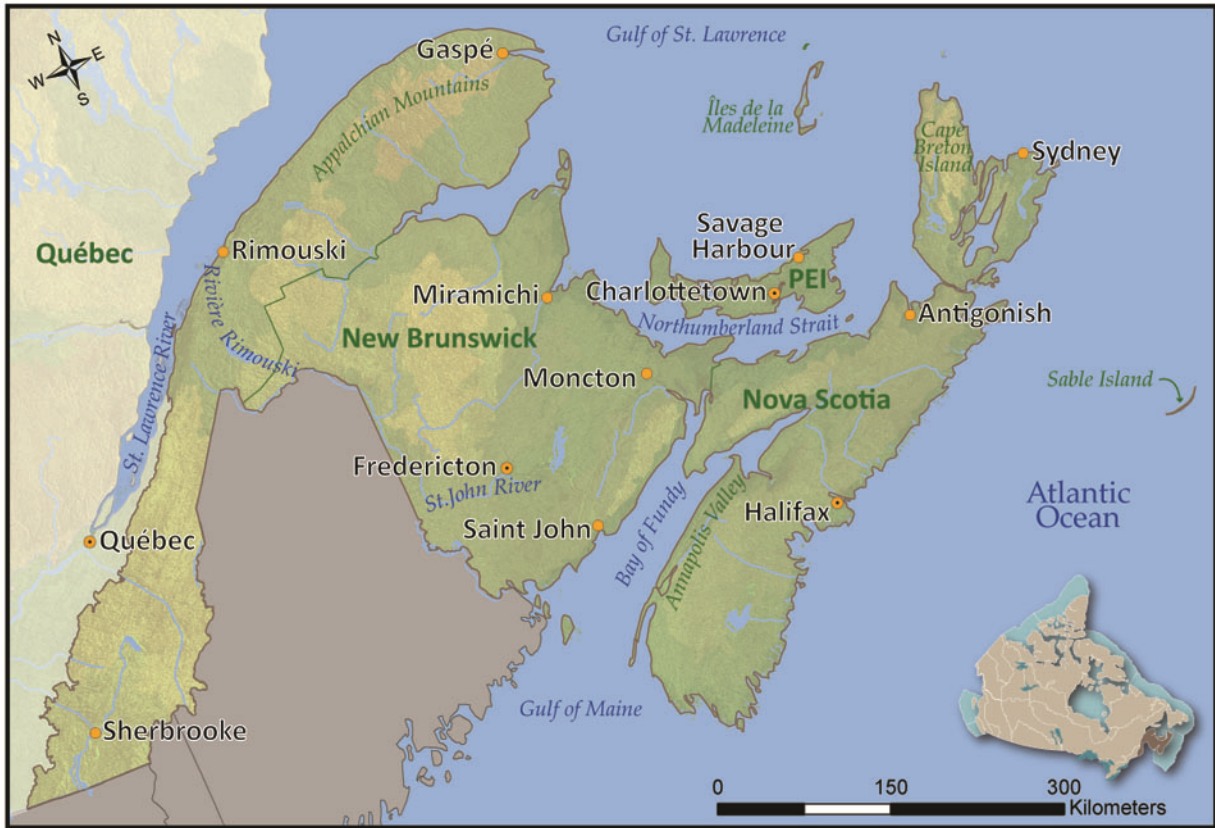


Figure 1. Overview map of the Atlantic Maritime Ecozone*.

ECOZONE⁺ BASICS

The Atlantic Maritime Ecozone⁺ (AME) (Figure 1) is located on the southern Atlantic coastline of Canada and fully encompasses the three Canadian Maritime provinces as well as a portion of southern Quebec (see national map on page ii).

The AME is a diverse landscape characterized by several types of forest, rocky shorelines, agricultural lands, lakes, and rivers. The ocean’s proximity has a tremendous influence on the area’s physical features and climate and plays an important role in shaping its ecosystems.

Table 1 provides a summary of the main features of the ecozone⁺.

Table 1. Atlantic Maritime Ecozone⁺ overview.

Area	205,836 km ² (2.1% of Canada)
Topography	Dominated by two features: the northern extension of the Appalachian Mountains and the coastal lowlands of the Northumberland Plain
Climate	Cool, moist maritime climate
River basins	St. Lawrence, St. Mary’s, and Miramichi rivers flowing to the Atlantic Ocean Saint John River is the largest inland river
Geology	Landscape built by millions of years of volcanic and tectonic activity, mountain building, erosion, sedimentation, and several major glaciations Mix of sedimentary and igneous bedrock Surficial materials are 70% till
Settlement	Majority of population located along low-lying coast Major settlements include Halifax, Saint John, Moncton, Fredericton, Charlottetown, Rimouski, and Sherbrooke
Economy	Resource-based industry (forestry, agriculture, fishing, mining) Service industry Some manufacturing
Development	Intensive development limited to major coastal communities Oil and gas development increasing offshore
National/global significance	Seven Canadian national parks or national park reserves (R): Cape Breton Highlands, Prince Edward Island, Fundy, Kejimikujik, Kouchibouguac, Forillon, and Sable Island (R) Thirteen National Wildlife Areas: Boot Island, John Lusby Marsh, Chignecto, Sand Pond, Sea Wolf Island, Wallace Bay, Cape Jourimain, Portage Island, Portobello Creek, Shepody, Tintamarre, Pointe-au-Père, and Îles de l’Estuaire Two biosphere reserves: Fundy and Southwest Nova Eight Ramsar sites (wetlands of international significance): Baie de l’Isle-Verte, Chignecto, Musquodoboit Harbour, Southern Bight Minas Basin, Malpeque Bay, Mary’s Point, Shepody Bay, and Tabusintac Lagoon and River Estuary Three Western Hemisphere Shorebird Reserve Network sites: Mary’s Point, Shepody Bay, and Southern Bight–Minas Basin One World Heritage Site: Miguasha National Park of Quebec (Devonian fossil beds) Highest tides in the world in the Bay of Fundy

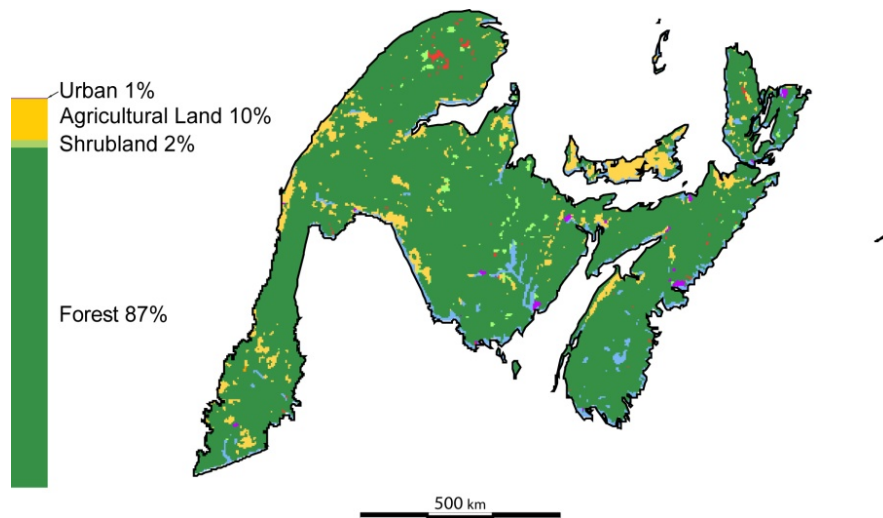


Figure 2. Land cover of the Atlantic Maritime Ecozone⁺, 2005.ⁱ
Source: Ahern *et al.*, 2011⁷ using data from Latifovic and Pouliot, 2005⁸

Jurisdictions: The AME includes the provinces of New Brunswick (NB), Nova Scotia (NS), and Prince Edward Island (PEI), and the Gaspé Peninsula, Îles-de-la-Madeleine, and part of the southern shore of the St. Lawrence River in Quebec. Major Aboriginal groups in this ecozone⁺ include the Mi'kmaq, Maliseet (of NB), Malécite (of QC), and Abenaki.

Population: Between 1971 and 2006, the human population increased from approximately 2.27 to 2.55 million (Figure 3), but has been generally stable since 1991. The majority of the population is found in its river valleys and along its low-lying coast.^{9, 10} There has been a significant migration of people from rural to urban areas.¹¹

Based on 2005 remote sensing data, forest is the predominant land cover type representing over 85% of the total area, followed by agricultural land at just over 10% (Figure 2).^{ii, 7}

ⁱ Using remote sensing data, Ahern *et al.*⁷ classified land cover into nine possible classes: Forest (tree crown density >10%), Shrubland (tree crown density <10%, shrub cover >40%), Grassland (tree or shrub cover on <10% of the land, herbaceous vegetation present), Agricultural Land (includes cropland and cropland/woodland); Low Vegetation and Barren (shrubs <40%), Fire Scars, Urban, Snow/ice/glacier (permanent ice or snow), and Inland Water. See Ahern *et al.*⁷ for further details.

ⁱⁱ Statistics for the amount of each land cover type may differ from statistics used in other parts of this report, for example the agricultural land section. This is due to a combination of the inventory method used, the scale of the data used, and different classification schemes for land cover types.

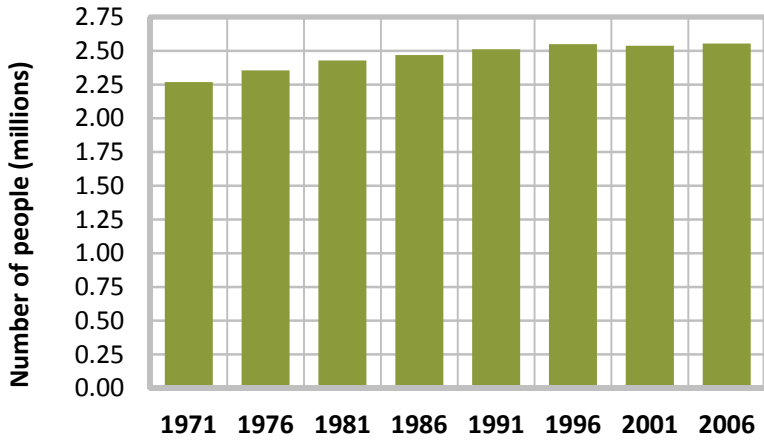


Figure 3. Human population of the Atlantic Maritime Ecozone⁺, 1971–2006.
 Source: Environment Canada, 2009¹²



Cape Breton Highlands National Park, Nova Scotia
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*Cavendish Beach, Prince Edward Island National Park
© Parks Canada*



*Peskawa Lake, Kejimikujik National Park, Nova Scotia
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*Coastal marsh in Lord Selkirk Provincial Park,
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KEY FINDINGS AT A GLANCE: NATIONAL AND ECOZONE⁺ LEVEL

Table 2 presents the national key findings from *Canadian Biodiversity: Ecosystem Status and Trends 2010*³ together with a summary of the corresponding trends in the AME. Topic numbers refer to the national key findings in *Canadian Biodiversity: Ecosystem Status and Trends 2010*. Topics that are greyed out were identified as key findings at a national level but were either not relevant or not assessed for this ecozone⁺ and do not appear in the body of this document. Evidence for the statements that appear in this table is found in the subsequent text organized by key finding. For many topics, additional supporting information can be found in the *Atlantic Maritime Ecozone⁺ Status and Trends Assessment*.⁴ See the Preface on page i.

Table 2. Key findings overview.

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE ⁺
THEME: BIOMES		
1. Forests	At a national level, the extent of forests has changed little since 1990; at a regional level, loss of forest extent is significant in some places. The structure of some Canadian forests, including species composition, age classes, and size of intact patches of forest, has changed over longer time frames.	Forests cover approximately 80% of the AME. Historically, land clearing for agriculture and urban areas has reduced the extent of forests, including conversion of 70% of PEI's forests. No significant change in the extent of forests was found between 1985 and 2005. Although observed trends varied among regions, there was a shift from older to younger stands. Forest composition has shifted to simpler, less diverse forests as a result of forest clearing and re-growth, forestry, and natural disturbances. Intact forests larger than 50 km ² cover only 5% of the AME.
2. Grasslands	Native grasslands have been reduced to a fraction of their original extent. Although at a slower pace, declines continue in some areas. The health of many existing grasslands has also been compromised by a variety of stressors.	Not relevant

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE⁺
3. Wetlands	High loss of wetlands has occurred in southern Canada; loss and degradation continue due to a wide range of stressors. Some wetlands have been or are being restored.	Wetlands cover 3.5% of the AME. It is not possible to determine trends in wetland extent over the entire AME, however, approximately 16–18% of freshwater wetlands in Nova Scotia were lost between European settlement and 1998. Many wetlands in the AME remain under continued threat of loss and degradation due to industrial and urban development, port expansion, cottage subdivisions, and agriculture. However, each of the four provinces have wetland conservation or similar policies that have mitigated the impacts of development projects and land-use decisions to some degree.
4. Lakes and rivers	Trends over the past 40 years influencing biodiversity in lakes and rivers include seasonal changes in magnitude of stream flows, increases in river and lake temperatures, decreases in lake levels, and habitat loss and fragmentation.	Between 1961–1982 and 1983–2003, changes in river flows included earlier onsets of spring freshet and decreased summer flows (low period from August to October). From 1970 to 2005, both minimum and maximum flows decreased at a high proportion of sites and minimum flows occurred later in the year. Dams have led to the local and regional extirpations of several plant, fish, and shellfish species.
5. Coastal	Coastal ecosystems, such as estuaries, salt marshes, and mud flats, are believed to be healthy in less-developed coastal areas, although there are exceptions. In developed areas, extent and quality of coastal ecosystems are declining as a result of habitat modification, erosion, and sea-level rise.	Coastal habitats have suffered significant losses and degradation as a result of human activities including industrial and urban development and cottage subdivisions. Coastal wetland loss and fragmentation is one of the most severe cases of wetland loss in Canada with 65% loss since the beginning of European settlement. Significant losses in beach and dune ecosystems have also been documented. Sea-level rise and increases in the frequency and intensity of storm surge events may increase erosion and flooding. Some species dependent upon coastal habitats, such as shorebirds, have also declined.

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE⁺
6. Marine	Observed changes in marine biodiversity over the past 50 years have been driven by a combination of physical factors and human activities, such as oceanographic and climate variability and overexploitation. While certain marine mammals have recovered from past overharvesting, many commercial fisheries have not.	Not relevant. Marine ecozones ⁺ are assessed in other ESTR reports.
7. Ice across biomes	Declining extent and thickness of sea ice, warming and thawing of permafrost, accelerating loss of glacier mass, and shortening of lake-ice seasons are detected across Canada's biomes. Impacts, apparent now in some areas and likely to spread, include effects on species and food webs.	There is a lack of long-term records for river and lake ice break-up and freeze-up. Available information showed no clear trends. There was a non-significant tendency toward decreasing sea ice cover and in the length of the ice season on the St. Lawrence River from 1971 to 2005.
THEME: HUMAN/ECOSYSTEM INTERACTIONS		
8. Protected areas	Both the extent and representativeness of the protected areas network have increased in recent years. In many places, the area protected is well above the United Nations 10% target. It is below the target in highly developed areas and the oceans.	In 2009, almost 11,000 km ² (5.3%) of the AME was protected, an increase from just over 3,000 km ² (1.6%) in 1992. This includes 10,963 km ² (4.9%) protected as IUCN categories I–IV.
9. Stewardship	Stewardship activity in Canada is increasing, both in number and types of initiatives and in participation rates. The overall effectiveness of these activities in conserving and improving biodiversity and ecosystem health has not been fully assessed.	Trends in stewardship activities were not assessed for the AME for this current assessment thus this key finding is not included in this summary.
10. Invasive non-native species	Invasive non-native species are a significant stressor on ecosystem functions, processes, and structure in terrestrial, freshwater, and marine environments. This impact is increasing as numbers of invasive non-native species continue to rise and their distributions continue to expand.	Because it has many ocean ports, the AME has been a point of entry for many invasive non-native species, which are a threat to native biodiversity. Introduced invasive species have altered wetlands and coastal ecosystems, while invasive non-native insects and diseases have impacted forest ecosystems. Trend data do not exist for many species.

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE⁺
11. Contaminants	Concentrations of legacy contaminants in terrestrial, freshwater, and marine systems have generally declined over the past 10 to 40 years. Concentrations of many emerging contaminants are increasing in wildlife; mercury is increasing in some wildlife in some areas.	While relevant, contaminant trends were not assessed so this key finding is not included in this summary.
12. Nutrient loading and algal blooms	Inputs of nutrients to both freshwater and marine systems, particularly in urban and agriculture-dominated landscapes, have led to algal blooms that may be a nuisance and/or may be harmful. Nutrient inputs have been increasing in some places and decreasing in others.	Croplands in the AME have high levels of residual soil nitrogen and levels have increased from 1981 to 2006. As a result, the potential for leaching of nitrate out of soils and into water is high. A corresponding increase in nitrates has been found in ground and surface water in PEI. From 2002 to 2008, 18 estuaries had recurring anoxic events. Risk of surface water contamination from soil phosphorus has gradually shifted from lower to higher risk classes since 1991, with a higher proportion of cropland exceeding threshold values. In part of the Quebec portion of the AME, the number of lakes and rivers with algal blooms increased from three to 16 lakes between 2004 and 2008.
13. Acid deposition	Thresholds related to ecological impact of acid deposition, including acid rain, are exceeded in some areas, acidifying emissions are increasing in some areas, and biological recovery has not kept pace with emission reductions in other areas.	Parts of the AME are highly sensitive to acid. Levels of sulphate and nitrate deposition decreased substantially between 1990 and 2004. Nevertheless, from 1999 to 2003, atmospheric sulphur and nitrogen deposition exceeded the critical load in several areas. The AME is North America's most heavily affected region in terms of the percentage of fish habitat lost due to acid rain with many rivers in Nova Scotia no longer supporting salmon.
14. Climate change	Rising temperatures across Canada, along with changes in other climatic variables over the past 50 years, have had both direct and indirect impacts on biodiversity in terrestrial, freshwater, and marine systems.	Between 1950 and 2007, summer temperatures increased by 1.1°C and precipitation increased 18.6% in fall. The number of days with precipitation increased in spring, summer, and fall. Future climate predictions include increased air and water temperatures, a longer growth season, and less sea ice cover in the Gulf of St. Lawrence as well as changes in storm intensity and frequency, and forest composition.

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE⁺
15. Ecosystem services	Canada is well endowed with a natural environment that provides ecosystem services upon which our quality of life depends. In some areas where stressors have impaired ecosystem function, the cost of maintaining ecosystem services is high and deterioration in quantity, quality, and access to ecosystem services is evident.	Important ecosystem goods and services in the AME include forest products, water, food production, fishing, hunting, wastewater assimilation, and tourism. The combined estimated value of ecosystem goods and services for the Atlantic provinces (excluding the Quebec portion of the AME) is over \$4.7 billion.
THEME: HABITAT, WILDLIFE, AND ECOSYSTEM PROCESSES		
16. Agricultural landscapes as habitat	The potential capacity of agricultural landscapes to support wildlife in Canada has declined over the past 20 years, largely due to the intensification of agriculture and the loss of natural and semi-natural land cover.	Although wildlife habitat capacity on agricultural landscapes remained high, it declined significantly between 1986 and 2006 due to expansion of cropland onto cover types that are less supportive of wildlife. Cropland in the AME has some of the highest erosion risk on agricultural land in Canada due to intensive tillage and a climate that poses a high threat of water erosion in some areas. However, soil erosion risk declined from 1981 to 2006.
17. Species of special economic, cultural, or ecological interest	Many species of amphibians, fish, birds, and large mammals are of special economic, cultural, or ecological interest to Canadians. Some of these are declining in number and distribution, some are stable, and others are healthy or recovering.	The Atlantic-Gaspésie population of the woodland caribou was reassessed in 2002 and its status updated from Threatened to Endangered. Moose populations have declined while white-tailed deer populations have expanded. The Bay of Fundy populations of Atlantic salmon face imminent extinction. Trends in other populations of Atlantic salmon were mixed, although many have declined. All landbirds, except forest birds, declined from the 1970s to the 2000s, with the greatest declines in bird assemblages of grassland habitats and other open habitats.
18. Primary productivity	Primary productivity has increased on more than 20% of the vegetated land area of Canada over the past 20 years, as well as in some freshwater systems. The magnitude and timing of primary productivity are changing throughout the marine system.	From 1985 to 2006, primary productivity, as measured by the Normalized Difference Vegetation Index, increased for 33,408 km ² (16.5%) of the AME and decreased for 720 km ² (0.4%). Areas of increase were concentrated in mixed forests along the Gaspé Peninsula and on Cape Breton Island, and were possibly a result of commercial logging.

Themes and topics	Key findings: NATIONAL	Key findings: ATLANTIC MARITIME ECOZONE⁺
19. Natural disturbance	The dynamics of natural disturbance regimes, such as fire and native insect outbreaks, are changing and this is reshaping the landscape. The direction and degree of change vary.	Natural disturbance regimes are highly altered. Though historically important, fire is of lesser significance due to early detection and active suppression. Extreme weather events and insect outbreaks are the primary disturbance agents. The frequency and severity of tropical storms and hurricanes has increased from 1900 to 2000. Also, trend data from Charlottetown, PEI, suggests an increase in the severity and frequency of storm surge events. Spruce budworm is the most influential insect. Although there is no consensus on whether spruce budworm outbreaks are increasing in frequency or severity, human activities are a factor.
20. Food webs	Fundamental changes in relationships among species have been observed in marine, freshwater, and terrestrial environments. The loss or reduction of important components of food webs has greatly altered some ecosystems.	Due to a variety of human-caused pressures, larger mammalian predators have been under continuous pressure in the AME. Top predators including wolves have been extirpated and other predators, such as American martens, black bears, and lynx, have been lost from certain regions. Coyotes have expanded their range into the AME.

THEME: SCIENCE/POLICY INTERFACE		
21. Biodiversity monitoring, research, information management, and reporting	Long-term, standardized, spatially complete, and readily accessible monitoring information, complemented by ecosystem research, provides the most useful findings for policy-relevant assessments of status and trends. The lack of this type of information in many areas has hindered development of this assessment.	Long-term status and trend data are unavailable for many ecosystem components, particularly wetlands, changes in trophic structure, nonvascular plants, and invertebrates. Comprehensive data covering the entire AME is also rare; some results are available from case studies.
22. Rapid change and thresholds	Growing understanding of rapid and unexpected changes, interactions, and thresholds, especially in relation to climate change, points to a need for policy that responds and adapts quickly to signals of environmental change in order to avert major and irreversible biodiversity losses.	As a result of the low capacity for buffering against acid in much the AME, thresholds for acid deposition were exceeded and Atlantic salmon populations declined. Rivers have not recovered with reductions in acid deposition. Due to impacts from forest management practices and fragmentation, forests have reduced capacity to support native species, such as large mammals. Climate change has and will continue to interact with other stressors, such as coastal erosion, invasive non-native species, and insect outbreaks, accelerating ecosystem damage.

THEME: BIOMES

Key finding 1

Theme Biomes

Forests

National key finding

At a national level, the extent of forests has changed little since 1990; at a regional level, loss of forest extent is significant in some places. The structure of some Canadian forests, including species composition, age classes, and size of intact patches of forest, has changed over longer time frames.

Forest is the predominant land cover in the AME, although total estimates have varied depending on the methods used. Using a mix of remote and ground-based sampling, the Canadian National Forest Inventory found that forests comprised approximately 77% of the area of the AME in 2001, consisting of 44% coniferous, 33% mixed, and 21% broadleaf forest.¹⁰ Based on 2005 remote sensing data, Ahern *et al.*⁷ estimated forest cover at over 85%. Differences between the two estimates reflect different methodologies and definitions of forest rather than a change in the area of forest in the AMEⁱⁱⁱ.

Land clearing for agriculture and urban areas reduced the extent of post-settlement forests in certain areas, yet the AME remains well forested overall. By the beginning of the 20th century, 70% of the forest had been cleared for agriculture in PEI.¹⁴ Agricultural land also replaced forest in much of Nova Scotia's Annapolis and New Brunswick's Saint John river valleys. However, Ahern *et al.*⁷ found no significant change in the extent of forest cover between 1985 and 2005 based on remote sensing data. An analysis of forest density found that, other than in the Annapolis River Valley, the Saint John River Valley, and on most of Prince Edward Island, forest density was high for most of the AME. Over 30% of the 1 km² cells within the AME were more than 90% forested and another 20% were more than 80% forested.⁷

Age class distribution and composition of forests have changed through time, however, drawing general conclusions for the AME as a whole was difficult because there were no long-term data sets that covered the entire ecozone⁺. In general, the successional stage and age distribution of the forest shifted from old-growth to younger age classes.¹⁵ Over the past several decades, forests have also become simplified in species and ecosystem diversity as a result of forest clearing and regrowth and natural disturbances.¹⁶

For more than 300 years the economy of the region has been dependent on forests to supply a diversity of products and services.¹⁷

ⁱⁱⁱ The Canadian National Forest Inventory^{10, 13} used inventory data from provincial, territorial, and other forest management agencies as well as remote sensing data to estimate forest cover. In contrast, Ahern *et al.*⁷ (see Figure 2) is based solely on remote sensing data (and defines Forest as areas with tree crown density >10%).

There are three forest regions in the AME (Figure 4):¹⁸

1. The Acadian Forest Region, which extends into the northeastern United States, includes all of Nova Scotia and Prince Edward Island, and all but the northwestern corner of New Brunswick. It occupies an area of 122,000 km², is entirely within the AME in Canada, and represents 44% of the area of the AME.^{19,20} The region is transitional between the mostly deciduous forests of the south and west and the boreal coniferous forests of the north, and includes components of both.¹⁶
2. The Great Lakes–St. Lawrence Forest Region is predominantly a closed, mixed coniferous-deciduous forest. It is strongly influenced by the warm summers of the maritime climate that allow hardwoods to thrive. The forest region extends inland from the Great Lakes and St. Lawrence River to southeastern Manitoba, excluding the area north of Lake Superior. In the AME, this region occupies the northeast corner of New Brunswick, part of the Gaspé Peninsula, and the southern shore of the St. Lawrence River.
3. The Boreal Forest Region extends in a continuous belt from Newfoundland and Labrador west to the Rocky Mountains and north to Alaska. In the AME, it stretches from the northwestern tip of New Brunswick into the Gaspé Peninsula. This forest region is mostly coniferous, with black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*) as principal species, but also includes some deciduous trees, such as white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*).

Quebec uses major bioclimate domains and subdomains to classify its forests and four of these include parts of the AME: sugar maple–basswood (east), sugar maple–yellow birch (east), balsam fir–yellow birch (east), and balsam fir–white birch (east) (Figure 5). These subdomains also include parts of the Boreal Shield and Mixedwood Plains ecozones[†]. Because the sugar maple–basswood (east) mostly includes land outside the AME, it is not included here. The Quebec forest subdomains in the AME overlap with the Great Lakes–St. Lawrence and Boreal forest regions defined above.

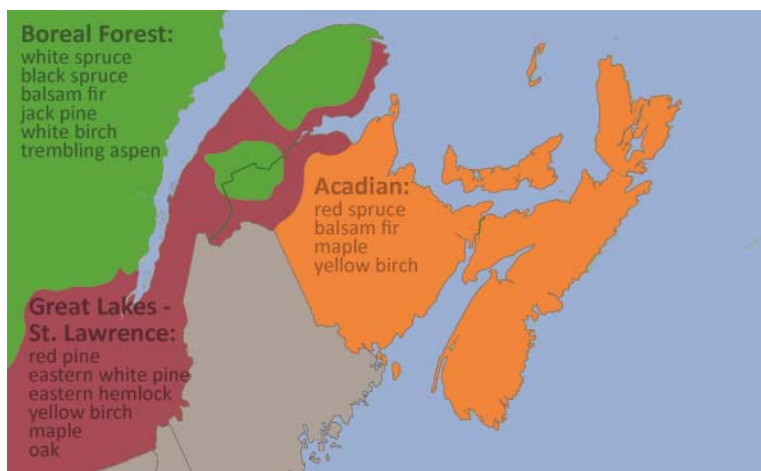


Figure 4. Forest regions and the principal tree species within each region.

Source: Natural Resources Canada, 2007²¹

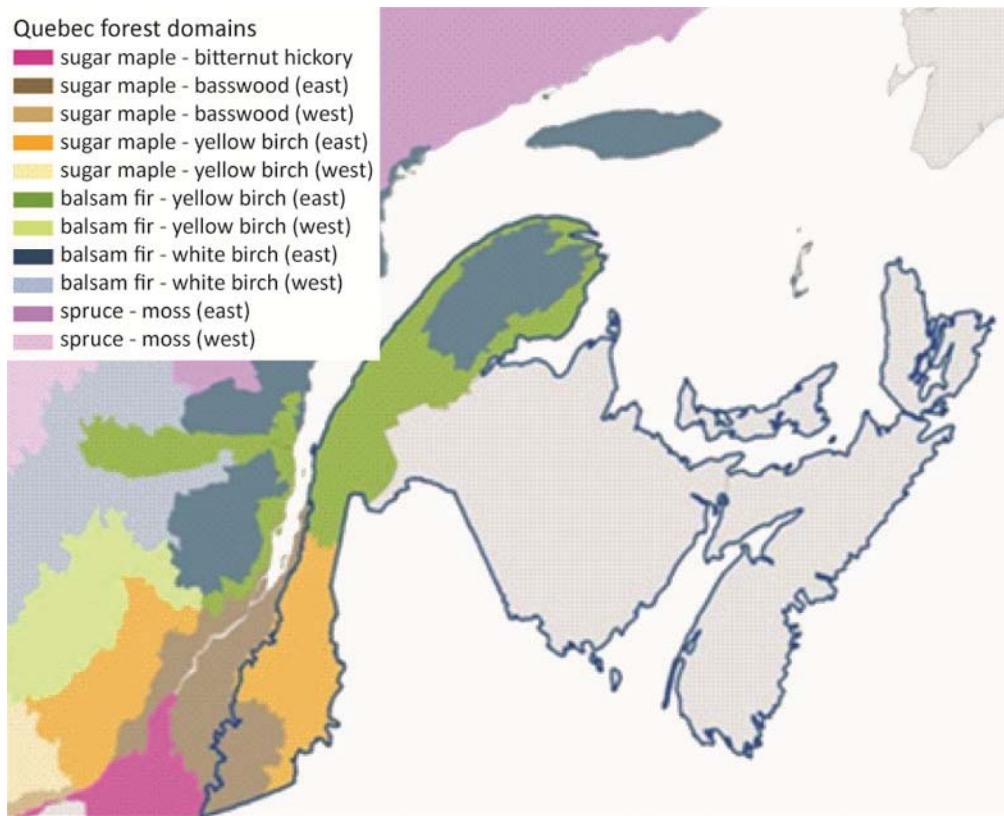


Figure 5. Quebec forest domains.

Source: *Ministère des Ressources naturelles et Faune, 2005*²²

Forest age structure

It has been estimated that as much as 50% of the forest in the AME may have been dominated by late-successional, old-growth forest types before European settlement.¹⁵ In 2003, only about 1–5% of forests were estimated to be older than 100 years, and ground surveys suggest that far less than this had true old-growth forest characteristics.¹⁵ A high proportion of the forests fell within the young age classes in 1999 (Figure 6), reflecting re-growth after forest harvesting.¹⁰

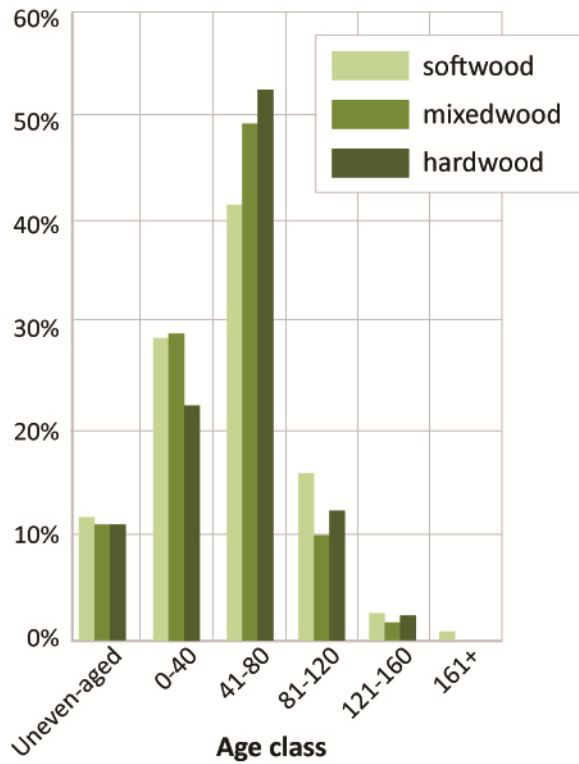


Figure 6. Age-class distribution by forest type on stocked forest land as a percentage of the total stocked forest area in the Atlantic Maritime Ecozone⁺, 1999.

Source: adapted from Canadian Council of Forest Ministers, 2005¹⁰

Acadian forest

Younger forests increased and older forests declined between 1958 and 2003 in Nova Scotia (Figure 7).²³ The youngest age class (less than 20 years) increased as a proportion of total forest cover, from 3.8% in the early 1970s to 23.9% in the 1997–2003 inventory. Forests greater than 101 years of age decreased from 8.7% in 1958 to 0.3% in the 1997–2003 inventory and forests between 81 and 100 years decreased from 16.4 to 1.2%.

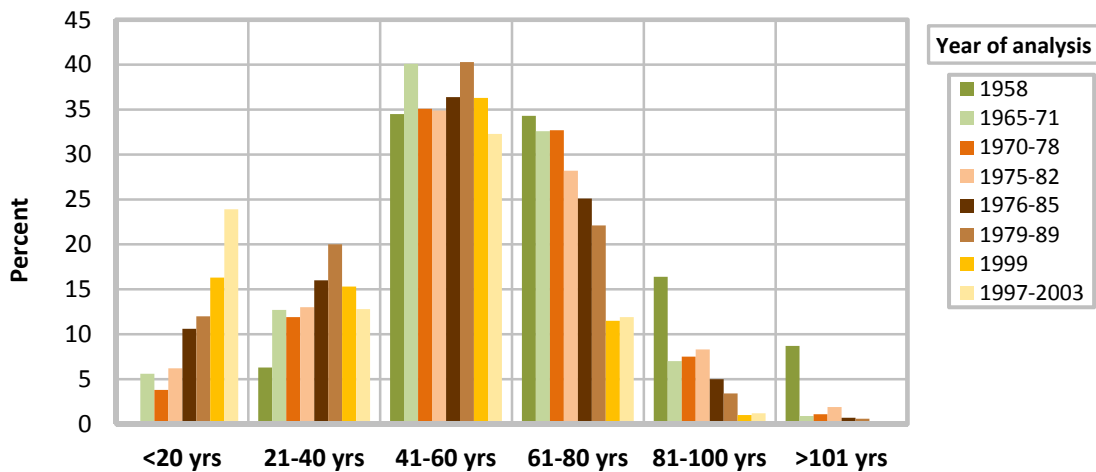


Figure 7. Percent of total forest area in each age class in Nova Scotia, 1958–2003.

Time periods are ranges and vary as Pannoza and Coleman (2008) compiled data from several sources: *Forest Resources of Nova Scotia* (1958); *Nova Scotia Forest Inventory provincial summary* (1965–1971, 1970–1978, 1975–1982, 1976–1985, 1979–1989); *Department of Natural Resources GIS 1995 inventory data* (1999); and *Department of Natural Resources GIS unpublished inventory data* (1997–2003).

Source: adapted from Pannoza and Coleman, 2008²³

Forest subdomains in Quebec portion of AME

Trends from the 1970s to the 1990s showed a gain in balsam fir domain forest stands in a mature developmental stage (Figure 8). Within this 30-year period, 19% of the balsam fir–yellow birch forest sub-domain became mature, while 23% was lost from the young category.²⁴ In the balsam fir–white birch sub-domain, mature forest stands and regenerated stands remained stable (2% increase and 1% decrease respectively) over the same time period, while young forest stands decreased by 5% and regenerating forest stands increased by 3%. For the sugar maple–yellow birch subdomain, young forest stands decreased by 3% and regenerated stands increased by 6%.²⁴ Over the 30-year period, the proportion of mature stands did not change. These data included areas outside the AME.

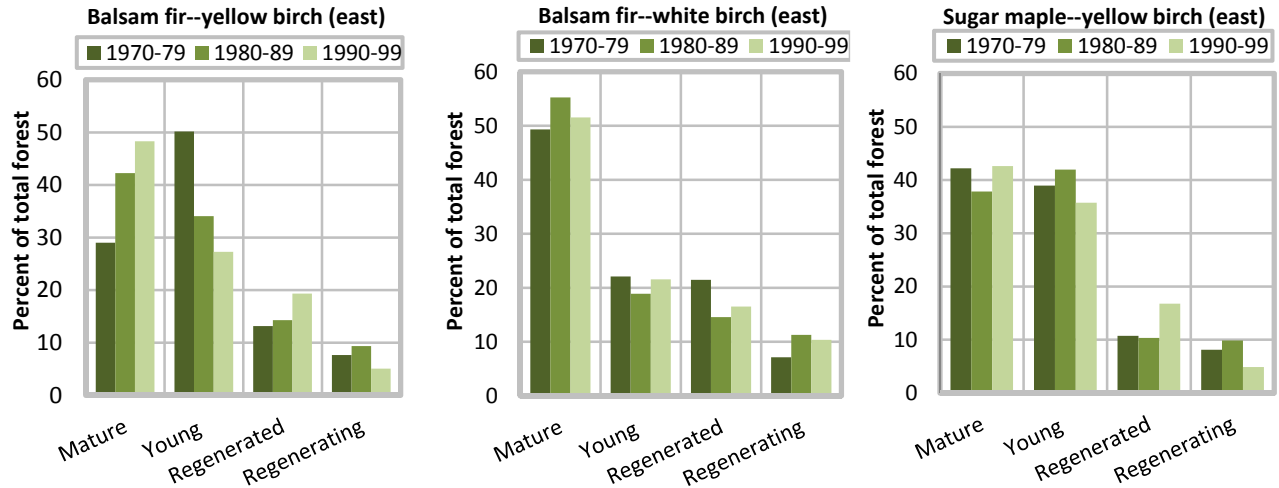


Figure 8. Proportion of forest at each major developmental stage in Quebec's subdomains that occur in the Atlantic Maritime Ecozone⁺, 1970s, 1980s, and 1990s.

Development stages are based on stand height and growth in volume: regenerating = disturbed stands <2 m in height; regenerated = disturbed stands 2–7 m in height; young = stands >7 m with increasing mean annual growth (volume); mature = stands >7 m with decreasing mean annual growth (volume). Data included area outside the AME.

Source: Ministère des Ressources naturelles et Faune, 2009, *Statistiques forestières*, unpublished data; updated from Ministère des Ressources naturelles, 2002²⁵

Forest composition

In many parts of the AME, the forest has been simplified both in species and ecosystem diversity over the past several decades. This was primarily a result of forest clearing for agriculture and subsequent abandonment, timber removal of selected species, and clear-cutting as well as natural disturbance.¹⁶

Acadian forest

As older forests were replaced by relatively young, often even-aged, early successional forest types, the abundance and age of late-successional species such as sugar maple (*Acer saccharum*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), red oak (*Quercus rubra*), yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*), and eastern white cedar (*Thuja occidentalis*) declined.^{16, 26} Younger forests have higher frequencies of balsam fir, red maple (*Acer rubrum*), white spruce (*Picea glauca*), white birch, and trembling aspen.^{16, 27} Similar changes are occurring in other eastern forests where species composition was altered by logging and land clearing throughout the twentieth century.²⁸

A case study in Kings County, NB, compared forest species composition in 1800 and 1993. Species distribution in 1800 was more even than in 1993 (Figure 9).¹⁶ The study showed that cedar was likely as common as balsam fir in the early 1800s, but by the 1990s, balsam fir was four times as common as cedar. The spruce genus increased in frequency, as did poplar, and

white pine remained stable, but the rest of the other tree genera were more common 200 years ago than today. Cedar, hemlock, ash, beech, and larch declined over the time period. Balsam fir and the spruces comprised about 50% of the forest in 1993, while 200 years ago, they accounted for only 25%.¹⁶

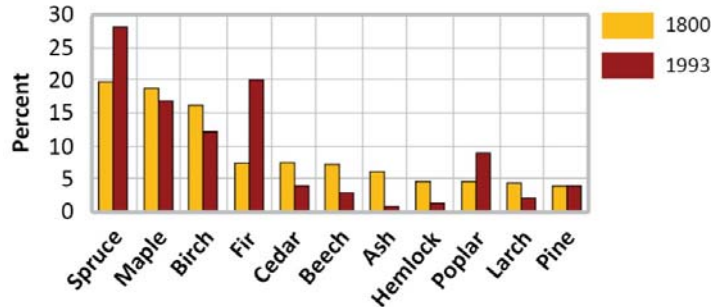


Figure 9. Estimated frequency of major forest tree genera in Kings County, NB, 1800 and 1993. Source: Loo and Ives, 2003¹⁶

Forest subdomains in Quebec portion of AME

From the 1970s to 1990s, conifers, particularly balsam fir, in the balsam fir subdomains declined,²⁵ while mixedwood stands increased. In the balsam fir–yellow birch and balsam fir–white birch subdomains, conifer proportions decreased by 8 and 16%, respectively. Conifers in the sugar maple–yellow birch subdomain declined, while mixedwood stands increased (Figure 10). These data include public and private forests, and include all the area of the subdomains, including some area outside the AME.

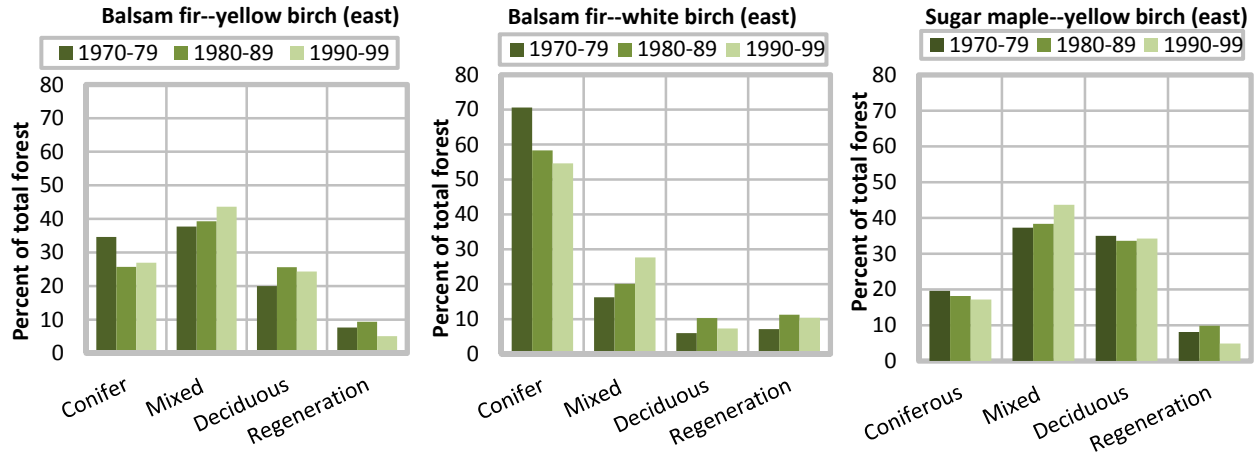


Figure 10. Proportion of total area covered by different forest cover types in the Quebec subdomains that occur in the Atlantic Maritime Ecozone[†], 1970s, 1980s, and 1990s.

Forest cover types are based on stand height and composition; regenerating = <2 m in height; deciduous = >75% deciduous; mixed = 25–75% deciduous; coniferous = >75% coniferous. Data included area outside the AME.

Source: Ministère des Ressources naturelles et Faune, 2009, Statistiques forestières, unpublished data; updated from Ministère des Ressources naturelles, 2002²⁵

Differences in land cover types were also measured between 1993 and 2001 for the Appalachian Ecoregion which overlaps with parts of the area above. Jobin *et al.*²⁹ reported that the abundance of mixedwood forest declined by over 12% while coniferous stands increased by 7% over this time period (Figure 11).

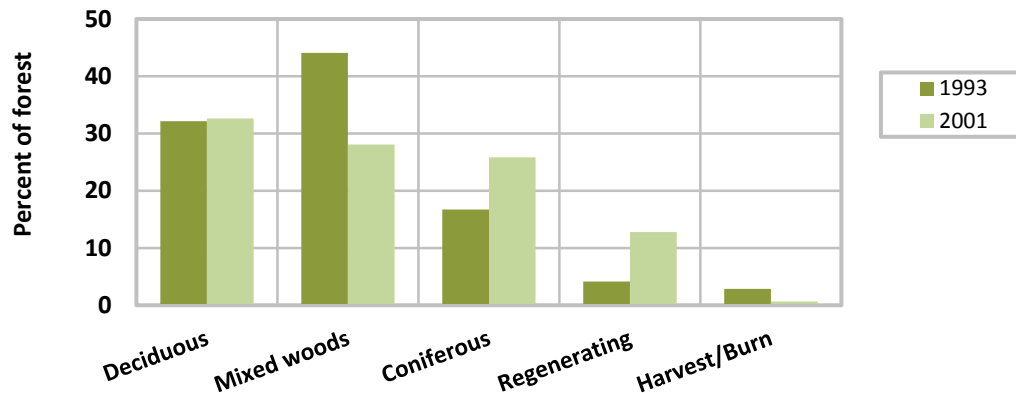


Figure 11. Change in forest types for the Appalachian Ecoregion in southern Quebec between 1993 and 2001.

Source: Jobin *et al.*, 2007²⁹

Fragmentation

Fragmentation reduces habitat connectivity, increases edge density, and increases the isolation of remnant habitat patches. In contrast to more remote, less populated ecozones⁺, remaining natural ecosystems of the AME are highly fragmented. Only 5% of the AME is covered by intact fragments of natural ecosystems (primarily forests) larger than 50 km² (Figure 12).¹⁹



Figure 12. Intact landscape fragments larger than 50 km² in the Atlantic Maritime Ecozone⁺, 2003. A landscape fragment is a contiguous mosaic of various ecosystems, naturally occurring and essentially undisturbed by significant human influence. Source: adapted from Lees et al., 2006¹⁹

Forest birds

Changes in the age structure of the forest, with increasing early-successional stands and decreasing contiguous mature stands, and the replacement of some hardwood stands with softwood plantations and agricultural land have resulted in changes in the bird community.^{30, 31} Overall, forest bird populations have been generally stable but with a tendency to decline, especially since 2000 (Figure 13). There have been large declines for several species, while others have stable or increasing populations. For example, the Canada warbler (*Cardellina canadensis*), a species recently assessed as Threatened by the Committee on the Endangered Status of Wildlife in Canada (COSEWIC), has declined by 80% in the AME since the 1970s. Although the primary cause of its decline is unclear, research has shown this species is sensitive to forest fragmentation and human disturbance. Populations may have been affected on both the breeding and wintering grounds by habitat loss and degradation. The decline in spruce budworm (*Choristoneura fumiferana*) abundance may also have reduced an important food source for Canada warbler.^{32, 33} The boreal chickadee (*Poecile hudsonicus*) has also declined markedly in this region and throughout its range.^{34, 35}

The AME region in Canada and similar neighbouring areas in the United States support over 90% of the world's breeding population of Bicknell's thrush (*Catharus bicknelli*), one of the rarest songbirds in North America and listed as Threatened in Canada.³⁶ This bird lives in the high-elevation coniferous forests and is particularly susceptible to climate change, which may result in shifts in high-elevation breeding zones. Other threats include habitat loss and degradation on both the breeding and wintering grounds, squirrel predation at nests, and environmental contaminants.³⁷⁻³⁹ Surveys over the last several years indicate this species has undergone considerable annual decline.^{35, 40, 41}

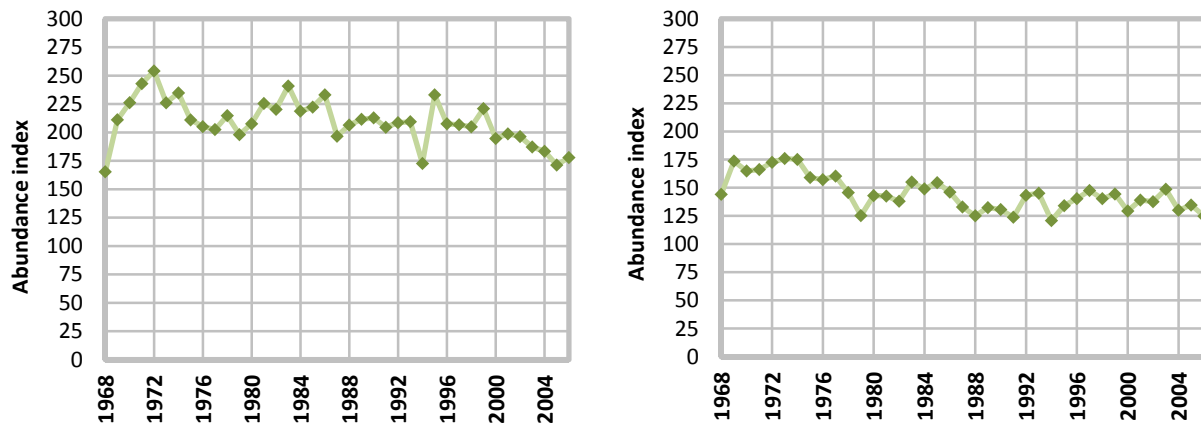


Figure 13. Annual indices of population change for birds of forest habitat (left) and shrub-early successional habitat (right), 1968–2006.

Shrub/early successional assemblage includes shrubland, old field, and mid-successional stage habitat from grassland to forest.

Source: Downes et al., 2011⁴² using data from the Breeding Bird Survey⁴³

A large portion of forested land in the ecozone+ is in early successional stages. The overall slightly negative trends in the indices of population change for birds inhabiting forest and shrub-early successional habitat types (Figure 13) were influenced by the strong declines in abundant species such as the white-throated sparrow (*Zonotrichia albicollis*) and song sparrow (*Melospiza melodia*). However, declines in these species have been largely balanced by increases in several generalist species, such as Nashville warbler (*Oreothlypis ruficapilla*), yellow warbler (*Setophaga petechia*), and chestnut-sided warbler (*Setophaga pensylvanica*), which utilize and have benefited from increases in shrub-early successional forest habitat.⁴⁴

Cumulative human impact

The organization Two Countries One Forest quantified the human footprint on terrestrial ecosystems of the Appalachian/Acadian Ecoregion (which includes the AME) by integrating four categories of human influence: settlement, access, land use, and electrical power infrastructure (Figure 14).⁴⁵ In 2008, the greatest human impacts were primarily on coastlines, valleys, and other low-lying areas, reflecting the historical pattern of settlement. Only 0.2% of

the ecoregion has a human footprint score of 0, indicating no human transformation of the landscape. More than 90% of the ecoregion has a low human footprint (score of less than 50). Large areas are classified as having low impact; however, they tend to be separated by areas with high levels of human activity, thus fragmenting the region.⁴⁵ Only 5% of the total landscape is in intact natural fragments of larger than 50 km².¹⁹

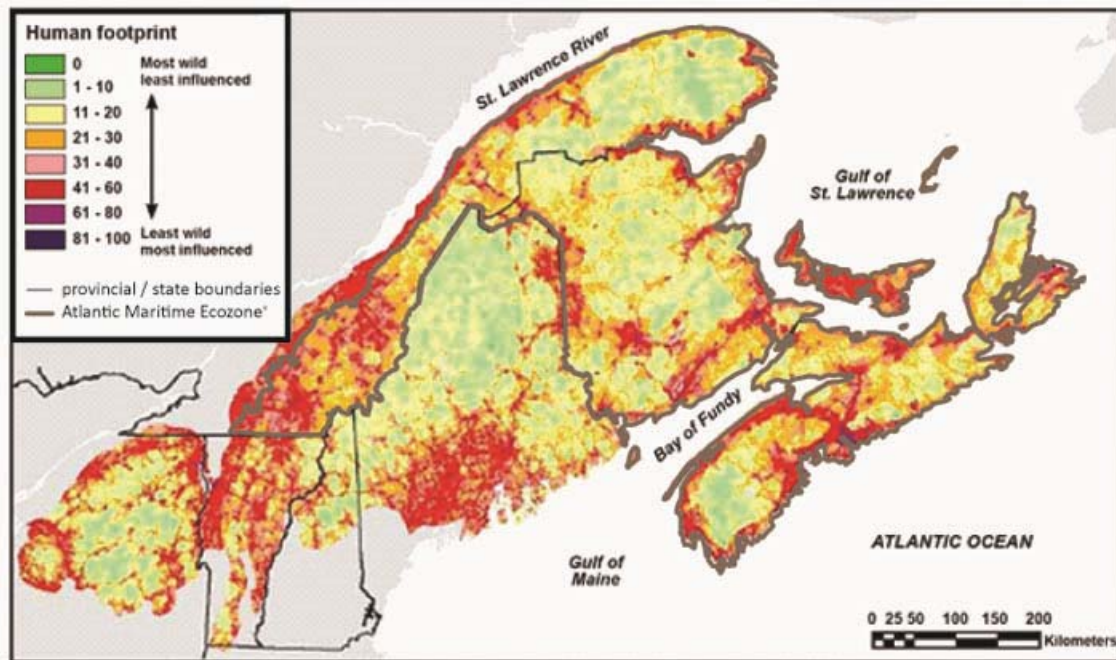


Figure 14. The human footprint of the Northern Appalachian/Acadian Ecoregion, 2008. Source: Trombulak et al., 2008⁴⁵

Key finding 3

Theme Biomes

Wetlands

National key finding

High loss of wetlands has occurred in southern Canada; loss and degradation continue due to a wide range of stressors. Some wetlands have been or are being restored.

There has been extensive wetland loss in the AME, particularly in coastal areas, where shoreline development is a continuing threat (see Coastal wetlands section on page 29). Although three of the four provinces in the AME have had wetland inventories completed since the 1980s, wetland mapping and assessment methodologies have changed, making it difficult to determine the amount of change over time.^{10, 46} According to data from Canada's Forest Inventory (CanFI),¹³ in 2001, wetlands covered approximately 3.5% of the land area of the ecozone⁺ and approximately 35% of those were treed.¹⁰ Although estimates of freshwater

wetland losses are not available for the AME as a whole, approximately 16 to 18% of freshwater wetlands in Nova Scotia had been developed or converted to other ecosystem types between European settlement and 1998.⁴⁷ Coastal wetland loss in Nova Scotia has been estimated at 65%.⁴⁸

Many wetlands in the AME remain under continued threat of loss and degradation due to industrial and urban development, port expansion, cottage subdivisions, and agriculture. However, each of the four provinces have wetland conservation or similar policies that have mitigated the impacts of development projects and land-use decisions to some degree.⁴⁹ Bogs are being impacted by commercial peat moss extraction and cranberry production.

Waterfowl

Trends for selected breeding waterfowl species show either stable or increasing populations since 1993 (Table 3).⁵⁰ The American black duck (*Anas rubripes*), the most abundant duck in the AME, has been the focus of special conservation effort because the wintering population in the United States decreased by almost 50% between 1955 and 1985.^{51, 52} In the AME, from 1993 to 2006, black duck populations were stable (Table 3).⁵⁰ Logging, hydroelectric development, transmission line construction, agriculture, urbanization, and industrial development threaten breeding and staging habitats.⁵¹ In addition, it is likely that the species has had to compete for habitat with a growing mallard (*Anas platyrhynchos*) population.⁵³ Some evidence shows that habitat availability and quality may not be limiting, however,⁵³ and recent increases and stabilization of the black duck may reflect increased hunting restrictions in Canada and the United States.⁵² Black ducks are also closely related to mallards and the two species interbreed regularly, which may represent an additional conservation concern for the species.⁵⁴⁻⁵⁶

Table 3. Abundance trends for selected breeding waterfowl species in the Atlantic Maritime Ecozone[†], 1990s–2000s.

Species	Nesting habitat	Trend (%/yr)	P	Annual Index (in thousands)		
				1990s	2000s	% change
Mallard (<i>Anas platyrhynchos</i>)	Ground	30.1	*	2.3	4.6	98.1
American black duck (<i>Anas rubripes</i>)	Ground	2.2		57.7	63.7	10.5
Green-winged teal (<i>Anas crecca</i>)	Ground	5.9	n	8.4	11.7	38
Ring-necked duck (<i>Aythya collaris</i>)	Overwater	6.5	*	21.2	32.3	52.2
Canada goose (<i>Branta canadensis</i>)	Ground	22.5	*	1.1	3.6	244.3

P is the statistical significance: * indicates $P < 0.05$; n indicates $0.05 < P < 0.1$; no value indicates not significant

For a description of how species were selected and data methodology, see Fast *et al.*, 2011.

Source: Fast *et al.*, 2011⁵⁰

Lakes and rivers

National key finding

Trends over the past 40 years influencing biodiversity in lakes and rivers include seasonal changes in magnitude of stream flows, increases in river and lake temperatures, decreases in lake levels, and habitat loss and fragmentation.

Of the 1,792 lakes in the Atlantic Provinces, 98% are less than 99 km² in size.⁵⁷ The largest lake in the AME is Grand Lake, NB. The Saint John River in New Brunswick is the largest river system in the AME.⁵⁸ Seven rivers/river systems within the AME are classified as Canadian Heritage Rivers: the Saint John, St. Croix, and Upper Restigouche rivers in New Brunswick; the Shelburne River and Margaree-Lake Ainslie river system in Nova Scotia; and the Hillsborough River and Three Rivers (Cardigan, Brudenell, and Montague/Valleyfield) river system on Prince Edward Island.^{58, 59} Runoff increases significantly from west to east, varying from 60 cm annually in the western part of the AME to 200 cm along the Atlantic coast.⁵⁸⁻⁶¹

Lakes and rivers in the AME support diverse aquatic communities including species at risk such as the Atlantic salmon (*Salmo salar*), striped bass (*Morone saxatilis*), Atlantic whitefish (*Coregonus huntsmani*), American eel (*Anguilla rostrata*), wood turtle (*Glyptemys insculpta*), Blanding's turtle (*Emydoidea blandingii*), dwarf wedgemussel (*Alasmidonta heterodon*), yellow lampmussel (*Lampsilis cariosa*), skillet clubtail (*Gomphus ventricosus*), cobblestone tiger beetle (*Cicindela marginipennis*), and several coastal plain flora.

Streamflow in natural rivers

Two analyses of streamflow in rivers with minimal flow control or impact upstream over the past 40 years were conducted for ESTR. Cannon *et al.*⁶² looked at seasonal trends in streamflow at sites across Canada between two periods, 1961–1982 and 1983–2003. To facilitate the analysis of trends nationally, sites were organized into six groups with similar intra-seasonal patterns of flow (hydrology groups). Across sites in the AME, changes in flows between 1961–1982 and 1983–2003 included earlier onsets of spring freshet and decreased summer flows (summer flow period from August to October).⁶² Monk and Baird⁶³ found that minimum and maximum flow variables decreased at a high proportion of sites from 1970 to 2005 and the annual 1-day minimum flow occurred later in the year. Although the rise rate decreased significantly at 32% of the sites and the fall rate increased at 29%, no overall trend was found in the variability of annual runoff.⁶³ Figure 15 summarizes the number and direction of significant trends in streamflow variables for the 34 stations analyzed by Monk and Baird⁶³ and Figure 16 shows the results of the Cannon *et al.*⁶² analysis of seasonal trends at representative sites.

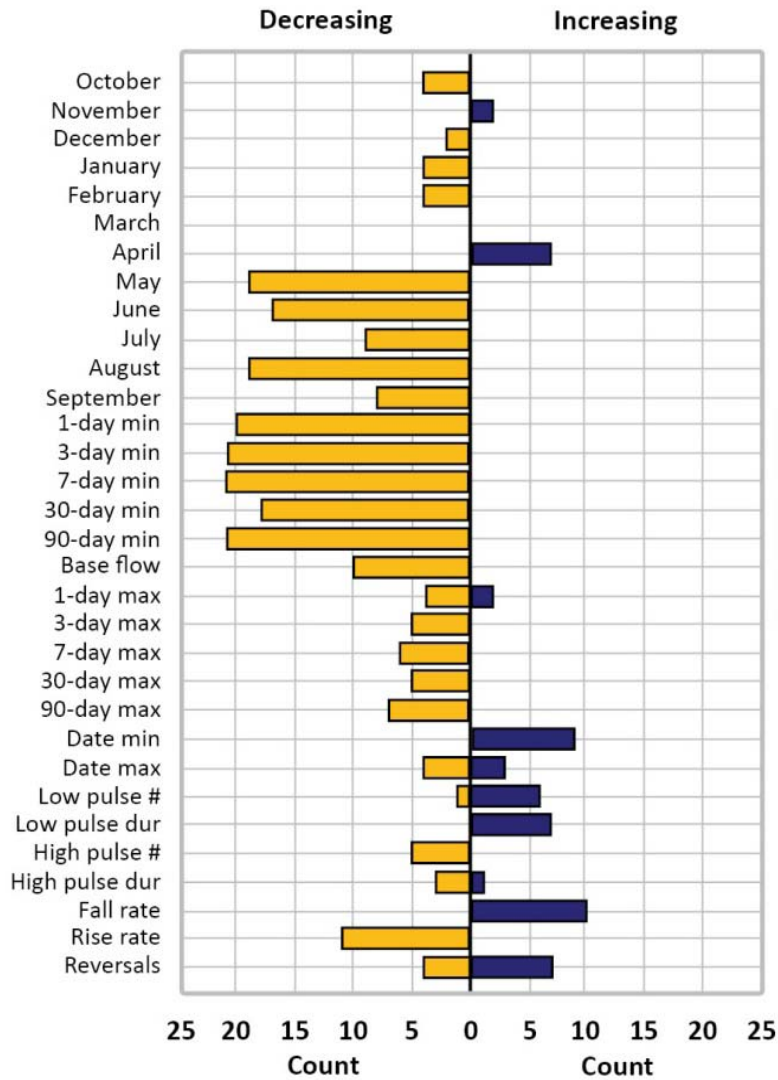
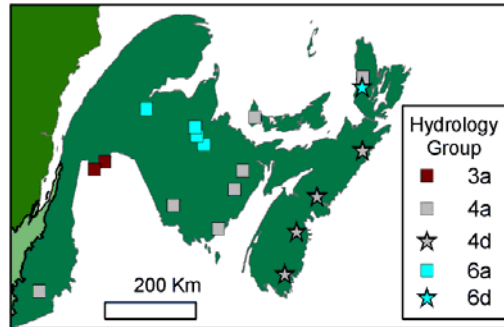


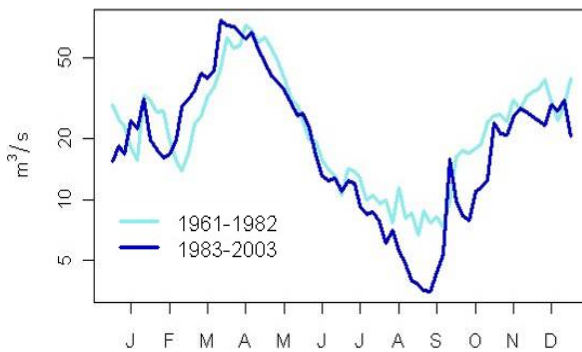
Figure 15. Summary of the total number of sites displaying increasing and decreasing trends in various streamflow variables in the Atlantic Maritime Ecozone⁺, 1970–2005.

Based on 34 gauging sites. Only sites with significant trends ($p < 0.1$) are shown.

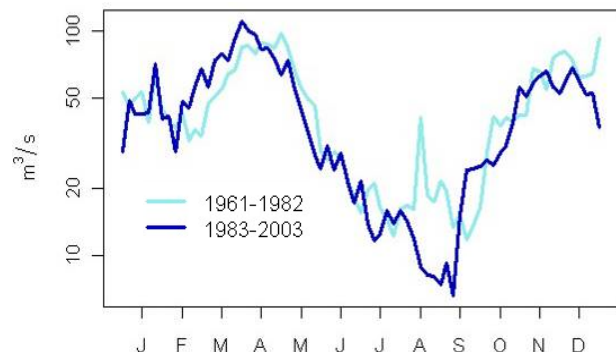
Source: Monk and Baird, 2014⁶³



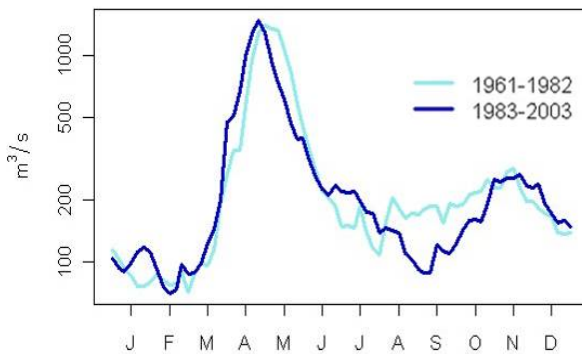
a) location of sites



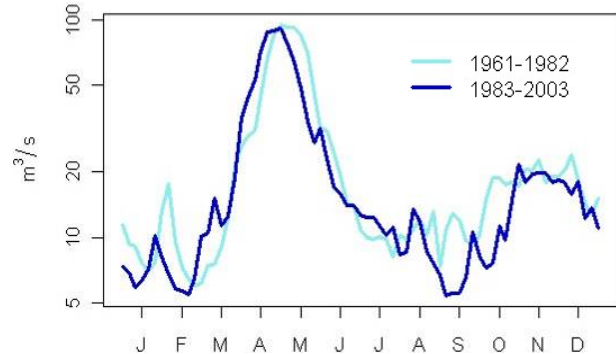
b) Group 4a: Kennebecasis River



c) Group 4d: St. Mary's River



d) Group 3a: Saint John River



e) Group 6a: Northwest Miramichi River

Figure 16. Changes in streamflow between 1961–1982 and 1983–2003 for representative sites of each hydrology group in the Atlantic Maritime Ecozone⁺.

Hydrology groups represent clusters of rivers showing similar hydrologic responses to variations in climate. For information on the specific hydrology groups mentioned above, see Cannon et al. 2011.⁶²

Source: Cannon et al., 2011⁶²

Water control structures

Although water control structures are less common in the AME than in some ecozones⁺, their impacts are often greater because of the coastal nature of the ecozone⁺ and large number of watersheds with limited numbers of natural lakes. Ecological impacts include local and regional species extirpations and habitat loss and alteration. Impacts of these structures on lakes and rivers include altering natural water level fluctuations, peak flows, seasonal flooding, and

natural disturbance regimes, as well as decreasing water quality.⁶⁴ A total of 74 large dams (greater than 10 m in height) have been constructed in the AME, although few since the 1970s.

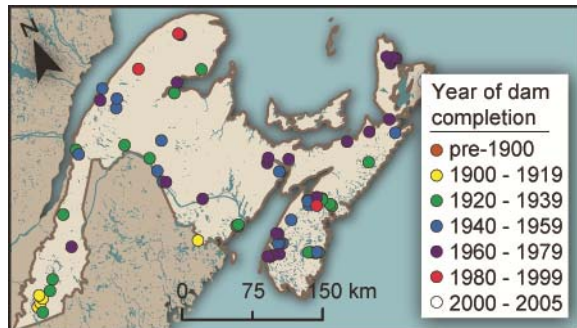


Figure 17. Spatial distribution of dams greater than 10 m in height within the Atlantic Maritime Ecozone⁺, grouped by year of completion between 1830 and 2005.

Source: Canadian Dam Association, 2003⁶⁵

Examples of the impacts of dams on biodiversity in the AME include:

- extirpation of three plants, Canadian honewort (*Cryptotaenia canadensis*), prairie goldenrod [*Oligoneuron album* (syn. *Solidago ptarmicoides*)], and American bittersweet (*Celastrus scandens*) from the Saint John River, NB, due to flooding from hydroelectric dams;⁶⁶
- local extirpation of two species at risk, Plymouth gentian (*Sabatia kennedyana*) and pink coreopsis (*Coreopsis rosea*), from at least two lakes in the Tusket River system in extreme southwestern Nova Scotia;^{67, 68}
- extirpation of one of only two populations of the endangered Atlantic whitefish (*Coregonus huntsmani*) in Nova Scotia as a result of the damming the Tusket River in 1929;⁶⁹ and
- extirpation of the dwarf wedgemussel (*Alasmidonta heterodon*), a species that was restricted to the AME in Canada, likely as a result of the loss of its fish host due to construction of a causeway over the tidal portion of the Petitcodiac River, NB, in 1967–1968.^{70, 71}

Coastal

National key finding

Coastal ecosystems, such as estuaries, salt marshes, and mud flats, are believed to be healthy in less-developed coastal areas, although there are exceptions. In developed areas, extent and quality of coastal ecosystems are declining as a result of habitat modification, erosion, and sea-level rise.

The coast is a defining feature of the AME. Coastal features include bays, coves, harbours, inlets, passages, channels, basins, points, heads, promontories, islands, capes, beaches, barrens, estuaries, and salt marshes.⁷² There is some information on the status of coastal features in the AME, however, trends in this biome are not well known. Where data exist, they are not comprehensive and not necessarily representative of the entire AME. Given these caveats, available data suggest that coastal wetlands, beaches, and dunes declined and that stressors, such as development (industrial, urban, and cottage development),⁷³ recreation, sea-level rise, and storm surges increased. Climate change will increase impacts to these coastal habitats.⁷³ Some coastal dependent species, such as certain shorebirds, also declined.

Coastal wetlands

Although coastal wetlands and shores cover less than 1% of the AME, they are one of the most important habitat types for maintaining native biodiversity. Loss and fragmentation of this ecosystem type in the AME is one of the most severe cases of wetland loss in Canada.²⁷ As already mentioned in the Wetlands section (page 24), an estimated 65% of the area covered by coastal marshes has been lost since European settlement.⁴⁸ Wetland loss began over 300 years ago when Acadians began draining salt marshes for agriculture. Since 1900, many coastal wetlands have been drained, flooded, and/or filled in for urban, industrial, or agricultural purposes and coastal developments, particularly cottage subdivisions.⁷⁴

Hanson *et al.*⁷⁵ quantified change in the extent of salt marshes in two undeveloped (Cape Jourmain and Shemogue) and three developed (Aboiteau, Shediac, and Cocagne) sites along the Northumberland Strait in southeastern New Brunswick between 1944 and 2001. Salt marshes declined at all five sites over the study period from a combination of development and climatic variables (Figure 18).

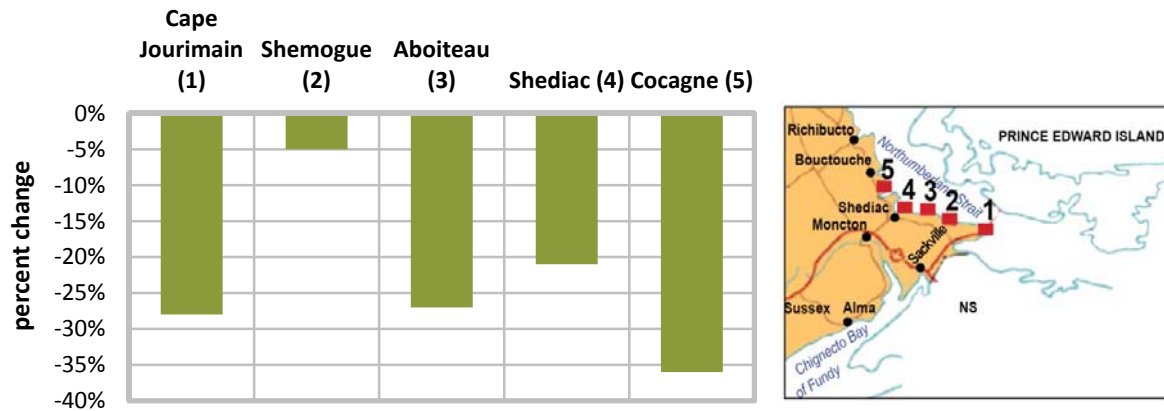


Figure 18. Decline in area of vegetated salt marsh in five locations in southeastern New Brunswick between 1944 and 2001.

Study sites Cape Jourimain (1) and Shemogue (2) are undeveloped areas. The other three sites (3–5) are largely residential.

Source: adapted from Hanson et al., 2006⁷⁵

Coastal wetlands continue to be degraded as a result of terrestrial runoff and sedimentation, the restriction of tidal water movement due to barriers and culverts,⁷³ and the rise in sea levels due to climate change. Industrial and commercial development, as well as some agricultural practices, are among the principal threats to estuarine ecosystems.⁷⁶ Continued sea-level rise will result in additional negative impacts on the coast⁷³ (see Sea-level rise and coastal erosion section on page 36).

Eelgrass

Eelgrass meadows are among the most productive ecosystems in the world,⁷⁷ and also among the most threatened.⁷⁸ Eelgrass (*Zostera marina*) is an important food for migrating and wintering waterfowl, and provides foraging areas for other birds.⁷⁹⁻⁸¹ Comprehensive trend data do not exist for eelgrass but compiling results from a number of mainly short-term studies (Table 4) suggests a general decline in eelgrass and some abrupt die-offs, along with some areas with stable to increasing trends.^{77, 80} Loss of eelgrass beds worldwide have been attributed to a range of natural and human-induced disturbances, including coastal erosion, hurricanes, sediment and nutrient loading (see Nutrient loading and algal blooms section on page 52), and various forms of mechanical disturbance.⁸² Another factor in declines on the Atlantic coast is the spread of the invasive green crab (*Carcinus maenas*), which can uproot eelgrass plants.⁸³

Table 4. Trends in eelgrass from studies in Nova Scotia and the Gulf of the St. Lawrence.

Location	Years	Eelgrass trends
Lobster Bay, NS	1978–2000	Estimated losses of 30 and 44% in two areas ⁸⁴
Antigonish Harbour, NS	2000–2001	Biomass decline of 95% followed by 50% decline in geese and ducks that feed on the eelgrass ⁸⁵
4 Nova Scotia inlets	1992–2002	Loss of 80% of total intertidal area occupied by eelgrass ⁸⁶
13 southern Gulf of St. Lawrence estuaries	2001–2002	Biomass decline of 40% ⁸⁷
Gulf of St. Lawrence in Quebec	various	Manicouagan Peninsula distribution expanded (1986 to 2004); generally also expanding or stable in other areas ⁸⁸

Shorebirds

Although the AME supports a number of breeding shorebird species, it is most important for migrant shorebirds. Coastal habitats, particularly those around the upper Bay of Fundy, are of critical importance as stopover and refueling areas, particularly for the smaller sandpipers.⁸⁹⁻⁹¹ The number of shorebirds passing through the Canadian Atlantic provinces declined since surveys were started in 1974 (Table 5),⁹²⁻⁹⁶ with declines particularly pronounced in the 1990s.⁹⁷ The reasons for the declines are not fully understood. Although coastal habitats have changed in ways that can negatively affect shorebirds,⁹⁸ trends in at least some species likely reflect factors in other parts of the birds' migration ranges.⁹⁸

Table 5. Trends in abundance of shorebirds migrating through coastal areas of the Atlantic Maritime Ecozone⁺, 1974–2006.

Species	Trend	P	Abundance index				Change
	(%/yr)		1970s	1980s	1990s	2000s	%
Red knot (<i>Calidris canutus</i>)	-10.9	*	39.5	11.2	9.1	3.3	-97.5
Least sandpiper (<i>Calidris minutilla</i>)	-6.6	*	80.7	22.2	9.8	11.6	-88.8
Lesser yellowlegs (<i>Tringa flavipes</i>)	-5.0	*	29.2	52.2	16.4	9.8	-80.6
Semipalmated sandpiper (<i>Calidris pusilla</i>)	-4.9		5170.9	4892	2623.7	3074.5	-80.0
Black-bellied plover (<i>Pluvialis squatarola</i>)	-3.0	*	51.0	43.1	23.0	26.7	-62.3
Dunlin (<i>Calidris alpina</i>)	-2.8		26.3	28.6	11.4	15.5	-59.7
Ruddy turnstone (<i>Arenaria interpres</i>)	-2.8	**	13.2	10.9	11.4	4.2	-59.7
Short-billed dowitcher (<i>Limnodromus griseus</i>)	-2.7		292.8	281.7	39.6	141.0	-58.4
Sanderling (<i>Calidris alba</i>)	-2.3		42.9	34.7	19.8	24.0	-52.5
Greater yellowlegs (<i>Tringa melanoleuca</i>)	-0.9		13.0	12.8	9.8	10.8	-25.1
Hudsonian godwit (<i>Limosa haemastica</i>)	-0.9		5.5	4.1	3.5	2.9	-25.1
Willet (<i>Tringa semipalmata</i>)	-0.8		16.6	15.9	11.1	14.1	-22.6
White-rumped sandpiper (<i>Calidris fuscicollis</i>)	-0.2		16.1	15.3	12.6	16.4	-6.2
Semipalmated plover (<i>Charadrius semipalmatus</i>)	1.9		103.8	123.0	153.1	159.3	82.6
Whimbrel (<i>Numenius phaeopus</i>)	2.5		1.9	1.5	3.1	4.3	120.4

P is the statistical significance: ** indicates P<0.01, * indicates P<0.05, no value indicates not significant “Change” is the percent change in the average abundance index over the entire period calculated from the overall trend (%/yr).

Source: Gratto-Trevor et al., 2011⁹⁷

Relatively few species of shorebirds breed in the AME, and only a small number in coastal areas. Of the four coastal breeding species in the AME for which trends can be determined from Breeding Bird Survey data (Table 6), only the trend for Wilson’s snipe (*Gallinago delicata*) was significant, declining at 2.6%/yr (P<0.01).⁹⁷

Table 6. Trends in abundance of coastal breeding shorebirds, 1970s to 2000s.

Species	Trend	P	Abundance index				Change
	(%/yr)		1970s	1980s	1990s	2000s	%
Upland sandpiper (<i>Bartramia longicauda</i>)	-3.1		3	0.2	0.1	0.1	-70%
Spotted sandpiper (<i>Actitis macularius</i>)	-2.6		0.8	0.9	0.7	0.4	-64%
Willet (<i>Tringa semipalmata</i>)	-3.1		1.1	1	0.4	0.4	-71%
Wilson's snipe (<i>Gallinago delicata</i>)	-2.6	**	5.2	4.8	2.9	2.3	-64%

P is the statistical significance: ** indicates $P < 0.01$, no value indicates not significant Change indicates the percent change in the average abundance index over the survey period (1968–2006) calculated from the overall trend (%/yr).

Source: Gratto-Trevor et al., 2011⁹⁷ using data from the Breeding Bird Survey⁴³

Waterfowl

The AME has many coastal areas where large numbers of waterfowl traditionally congregate during the spring and fall migrations.⁹⁹ Many waterfowl also winter in this region, for example, Barrow's goldeneye (*Bucephala islandica*).¹⁰⁰ Recent milder winters with longer ice-free periods have resulted in larger wintering populations and potential increases in the residency times of waterfowl during migration.¹⁰¹ Trends in breeding waterfowl are summarized in the Wetlands section on page 24.

Sandy shores and sand dunes

Sandy shores and sand dunes are primarily located along the New Brunswick coast of Northumberland Strait, the Minas Basin, the north shore of PEI, and Îles de la Madeleine. Beaches and dunes are important habitat for many species of wildlife, providing food and habitat to shorebirds and other fauna, flora, and microorganisms.⁷⁶ They are threatened by development, sand mining, recreation, sea-level rise, and increased storm severity related to climate change (see Sea-level rise and coastal erosion section on page 36).

Data on trends in erosion and deposition rates for beach and dune habitat is limited. O'Carroll et al.¹⁰² conducted a retrospective analysis of aerial photos to assess temporal changes in beach and dune habitat at five locations in southeastern New Brunswick between 1944 and 2001. They found that the amount of beach and dune habitat had declined in all sites, with a greater decline in beach than in dune in all five locations (Figure 19). Sand removal for aggregate production and the expansion of shoreline protection have also contributed to changes in these areas. The variety of changes observed illustrates that local accretion and erosion processes, storm events, and human activity have all been important factors in shaping coastal sand ecosystems.¹⁰²

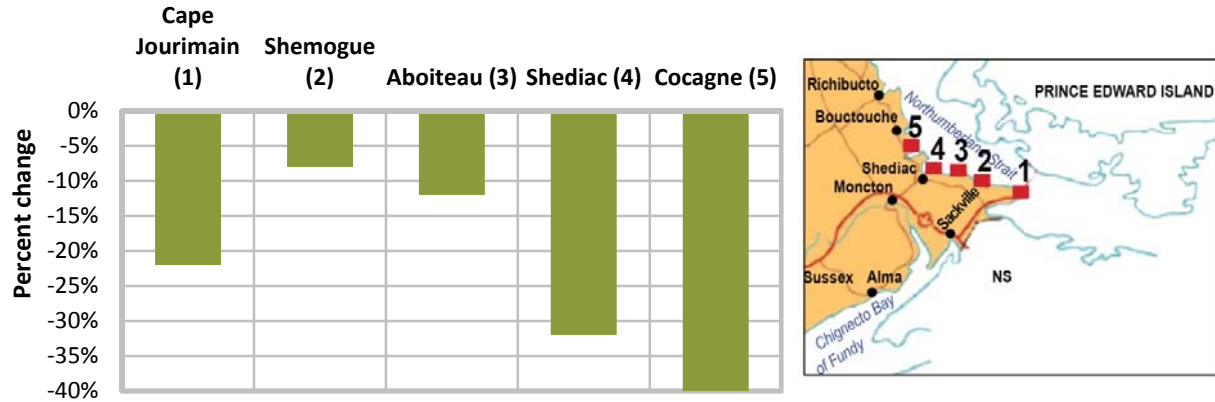


Figure 19. Decline in area of beach and dune habitat in five locations in southeastern New Brunswick between 1944 and 2001.

Study sites Cape Jourimain (1) and Shemogue (2) are undeveloped areas. The other three sites (3–5) are largely residential. For Shediac, the 32% decline was between 1944 and 1971 with little additional loss between 1971 and 2001.

Source: adapted from O'Carroll et al., 2006¹⁰²

Piping plover

The Atlantic population of piping plovers (*Charadrius melodus melodus*), listed as Endangered under Canada's *Species at Risk Act*, prefers early-successional habitat, such as barrier islands converted from sand spits by storm activity (Figure 20).⁷³ In 2002, the global piping plover breeding population was estimated at only 5,945 adults.¹⁰³ In the AME, 442 adults in 2001 and 435 adults in 2006 were detected at breeding sites. Despite active conservation programs there has been a 13% decline in the number of adults from 1991 to 2006 (Figure 20). There are several threats to piping plovers, with predation being one of the most important factors limiting populations across the North American breeding range. Current estimates in eastern Canada suggest that hatching success is less than 55%.¹⁰⁴ In addition, habitat loss and degradation are significant problems. Increased use of beaches and coastal development, including construction of cottages or homes, wharves, jetties, and erosion control structures can impact nesting beaches as well as brood-rearing and foraging habitat.¹⁰⁵ Impacts from climate change are another factor, including storm surges, which are becoming more frequent, and sea-level rise.^{106, 107}

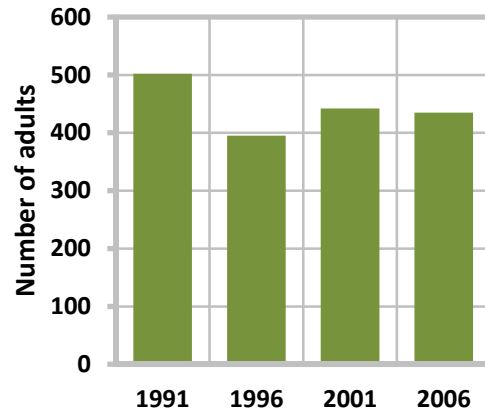
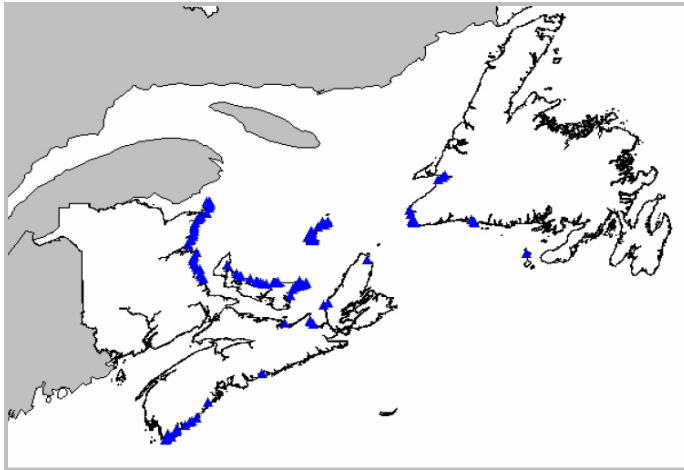


Figure 20. Distribution of 2006 piping plover nesting sites (left, map) and the number of piping plover adults counted during surveys (right, bar chart) in the Atlantic Maritime Ecozone⁺, 1991, 1996, 2001, and 2006.

Count data from International Piping Plover Censuses 1991–2006. Numbers reported reflect “high counts” and include all adults counted during all surveys at all sites (some sites surveyed multiple times). Source: map from Environment Canada, 2006,¹⁰⁶ data from Ferland and Haig, 2002¹⁰³ and Elliot-Smith et al., 2009¹⁰⁸

Coastal development

Since 1990, coastal areas of the AME have become more heavily populated. In New Brunswick, for example, the proportion of coastal subdivisions as a percentage of all subdivisions in the province increased 35% from 1990 to 1999.¹⁰⁹ In Nova Scotia, increased urbanization led to population declines in many rural areas of the province, while populations increased along the coast. There was a dramatic increase in the rates of subdivision and lot registrations on coastal land through the 20th century (Figure 21).⁷⁶

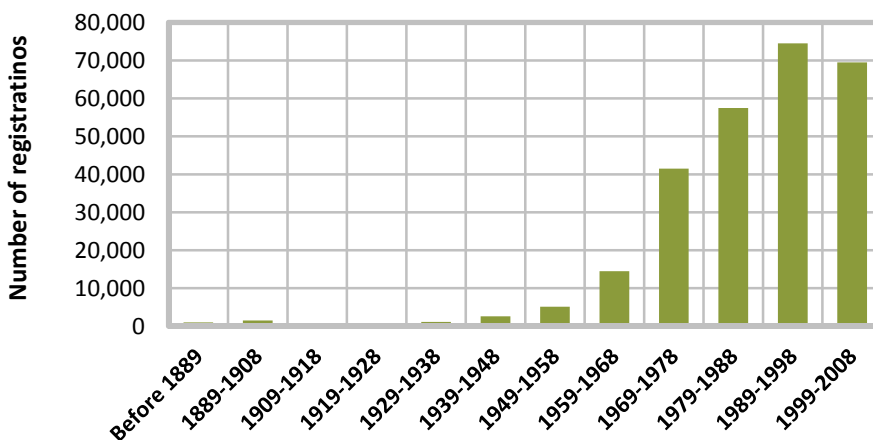


Figure 21. Trends in lot registration within two km of the Nova Scotia coastline by decade. Source: adapted from Nova Scotia Property Online Database by CBCL Limited, 2009⁷⁶

Sea-level rise and coastal erosion

Rates of sea-level rise depend on several factors, including the rate of glacier and ice cap melting, the warming of ocean waters, and isostatic rebound, which is the vertical movement of the Earth's crust.¹¹⁰ A national overview of coastal sensitivity to sea-level rise and associated storm impacts demonstrated that the Atlantic region has some of Canada's most severely threatened coastal areas.¹¹¹ Approximately 80% of the coastline is considered highly sensitive. Its most sensitive coastlines are generally low-lying areas with salt marshes, barrier beaches, and lagoons.

Over the past century, sea level in the Atlantic region has been rising; several harbours have experienced average rise rates of between 22 and 32 cm/century (Figure 22). Average sea level along the coastline of eastern Quebec rose by 17 cm over the last century.^{107, 112} A portion of sea-level rise is likely due to land subsidence after glacier retreat, but much is due to sea-level rise from changing climate. For example, from 1911 to 2005, the annual mean sea level at Charlottetown rose at an average rate of 32 cm/century.¹⁰⁷ Of this, approximately 20 cm/century was likely due to land subsidence after glacier retreat and the remaining 12 cm/century was due to sea-level rise.^{107, 113}

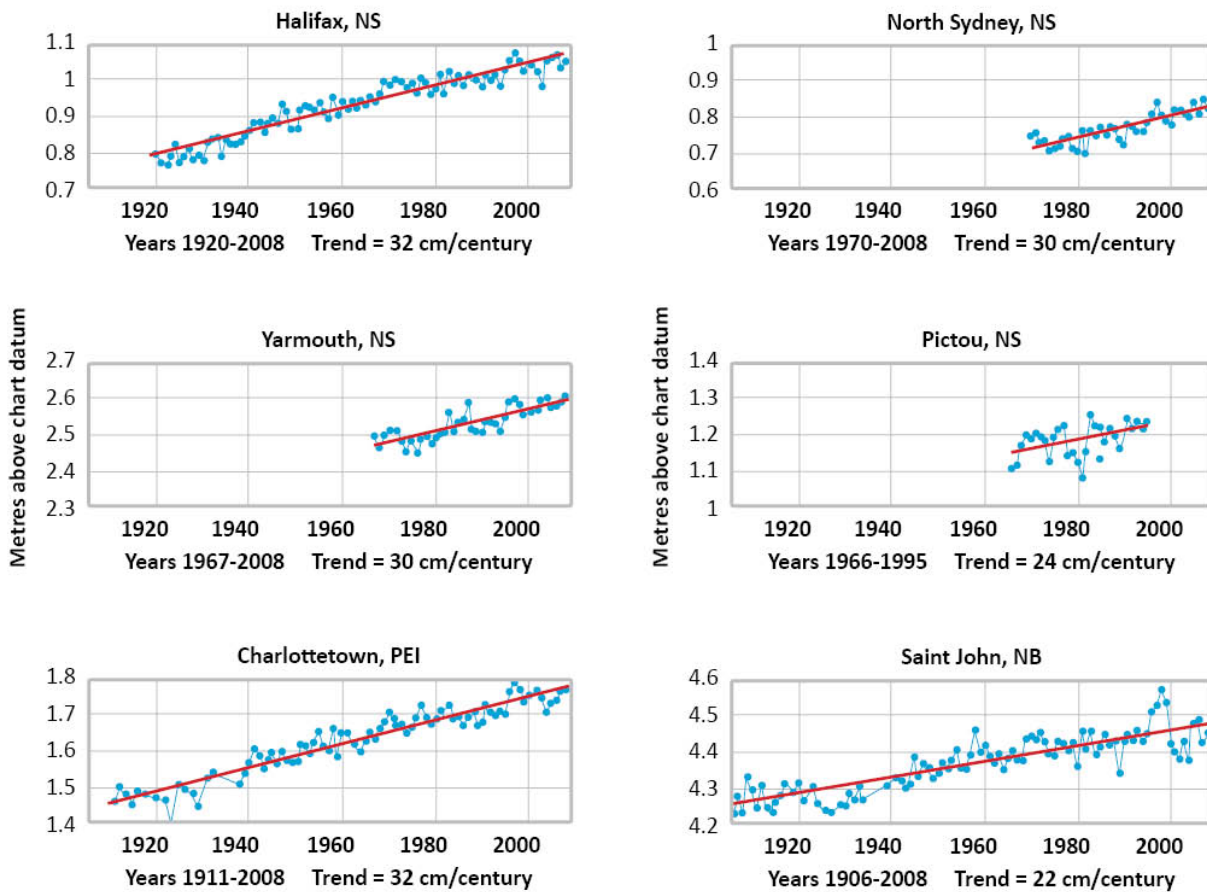


Figure 22. Trend in annual mean water level in six harbours in the Atlantic Maritime Ecozone[†].
Source: CBCL Limited, 2009⁷⁶ using data from Marine Environmental Data Service, Ottawa, 2008¹¹⁴

One of the primary impacts of rising sea levels is an increase in coastal retreat or coastal erosion. Although coastal erosion is a natural phenomenon, rising sea levels as well as other climate change-related impacts to physical and climatic processes will accelerate erosion rates in parts of the AME, such as the Gulf of St. Lawrence.^{115, 116} Accelerated coastal erosion is correlated with changes in climatic variables such as increased storm frequency,^{115, 117} shorter ice season, more freeze/thaw cycles and winter rain events,¹¹⁸ and higher sea levels.¹¹⁶ The most sensitive areas to coastal erosion within the AME are on the Gaspé Peninsula, at the entrance of the Baie des Chaleurs, and around PEI and Îles de la Madeleine.

In some areas of PEI, there is already evidence of a significant increase in coastal erosion rates. For example, erosion rates at Pigots Point, Savage Harbour were 1.4 m/yr from 1968 to 1981 and 3.2 m/yr from 1981 to 1990. This is not necessarily the case throughout the AME, however. In 2006, Environment Canada quantified sea-level rise, storm surge, and coastal erosion on the region's Gulf of St. Lawrence coastal zone and found that coastal retreat rates for southeastern New Brunswick did not increase significantly during the second half of the 20th century.¹⁰⁷

In addition to erosion, other impacts on ecosystems from sea-level rise include higher and more frequent flooding of wetlands and adjacent shores, expanded flooding during severe storms and high tides, accelerated coastal (dune and cliff) retreat or erosion, breaching of coastal barriers and destabilization of inlets, saline intrusion into coastal freshwater aquifers, and damage to coastal infrastructure. Increased storm surge activity also has implications for coastal erosion and flooding (see Natural disturbance section on page 73).

Key finding 7

Theme Biomes

Ice across biomes

National key finding

Declining extent and thickness of sea ice, warming and thawing of permafrost, accelerating loss of glacier mass, and shortening of lake-ice seasons are detected across Canada's biomes. Impacts, apparent now in some areas and likely to spread, include effects on species and food webs.

Although ice is not a defining feature of the AME, it can provide important habitat for species adapted to living in, under, and on top of ice, and provide crossing points for land animals, and help to regulate water circulation. The timing and duration of ice cover on rivers, lakes, and the ocean are important factors in the types of plants and animals that water bodies can support.

River and lake ice

Information on overall trends in river and lake ice break-up and freeze-up in the AME was limited and inconclusive,^{63, 119-121} and trends were limited to individual rivers or lakes (Table 7).¹²² Of the ten sites covered by a recent analysis of data from the volunteer IceWatch program, only one trend, toward a later ice thaw date, was detected from 1950 to 2005.¹²²

Table 7. Trends in lake freeze-up and break-up dates from studies in the Atlantic Maritime Ecozone [†].

Freeze up	Dates	Change over time period	Trend per year	Significance
Grand Lake, NB ¹²⁰	1952–1980	17.4 days earlier	0.6 days/year	<0.1
Lake Utopia, NB ¹²⁰	1971–2000	37.5 days later	1.25 days/year	<0.001
Break up				
Lake Utopia, NB ¹²⁰	1961–1990	15.6 days earlier	0.5 days/year	<0.01
Miramichi River, NB ¹²¹	1829–1955	7.3 days earlier/100 years		<0.01
Saint John River, NB ¹²³	1950s–1980s	15 days earlier		?

Sources are indicated as reference numbers after the name of the lake/river.

Prowse and Culp¹²⁴ provided a review of the effects of ice on instream ecological communities. In general, the life cycles of many aquatic organisms are both directly and indirectly influenced by ice through factors such as ice cover duration, instream temperatures, and hydrological variability. For example, Cunjak *et al.*¹²⁵ demonstrated that the interannual variability in the juvenile survival of Atlantic salmon (*Salmo salar*) in Catamaran Brook, NB, generally improved with increasing average winter flow but the lowest measured survival was associated with an atypical winter breakup and ice jam triggered by rain-on-snow snowmelt events.

Sea ice

Sea ice is important in the AME as it is believed to have a dampening effect on wave action that causes coastal erosion and flooding.¹⁰⁷ In parts of the AME that have sea ice annually, ice cover varies from year-to-year; cycles are apparent and have some correlation with the North Atlantic Oscillation, a phenomenon of fluctuations in the difference in atmospheric pressure between the Icelandic Low and the Azores High, which in turn influences wind strength and direction. In the Gulf of the St. Lawrence, sea ice has shown a tendency toward decreasing ice cover and length of the ice season but these trends were not significant (Figure 23).¹⁰⁷ Saucier and Senneville¹²⁶ suggest that winter sea ice will be gone from the Gulf of St. Lawrence before the end of the 21st century, which could result in significant coastal erosion, including loss of coastal marshes (see Coastal section on page 29).

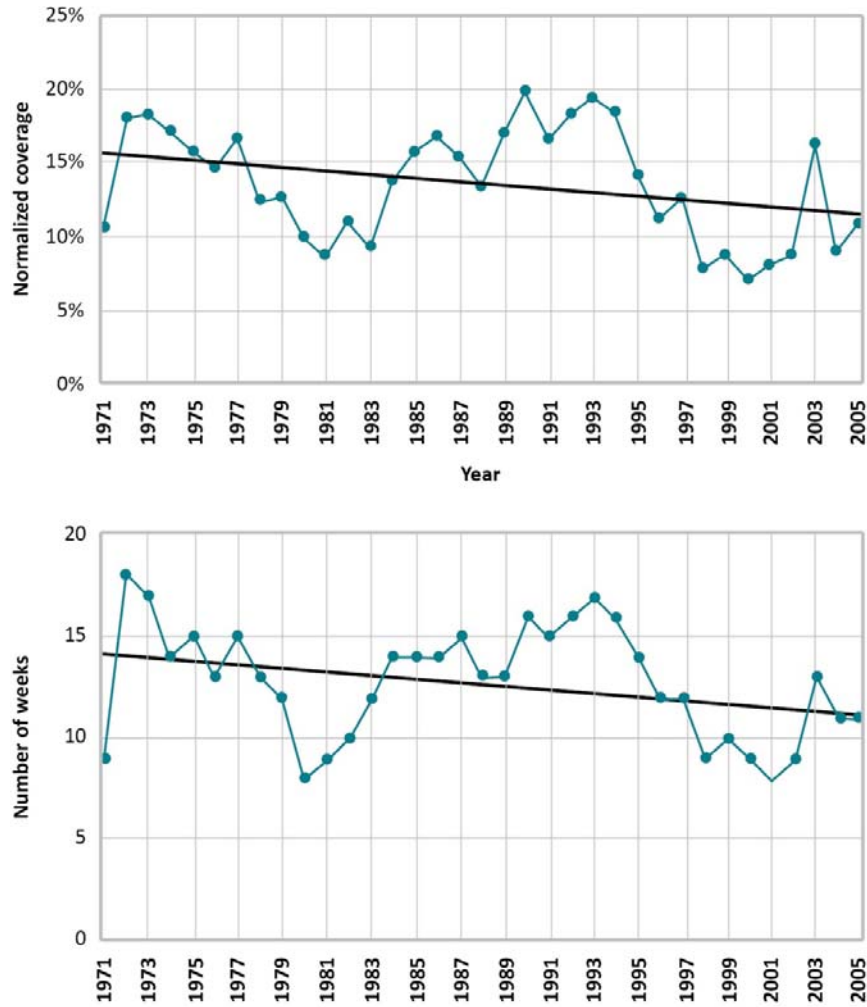


Figure 23. Trend in total accumulated ice coverage (top) and length of season (cover >10%) (bottom) for the Gulf of St. Lawrence, 1971–2005.
 Source: Forbes et al., 2006¹⁰⁷

THEME: HUMAN/ECOSYSTEM INTERACTIONS

Key finding 8

Theme Human/ecosystem interactions

Protected areas

National key finding

Both the extent and representativeness of the protected areas network have increased in recent years. In many places, the area protected is well above the United Nations 10% target. It is below the target in highly developed areas and the oceans.

In 2009, the protected areas in the AME consisted of 617 protected areas that covered 5.3% of the landbase (Figure 24). This total was comprised of 438 protected areas in IUCN categories I–IV (10,963 km²; 4.9% of the AME), 172 protected areas in IUCN categories V–VI (796 km²; 0.4% of the AME), and 7 protected areas (<0.01% of the AME) not classified by IUCN category (Figure 25). IUCN categories I–IV include nature reserves, wilderness areas, and other parks and reserves managed for conservation of ecosystems and natural and cultural features, as well as those managed mainly for habitat and wildlife conservation.¹²⁷ IUCN categories V–VI focus on sustainable use by established cultural tradition within the protected area.¹²⁷ In 1992 (the signing of the Convention on Biological Diversity), 1.6% of the AME was protected.^{iv}

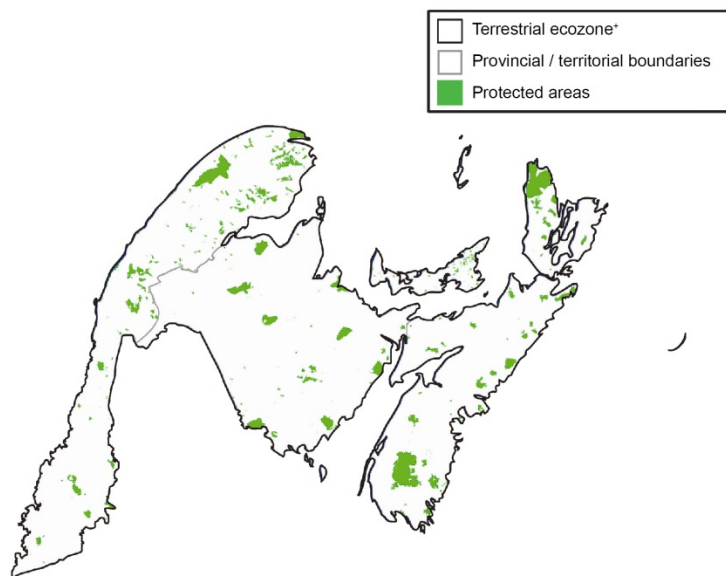


Figure 24. Distribution of protected areas in the Atlantic Maritime Ecozone*, May 2009.

Source: Environment Canada, 2009,¹²⁸ using Conservation Areas Reporting and Tracking System (CARTS) data (v.2009.05)¹²⁹ provided by federal, provincial, and territorial jurisdictions

^{iv} There are 2,100 km² of protected land in the AME with no information on the year established. Even if protected prior to 1992, the percentage of the AME protected prior to 1992 would still be 1.6%.

Prior to 1936, there was only 4 km² in category IV consisting of a single site, Amherst Point Migratory Bird Sanctuary in Nova Scotia, established in 1927. The total amount of protected area increased from under 1,000 km² in 1936, to just over 3,000 km² in 1992, and to over 11,000 km² in 2009 (Figure 25). The creation of seven national parks in the AME was responsible for most of the increases from 1936 to the 1980s. Cape Breton Highlands National Park in northern Nova Scotia, the first and largest national park in the AME (949 km²), was established in 1936. Kejimikujik National Park and National Historic Site in southern Nova Scotia, the second largest protected area in the region (404 km²), was opened in 1974. Recent additions since 1992 have been predominantly provincial parks and protected areas, mainly in Quebec and Nova Scotia.

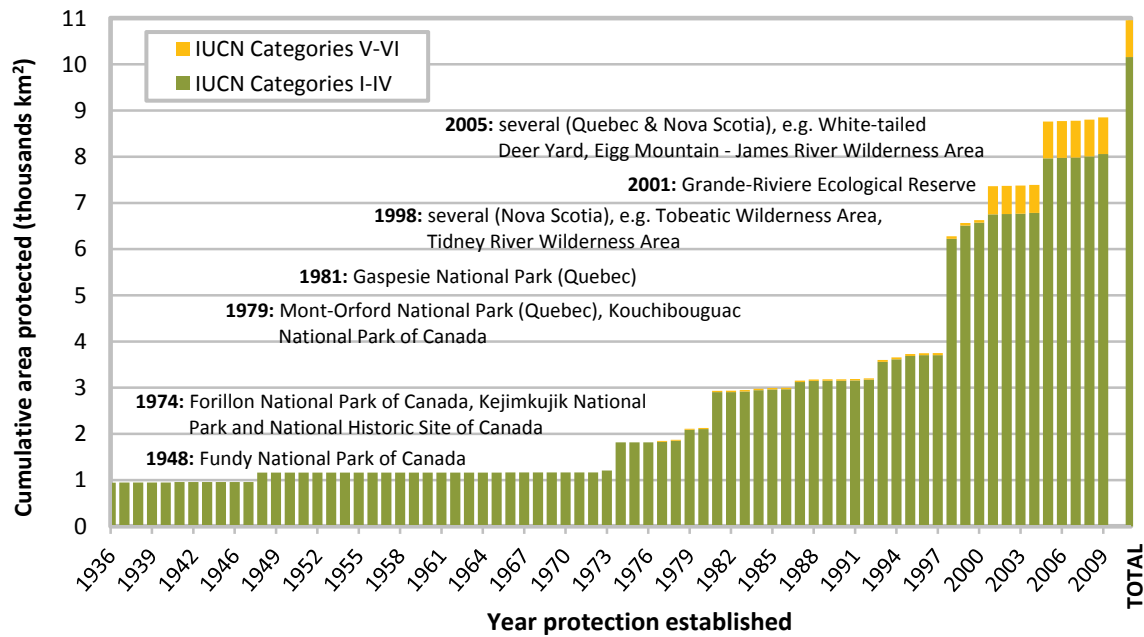


Figure 25. Growth of protected areas in the Atlantic Maritime Ecozone⁺, 1936–2009. Data provided by federal and provincial jurisdictions, updated to May 2009. Only legally protected areas are included. IUCN (International Union for Conservation of Nature) categories of protected areas are based on primary management objectives (see text for more information). The last bar marked 'TOTAL' includes protected areas for which the year established was not provided. Source: Environment Canada, 2009;¹²⁸ using Conservation Areas Reporting and Tracking System (CARTS) data (v.2009.05)¹²⁹ provided by federal, provincial, and territorial jurisdictions

Invasive non-native species

National key finding

Invasive non-native species are a significant stressor on ecosystem functions, processes, and structure in terrestrial, freshwater, and marine environments. This impact is increasing as numbers of invasive non-native species continue to rise and their distributions continue to expand.

Non-native species are plants, animals, or other organisms introduced by human activity into areas outside of their natural ranges. Non-native species are considered *invasive* when their introduction or spread threatens native species or ecosystems, or has the potential to cause considerable harm to the economy or society (e.g., due to their impacts on agricultural crops or forestry). Invasive non-native species are recognized as one of most significant threats to native biodiversity.¹³⁰ Since the AME borders the ocean and has many ports, it has often been a point of entry for invasive non-native species. Comprehensive trend data do not exist for the AME, so this section presents a few examples where data exist.

Invasive plants

The floras of Nova Scotia, New Brunswick, and PEI are composed of 37, 34, and 35% non-native species, respectively (Figure 26). However, there are currently only a few non-native plant species in the AME that appear to be having widespread negative impacts on native biological diversity.¹³¹ Only 36% of reported non-native species in the AME (not including Quebec) are known to be widely established (Figure 27).¹³² In general, the AME was less affected by invasive non-natives than the Great Lakes region or the heavily settled parts of the northeast United States.^{66, 131}

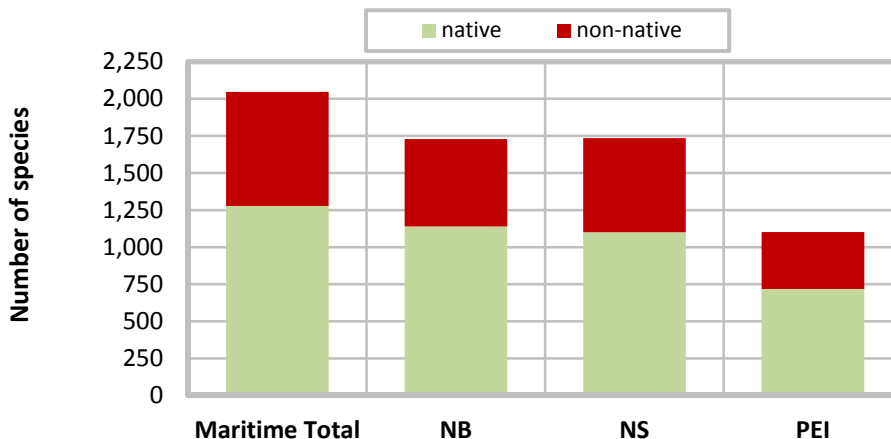


Figure 26. Total number of native and non-native plant species in the Maritime provinces, 2001. Data from Quebec is not included.

Source: adapted from Atlantic Canada Conservation Data Centre, unpublished data¹³³

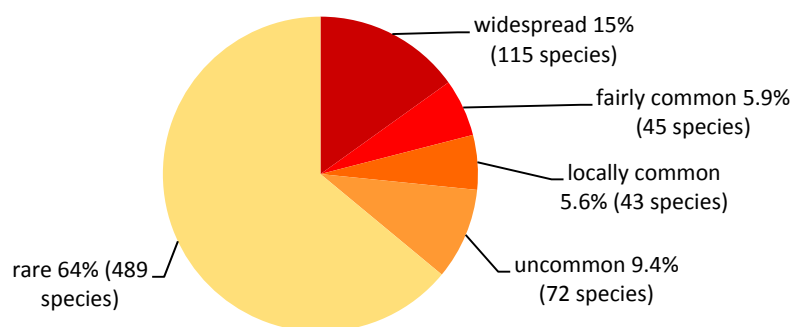


Figure 27. Abundance of non-native plant species in the Maritime Provinces, 2001. Data from Quebec was not included. Source: adapted from Blaney, unpublished data¹³²

Two non-native species in particular represent serious and broad threats: European common reed (*Phragmites australis* ssp. *australis*) and glossy buckthorn (*Frangula alnus*, also known by the synonym *Rhamnus frangula*). Other species of concern are Oriental bittersweet (*Celastrus orbiculatus*), purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), and garlic mustard (*Alliaria petiolata*). Another serious issue in the AME is the invasion of reed canary grass (*Phalaris arundinacea*) in streambeds and river shores.

Invasive non-native insects and diseases

Non-native insects and diseases have had significant ecological impacts,¹³⁴ especially on forest ecosystems.¹⁰ Trend data do not exist but important diseases include white pine blister rust, beech bark disease, and Dutch elm disease. There are 12 major introduced insect pest species in Nova Scotia with introduction dates ranging from the 1890s to 2000 (Table 8). Most of them arrived along the Eastern Seaboard in shipments from Europe over the last century. Many of these affect the entire AME.¹³⁴ Two examples are highlighted below.

Table 8. Major invasive non-native insects, and diseases in Nova Scotia, including year of introduction, location of first introduction to North America, and preferred host species, 1890s–2000.

Insect/disease	Year	Location of first introduction to North America	Preferred host
Beech bark disease	1890s	Halifax, NS	American beech (<i>Fagus grandifolia</i>)
Balsam woolly adelgid (<i>Adelges piceae</i>)	1910s	Western Nova Scotia	Balsam fir (<i>Abies balsamea</i>)
European spruce sawfly (<i>Gilpinia hercyniae</i>)	1922	Ottawa, ON	Spruce (<i>Picea</i> spp.)
Mountain-ash sawfly (<i>Pristiphora geniculata</i>)	1926	New York	Mountain ash (<i>Sorbus americana</i>)
White pine blister rust (<i>Cronartium ribicola</i>)	1929	Chester, NS	Eastern white pine (<i>Pinus strobus</i>)
European winter moth (<i>Operophtera brumata</i>)	1950	Nova Scotia	Oak (<i>Quercus</i> spp.)
Dutch elm disease	1969	Liverpool, NS	American elm (<i>Ulmus americana</i>)
Gypsy moth (<i>Lymantria dispar</i>)	1981	Yarmouth, NS	Hardwoods
Spruce longhorn beetle (<i>Tetropium fuscum</i>)	2000	Halifax, NS	Red spruce (<i>Picea rubens</i>)

Source: adapted from Neily et al., 2007¹³⁴

Beech bark disease

Beech bark canker disease and its associated insect pathogen, beech scale (*Cryptococcus fagisuga*), have effectively eliminated large American beech trees from tolerant hardwood forests of PEI, Nova Scotia, and southern New Brunswick.¹³⁵ Beech was once a major component of these forests. Both the insect and the disease it carried were introduced from Europe through the Port of Halifax and were established in New Brunswick by 1927.¹³⁶ Beech trees that are genetically resistant to infection survive in infected areas.¹³⁶ Considering that beech was one of the most common species in the region, the disease has altered Acadian forest composition and has affected the availability of mast (or beechnuts) which is harvested as a food source.¹⁶

Brown spruce longhorn beetle

In contrast to the spruce budworm (described in the Natural disturbance section on page 76), the brown spruce longhorn beetle (*Tetropium fuscum*) is a new non-native invasive forest pest. It has been present since 1990 in Point Pleasant Park in Halifax,^{10, 137-139} and remains localized to that area.^{138, 139} The potential impact of the species on the forests of the AME and the rest of Canada is uncertain. Though the beetle has infested mainly red spruce in Point Pleasant Park, it is capable of attacking all spruce species native to Canada, other softwood species such as firs, pines, and larches, and occasionally hardwood species.¹⁰

Invasive non-native freshwater species

Invasive non-native freshwater species can affect biodiversity and the health of aquatic ecosystems through competition with native aquatic species. .

Smallmouth bass

Smallmouth bass (*Micropterus dolomieu*) was originally found in lakes and rivers of eastern and central North America. As a result of widespread introductions, it is now found in south and central New Brunswick and Nova Scotia and east from southern Manitoba to Quebec.¹⁴⁰ It moved into New Brunswick in the 1870s¹⁴¹ and, between 1905 and 1948, was stocked in six lakes in the south. As of 2009, it was found in over 70 lakes and 31 rivers in New Brunswick due to unauthorized stocking and natural spread.¹⁴² In 2008, it was first recorded in the Miramichi River drainage, a world-class Atlantic salmon river.¹⁴² In Nova Scotia, smallmouth bass was introduced into 11 lakes between 1942 and 1953 through stocking¹⁴³ and again between 1967 and 1984 (Figure 28).¹⁴⁴ The distribution today includes most of the south and central portion of the province.¹⁴⁴

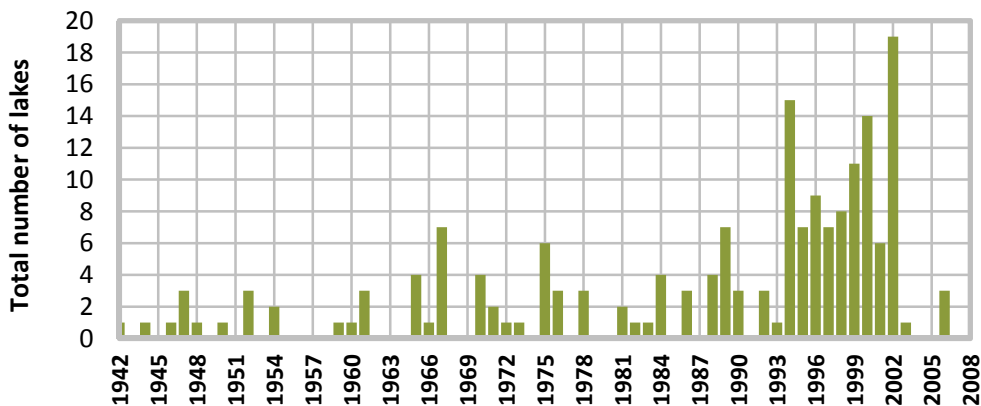


Figure 28. Number of lakes with first known occurrences of smallmouth bass in Nova Scotia, 1942–2008. Source: adapted from LeBlanc, 2009¹⁴⁴

In the AME, smallmouth bass are an effective predator and competitor of other fish, including native Atlantic salmon.¹⁴⁵ The establishment of smallmouth bass in new systems has been shown to alter food webs and resulted in changes in species composition, relative abundance, and habitat use of fish assemblages, particularly for small-bodied fish species.^{143, 146}

Didymo

Didymo (*Didymosphenia geminata*) is a single-celled, microscopic freshwater alga endemic to rivers and lakes in boreal and mountainous regions of the Northern Hemisphere. When the algae produces profuse amounts of stalks, nuisance blooms can develop.¹⁴⁷ Since its first observation in the Matapedia River in the summer of 2006, it was observed in several rivers in Bas-Saint-Laurent, Gaspé Peninsula, and northern New Brunswick.¹⁴⁸ Didymo increased benthic

macroinvertebrate densities thus affecting the aquatic food web of the Matapedia River from 2006 to 2007.¹⁴⁹ When a bloom occurs, the mat can grow to cover extensive areas of stream bed and exposed substrate, causing significant harm to ecosystems.¹⁵⁰ The full extent of impacts on the ecosystem, including salmon, is still uncertain^{147, 148}

Invasive non-native marine species

European green crab

Native to Europe and Northern Africa, the European green crab (*Carcinus maenus*) is one of the world's most successful invaders and has established on temperate coastlines on all continents.¹⁵¹ The main mechanism of spread has been through unintentional transport by the fishing vessel traffic and shipping, especially ships containing ballast water.¹⁵² Green crabs are omnivores and feed voraciously on aquatic plants, bivalves, and particularly on molluscs,¹⁵³ and are competitors for food with native predators and omnivores.¹⁵⁴ In some parts of their introduced range, they have caused declines in other crab and bivalve species and are a threat to shellfish and fishing industries.¹⁵⁴ In the Atlantic Maritime Ecozone⁺, green crabs also threaten valuable eelgrass habitat; they can cut off eelgrass plants right at their shoots and are capable of affecting entire eelgrass meadows.¹⁵⁵

Other potentially important invasive non-native marine species include several tunicates, which are not discussed here.

Key finding 12

Theme Human/ecosystem interactions

Nutrient loading and algal blooms

National key finding

Inputs of nutrients to both freshwater and marine systems, particularly in urban and agriculture-dominated landscapes, have led to algal blooms that may be a nuisance and/or may be harmful. Nutrient inputs have been increasing in some places and decreasing in others.

Although the input of nutrients into groundwater and surface water occurs from many sources including urban, industrial, agricultural, and air-borne, this section focuses on risk of nitrogen and phosphorous loading from agricultural land. This section uses PEI as a case study of the trends in nitrates in groundwater and surface water and Quebec as a case study of trends in phosphorus in rivers.

Nitrogen

Agricultural land^v in the AME have high levels of residual (or excess) soil nitrogen remaining on the land after inputs and outputs have been considered. Residual soil nitrogen levels

^v Agricultural land in this indicator includes Cropland, Pasture, and Summerfallow categories from the Canadian Census of Agriculture.

increased on most cultivated land from 1981 to 2006 (Figure 29). In 2006, the AME had the second highest residual soil nitrogen values of all agricultural ecozones⁺, next to the Pacific Maritime Ecozone⁺.¹⁵⁶ As a result, the potential for leaching of nitrate out of soils and into water is high. In PEI, high nitrate concentrations in groundwater and surface water have become a serious issue for drinking water and ecosystem health.¹⁵⁷

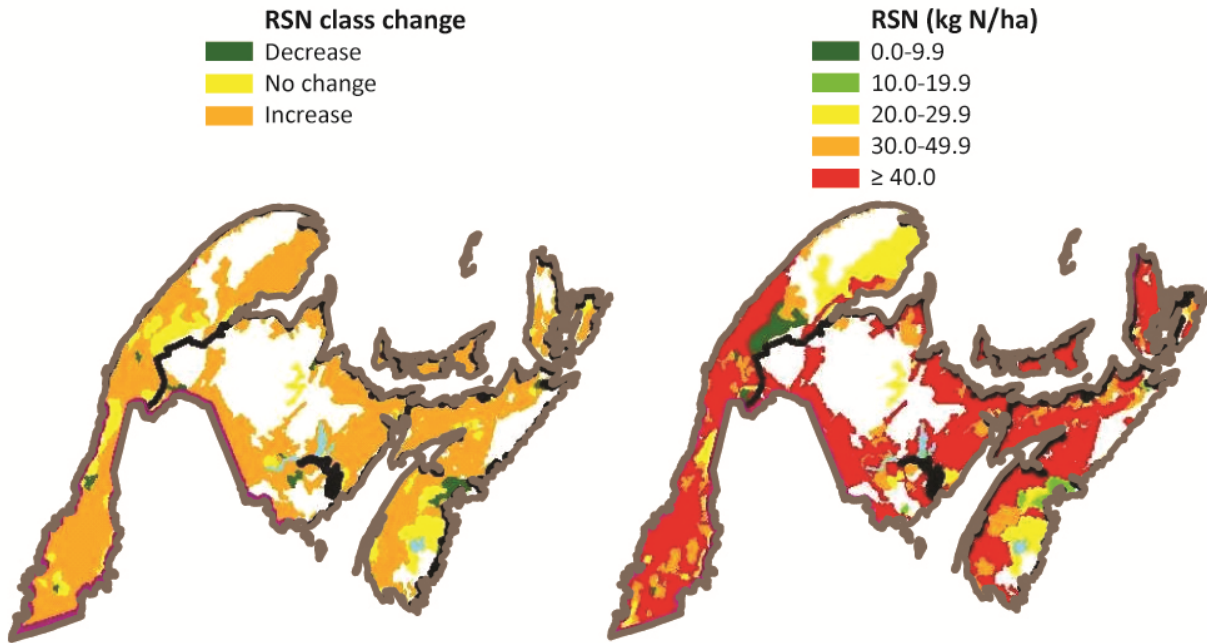


Figure 29. Change in Residual Soil Nitrogen (RSN) risk class from 1981 to 2006 (left) and risk classes in 2006 (right) for agricultural land in the Atlantic Maritime Ecozone⁺.

Agricultural land shown in this figure includes the Cropland, Improved Pasture, and Summerfallow categories from Canadian Census of Agriculture.

0.0-9.9 represents a very low risk class and ≥ 40 represents a very high risk class.

Source: Drury et al., 2011¹⁵⁶

Nitrate levels in groundwater and surface water in PEI

Natural background nitrate levels are typically less than 2 mg/L. Aquatic biodiversity in rivers, streams, and estuaries is more sensitive to nitrate levels greater than 2-3 mg/L, which can inhibit growth, impair the immune system, and stress some species.¹⁵⁷ Since the 1980s, PEI has experienced a steady increase in nitrate levels in groundwater. Average nitrate concentrations in groundwater from tested wells in PEI consistently exceeded 2 mg/L and remained above 3 mg/L between 1984 and 2007 (Figure 30). Nitrate concentrations in PEI's well water vary by watershed and patterns of contamination have remained consistent when compared between 2000-2005 and 2005-2008 (Figure 31). Generally, nitrate concentrations appear strongly associated with agricultural management practices in individual watersheds; watersheds with

the highest nitrate levels are in areas where the highest portion of the land is in potato production.

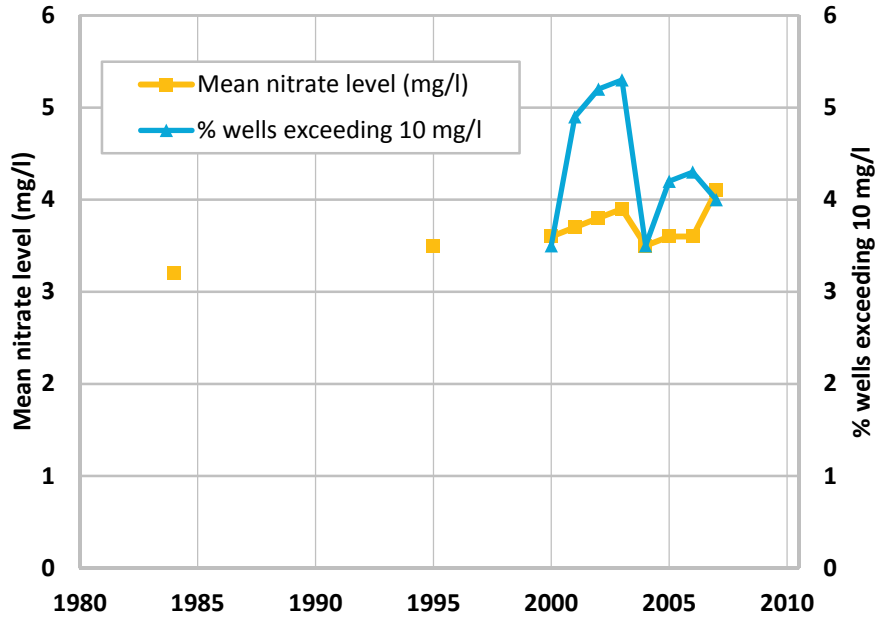


Figure 30. Mean nitrate levels and the percentage of private wells exceeding recommended nitrate concentrations, PEI, 1984–2007.

There were no data from 1985–1994 and 1996–1999.

Source: PEI Department of Environment, Energy and Forestry, unpublished data¹⁵⁸

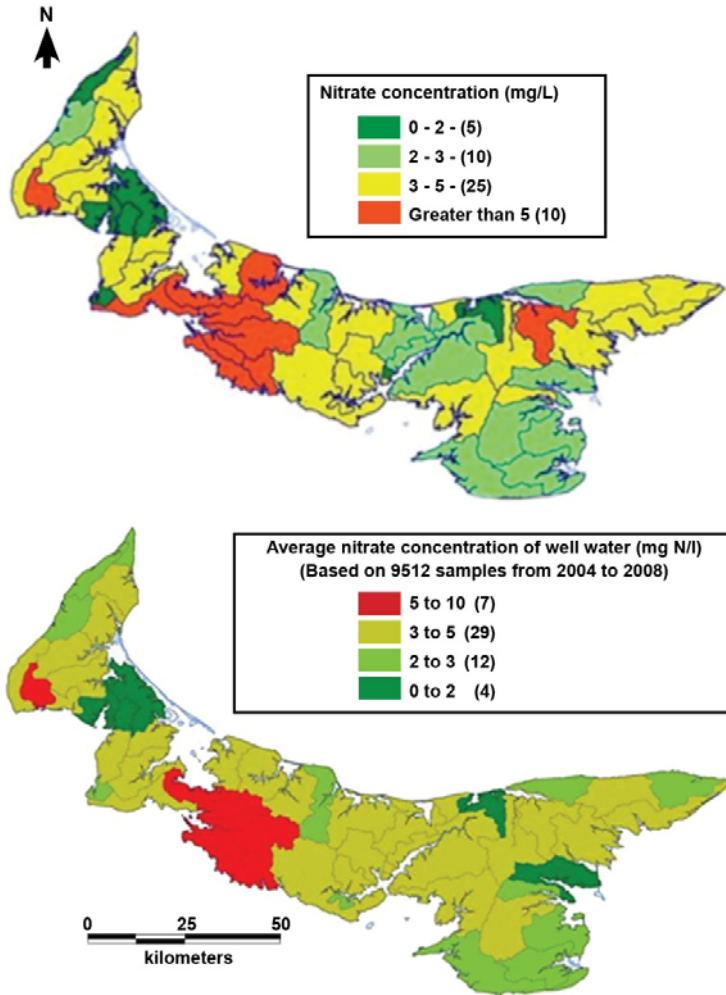


Figure 31. Change in average groundwater nitrate concentrations between 2000–2005 (top) and 2004–2008 (bottom) in watersheds in PEI.

Source: Commission on Nitrates in Groundwater, 2008 (2000–2005 data)¹⁵⁷; and Jiang, unpublished data (2004–2008 data)¹⁵⁹

Groundwater contributes as much as 65% of annual streamflow in a typical stream in PEI.¹⁶⁰ Nitrate enriched groundwater discharges to the local streams, leading to surface water contamination and aquatic ecosystem deterioration.¹⁶¹ Monitoring data for all of PEI indicate nitrate concentrations of stream water have increased over time, and in some cases, have increased several-fold since the 1960s.¹⁶¹ Excessive nutrient inputs can result in eutrophication, where macro algal overgrowth and dinoflagellate (phytoplankton) blooms deplete oxygen and/or release toxic substances, killing or choking out other wildlife. Algal overgrowth and dinoflagellate blooms can result from even relatively low levels of nitrate contamination (<2 mg/L), which lead to large-scale hypoxic or “dead zones”.^{161, 162} Between 2002 and 2008, 18 estuaries in PEI, the majority of which are on the north shore, were subject to recurring anoxic events (Figure 32).¹⁶³ Elevated nitrate in surface water has been suggested as one of the factors associated with the anoxia events.¹⁶¹

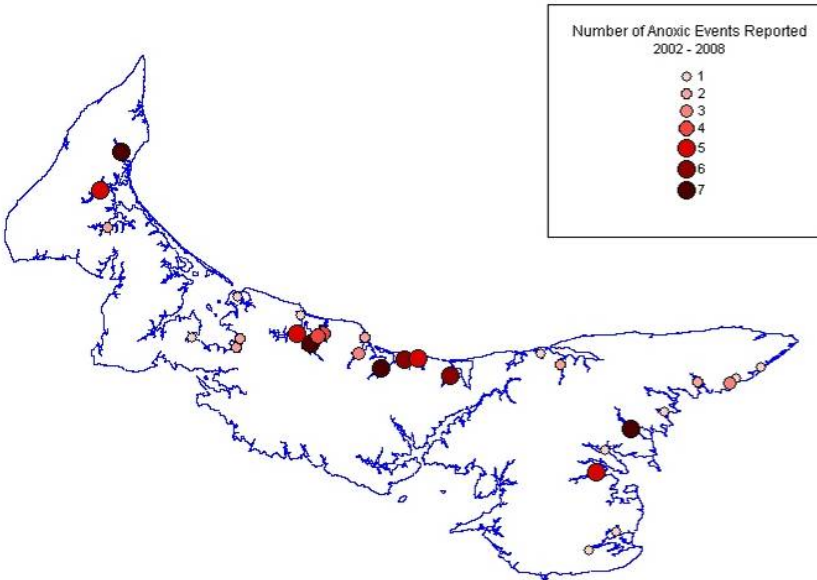


Figure 32. Number of anoxic events reported on Prince Edward Island between 2002 and 2008.
 Source: PEI Department of Environment, Fisheries and Forestry, unpublished data

Phosphorous

According to monitoring data collected by Agriculture and Agri-Food Canada, from 1981–2006, risk of surface water contamination from soil phosphorus has increased in Canada, with an increasing percentage of agricultural watersheds at high and very high risk for contamination by phosphorus.¹⁶⁴ In Quebec and the Atlantic provinces, in particular, risk has gradually shifted from lower to higher risk classes since 1991 (Figure 33).¹⁶⁴ In terms of the amount of phosphorus in soils, the amount of farmland in Quebec and the Atlantic provinces exceeding the threshold value of 4 mg of phosphorus/kg of soil has increased from less than 2% in 1981 to over 33% in 2006.¹⁶⁵

Phosphorus concentrations in rivers in Quebec

In contrast to the results for agricultural lands above, phosphorus concentrations decreased by more than 50% at one station, between 0 and 50% at a second station, and were stable at three stations between 1988 and 1998 in rivers within the Quebec portion of the AME.¹⁶⁶ However, phosphorus levels also decreased at a series of control sites (witness stations) on rivers in the Appalachian Mountain lowlands when comparing 1979–2002 to 2000–2002.¹⁶⁶ These sites have watersheds with little to no human settlement. This suggests the factors influencing phosphorus concentrations in rivers may be declining naturally, regardless of human activities.

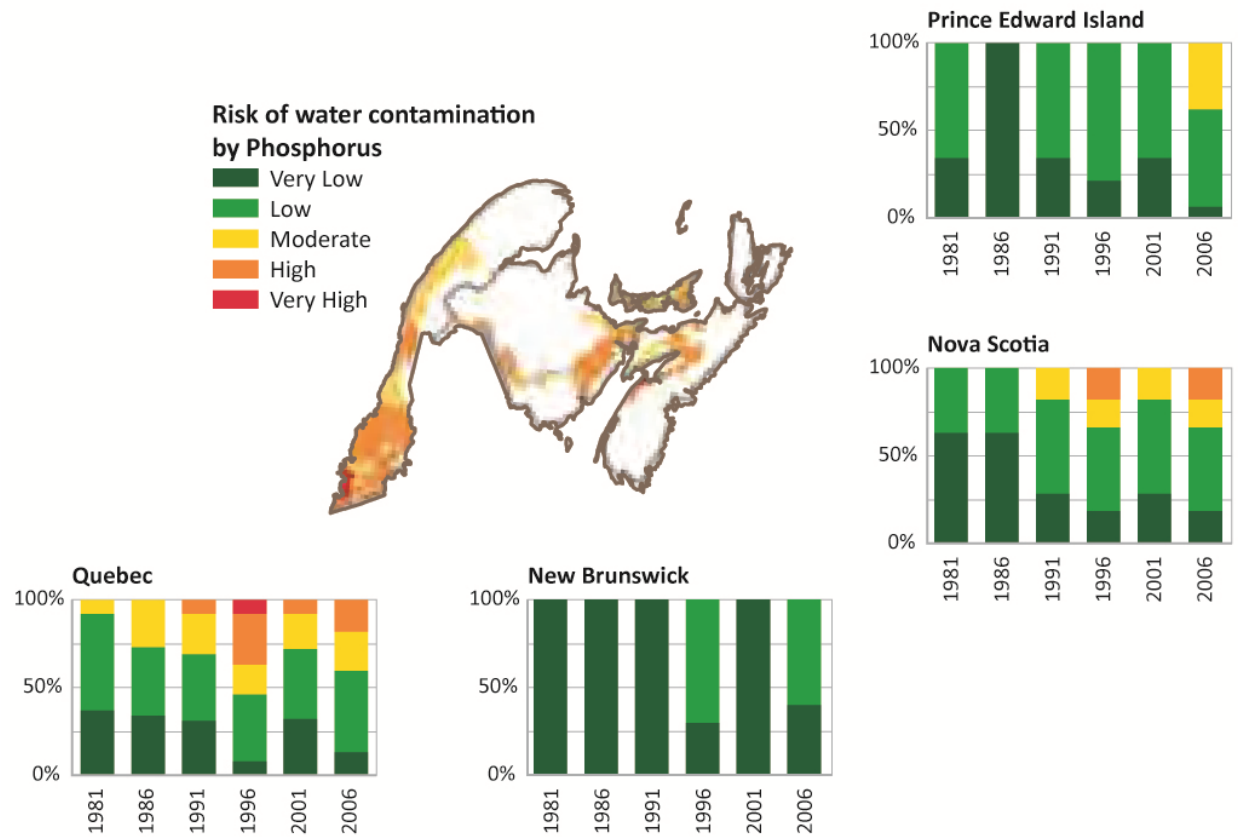


Figure 33. Risk of water contamination by phosphorous in agricultural watersheds under 2006 management practices in the Atlantic Maritime Ecozone⁺ (map) and trend in the proportion of farmland in each risk class, 1981–2006, by province (bar graphs).

The Indicator of Risk of Water Contamination by Phosphorus (IROWC-P) was developed to assess the trends over time for the risk of surface water contamination by P from Canadian agricultural land at the watershed scale.

Quebec bar graph includes some area outside of the ecozone⁺.

Source: adapted from van Bochove et al., 2010¹⁶⁴

Algal blooms in Quebec

Blooms in blue-green algae (*Cyanobacteria*) have been linked to high phosphorus levels in surface water.¹⁶⁷ The number of lakes and rivers affected by blue-green algae in the Quebec portion of the AME has increased from three to 16 lakes between 2004 and 2008 (Figure 34).

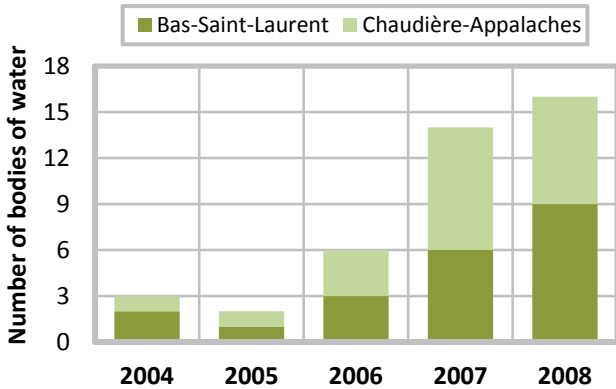


Figure 34. Number of lakes and rivers where blue-green algae was detected for Quebec administrative units that overlap with the Atlantic Maritime Ecozone[†], 2004–2008.

The Quebec administrative units that have the majority of their area in the AME are bas-Saint-Laurent and Chaudière-Appalaches.

Source: adapted from Ministère du Développement durable, de l'Environnement et des Parcs, 2009¹⁶⁸

Key finding 13

Theme Human/ecosystem interactions

Acid deposition

National key finding

Thresholds related to ecological impact of acid deposition, including acid rain, are exceeded in some areas, acidifying emissions are increasing in some areas, and biological recovery has not kept pace with emission reductions in other areas.

As a result of emission reductions, levels of sulphate and nitrate deposition in the AME decreased substantially between 1990 and 2004 (Figure 35).¹⁶⁹ Nonetheless, due to the poor buffering ability of its geology and soils, much of the AME is highly sensitive to acid¹⁷⁰ and atmospheric sulphur and nitrogen deposition exceeded critical loads in several areas from 1999 to 2003 (Figure 36).¹⁷¹ Of particular concern is the potential long-term impact on forest health, for example, reduced growth rates, reduced productivity, increased mortality, and eventual changes in the composition of forest species.^{169, 171-173}

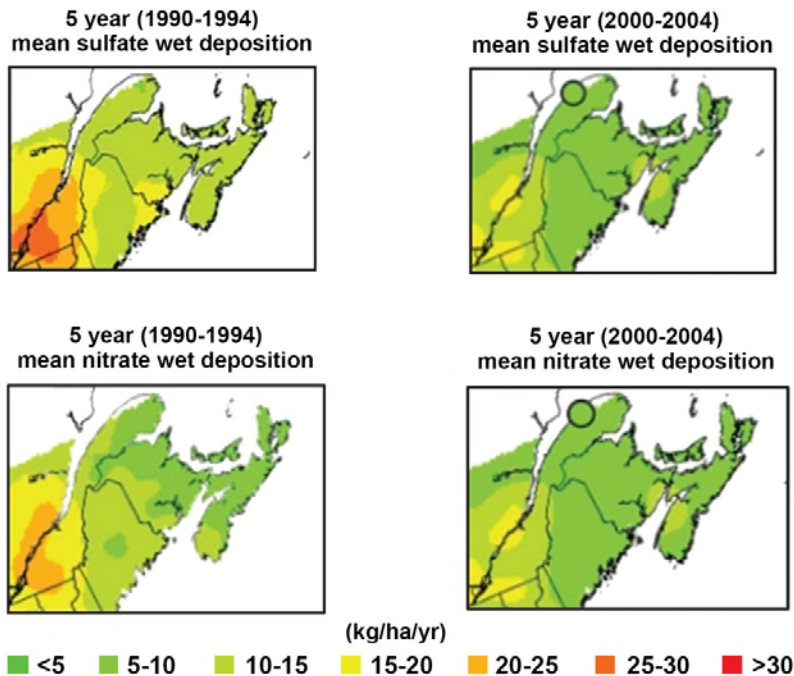


Figure 35. Trend in wet sulphate and wet nitrate deposition in the Atlantic Maritime Ecozone[†], 1990–1994 and 2000–2004.

Source: adapted from Commission for Environmental Cooperation, 2008¹⁶⁹

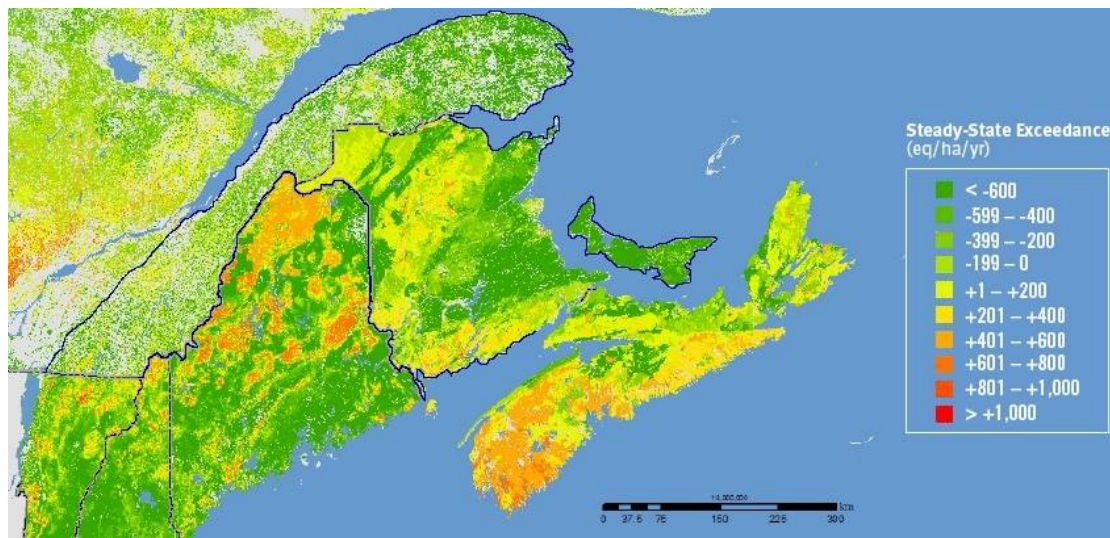


Figure 36. Map of forest areas in the New England states and eastern Canadian provinces where critical load has been exceeded due to acid deposition, ca. 1999–2003.

Data for atmospheric deposition rates from 1999–2003 in New England states and 1999–2002 in Quebec and the Atlantic provinces. Yellow, orange, and red areas are where sulphur and nitrogen have exceeded their critical loads. Green areas are where critical loads have not been exceeded.

Source: modified from New England Governors/Eastern Canadian Premiers Forest Mapping Group, 2007¹⁷¹

Another concern is the impact on fish and freshwater systems. The AME includes North America's most heavily affected region in terms of the percentage of fish habitat lost due to acid rain.^{170, 174} Atlantic salmon are highly sensitive to acidity, and by 1996, 14 runs in coastal Nova Scotia were extinct because of water acidity, 20 were severely impacted, and a further 15 were lightly impacted.¹⁷⁵ There has been no measurable change in pH despite declines in sulphur dioxide emissions and recovery of water chemistry and ecology is expected to take several more decades in Nova Scotia than in other parts of Canada.^{170, 175, 176} Recent research also suggests that the main driver of fish impacts is aluminum, which has been activated by acid deposition and reached levels that are toxic to fish.¹⁷⁷

Key finding 14

Theme Human/ecosystem interactions

Climate change

National key finding

Rising temperatures across Canada, along with changes in other climatic variables over the past 50 years, have had both direct and indirect impacts on biodiversity in terrestrial, freshwater, and marine systems.

Trends in climatic variables

Table 9 summarizes significant trends in climatic variables in the AME from 1950 to 2007. The ecozone⁺ is characterized by large variability at interannual and decadal to multi-decadal scales. Across the ecozone⁺ as a whole, summer temperatures increased by only 1.1°C (Table 9, Figure 37). Relative to the rest of Canada, temperatures in the AME, Newfoundland Boreal, and Mixedwood Plains ecozones⁺ rose the least over the 1950 to 2007 period.¹⁷⁸ In the AME, this was related to a widespread cooling trend over the northeast Atlantic ocean from approximately 1950 to 1980.¹⁷⁹

Table 9. Summary of changes in climate variables in the Atlantic Maritime Ecozone⁺, 1950–2007.

Climate variable	Overall ecozone ⁺ trend (1950–2007)	Comments and regional variation
Temperature	<ul style="list-style-type: none"> • ↑ of 1.1°C in summer • No trend in spring, fall, or winter 	<ul style="list-style-type: none"> • Trends are consistent across ecozone⁺ • Spring temperatures ↑ at two stations, near Sussex, NB, and Greenwood, NS
Precipitation	<ul style="list-style-type: none"> • ↑ of 18.6% in fall • ↑ number of days with precipitation in spring, summer, and fall • No trend in ratio of snow to total precipitation 	<ul style="list-style-type: none"> • ↑ in fall largely concentrated around northern portion of ecozone⁺
Snow	<ul style="list-style-type: none"> • No trend in maximum snow depth or duration 	<ul style="list-style-type: none"> • Snow cover season ↓ by >20 days at some stations (spring and fall) • Maximum snow depth ↓ by >40 cm at some stations
Drought Severity Index	<ul style="list-style-type: none"> • No trend • No extreme wet or severe drought years 	<ul style="list-style-type: none"> • ↑ of >2 index units near Rimouski, QC (index ranges from 4 to –4) • ↓ of >2 index levels near Saint John, NB
Growing season	<ul style="list-style-type: none"> • No change in length or start and end data 	<ul style="list-style-type: none"> • ↑ in length of growing season between 20–40 days and earlier start by 15–30 days at one station at the southern tip of Quebec • Growing season started 0–15 days earlier at 3 stations around the Bay of Fundy

Only significant trends ($p < 0.05$) are shown.

Source: Zhang et al., 2011¹⁷⁸ and supplementary data provided by the authors

Fall precipitation increased as did the number of days with precipitation in spring, summer, and fall (Table 9), although there was some variation across stations (Figure 38). No overall trends in snow cover duration and annual maximum snow depth were found, however, trends were significant at a few individual stations where they consistently showed a shorter duration of snow cover (Figure 39) and lower maximum snow depths. Changes in precipitation have an impact on hydrology as discussed in the Lakes and rivers section on page 29.

Climate stations were well distributed across the AME and trends at individual stations were generally well reflected in the overall trends. There were some exceptions where individual stations showed significant changes that were different from the overall trends (see Table 9, Figure 37, Figure 38, and Figure 39).

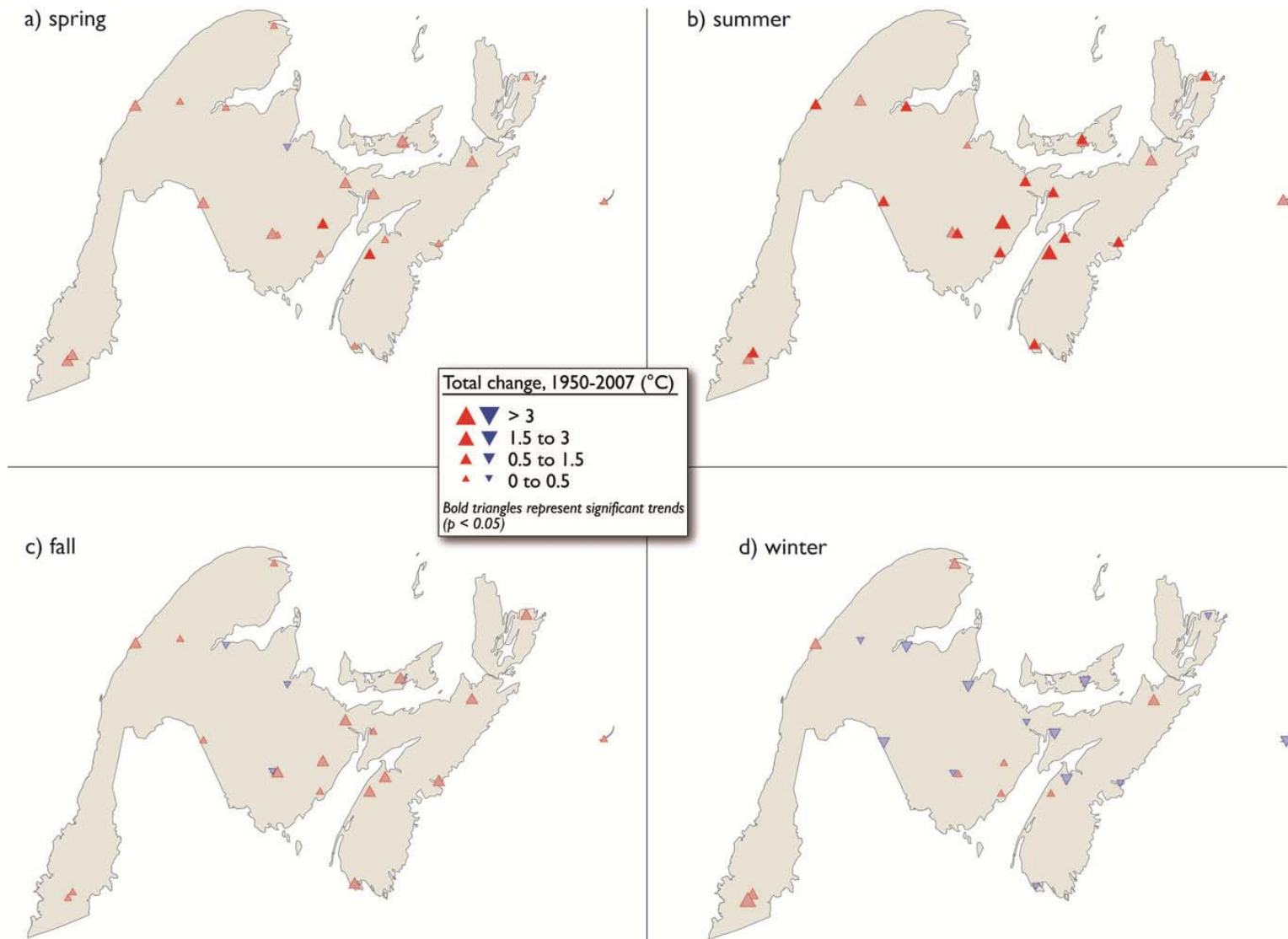


Figure 37. Change in mean temperatures in the Atlantic Maritime Ecozone⁺, 1950–2007, for: a) spring (March–May), b) summer (June–August, c) fall (September–November), and d) winter (December–February).

Source: Zhang et al., 2011¹⁷⁸ and supplementary data provided by the authors

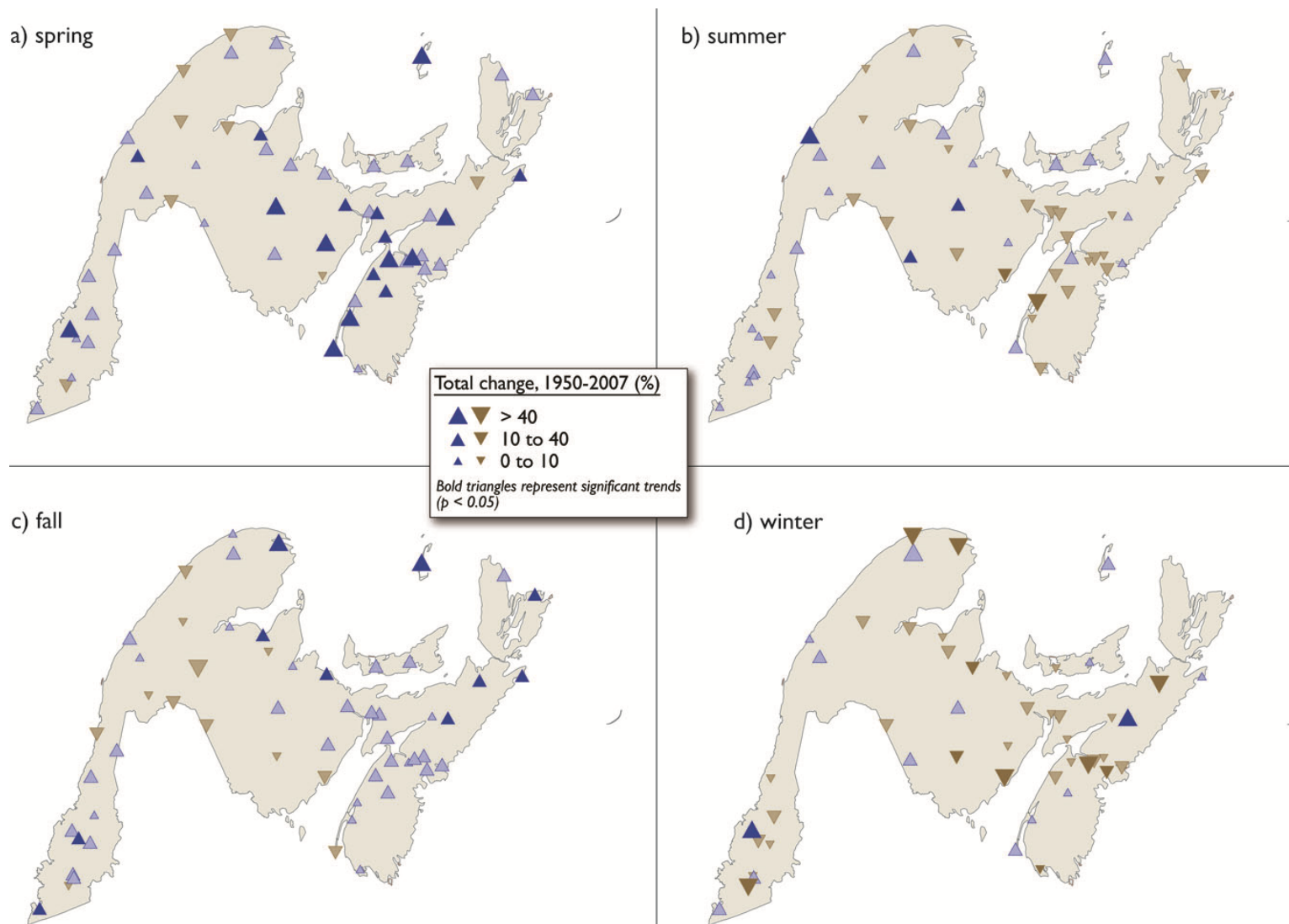


Figure 38. Change in the amounts of precipitation in the Atlantic Maritime Ecozone⁺, 1950–2007, for: a) spring (March–May), b) summer (June–August), c) fall (September–November), and d) winter (December–February). Expressed as a percentage of the 1961–1990 mean. Source: Zhang et al., 2011¹⁷⁸ and supplementary data provided by the authors

a) August to January



b) February to July



Figure 39. Change in snow durations (the number of days with ≥ 2 cm of snow on the ground) in the Atlantic Maritime Ecozone[†], 1950–2007, in: a) the first half of the snow season (August–January), which indicates change in the start date of snow cover, and b) the second half of the snow season (February–July), which indicates changes in the end date of snow cover.

Source: Zhang et al., 2011¹⁷⁸ and supplementary data provided by the authors

Future climate predictions

Climate change is expected to have a range of effects of the AME. These include:

- Increased average annual air temperatures, although likely less than other parts of Canada;¹⁸⁰
- Increased river water temperatures;¹⁸¹
- A longer, warmer growing season;¹⁸¹
- Decreased sea ice cover in the Gulf of St. Lawrence;¹²⁶
- Changes in storm intensity and frequency;¹⁸² and Changes in forest composition (e.g., a reduction in the proportion of yellow birch and an expansion by white birch and poplar).²⁶

Some fish species, such as Atlantic salmon, are cold-water species, and warmer waters could have a negative impact their growth.¹⁸¹ Warmer waters can increase salmon's susceptibility to disease and infection, increase mortality rates, and decrease the availability of suitable habitat. Modeling suggests that climate change could increase river water temperatures in the region by 2–5° C and produce more extreme low flow conditions.¹⁸¹ Research in the Miramichi River examined the relationship between climate, hydrological parameters, and the length of juvenile salmon (parr) and detected a significant decline in length. Fish length is an indicator of growth that also affects competition, predation, smoltification, and marine survival. This relationship was associated with the warming observed and the results suggest that future climate change will adversely affect juvenile salmon in the Miramichi River.¹⁸¹

Key finding 15

Theme Human/ecosystem interactions

Ecosystem services

National key finding

Canada is well endowed with a natural environment that provides ecosystem services upon which our quality of life depends. In some areas where stressors have impaired ecosystem function, the cost of maintaining ecosystem services is high and deterioration in quantity, quality, and access to ecosystem services is evident.

Ecosystem services are the direct goods and indirect services from a healthy, natural environment that ensure human well-being. These include four different types of services: provisioning services, regulating services, supporting services, and cultural services. Provisioning services in the AME include forest products, water, food, and commercial freshwater fishing. Regulating services such as wastewater assimilation are important, as are the supporting services provided by wetlands. Ecosystems also contribute important cultural services, such as recreational fishing, hunting, outdoor recreation, and tourism.

Valuation of ecosystem goods and services accounts for ecosystem stocks and flows using biophysical or monetary measures. Basic economic analysis typically accounts for flows of goods from ecosystems including, for example, forest products, fish, food, and energy and

mineral resources. These are traded in economic markets and their value over time may serve as indicators of ecosystem status and trends. Other ecosystem goods and services, however, such as climate regulation, water purification, and waste assimilation are not traded in markets and are referred to as non-market goods and services.

The combined estimated value of ecosystem goods and services for the Atlantic provinces (excluding the Quebec portion of the AME, because it could not be easily separated out from other parts of Quebec) is over \$4.7 billion (Table 10).

Table 10. Summary of the estimated values of ecosystem goods and services in the Atlantic Maritime Ecozone[†], excluding the Quebec portion.

Service	Year	Value (millions)**	Measure
Water	Various	\$2,434	Various
Forests	2006	\$466	GDP + farm value
Outdoor recreation	1996	\$463	Expenditures
Fishing (commercial)	2006	\$406	Landed value
Agriculture	2006	\$347	Added value
Tourism	2006	\$300	Expenditures
Wetlands*	2007	\$122	Choice experiment
Recreational fishing	2006	\$122	Expenditures
Total		\$4,753	

* Wetland figures not included in total to avoid double counting

** Values converted to 2006 dollars

Source: Eaton, 2013⁴ using data from various sources

THEME: HABITAT, WILDLIFE, AND ECOSYSTEM PROCESSES

Key finding 16

Theme Habitat, wildlife, and ecosystem processes

Agricultural landscapes as habitat

National key finding

The potential capacity of agricultural landscapes to support wildlife in Canada has declined over the past 20 years, largely due to the intensification of agriculture and the loss of natural and semi-natural land cover.

Although some biodiversity is lost when land is converted to agriculture, agricultural lands still contribute significant biodiversity values as the varied habitats on agricultural landscapes provide some or all of the requirements for many wildlife species.¹⁸³

Agricultural lands^{vi} comprised close to 10% of the AME in 2006 and were characterized generally by small-scale farming. With the exception of a few areas of higher production (e.g.,

^{vi} Agricultural land in this section was defined as cropland, summer fallow, pastureland, and woodlands and wetlands that were reported by farmers in the Canadian Census of Agriculture.

PEI, Annapolis–Minas Lowlands, Saint John River Valley), agricultural land made up a relatively small component of the broader landscape (Figure 40).¹⁸⁴ Most agricultural areas were made up of a diversity of cover types that included a considerable amount of natural and semi-natural land. The relatively light agricultural footprint along with the presence of abundant, high-value habitat on agricultural land means that the influence of agriculture on habitat is much less here than in the major Canadian agricultural ecozones[†].

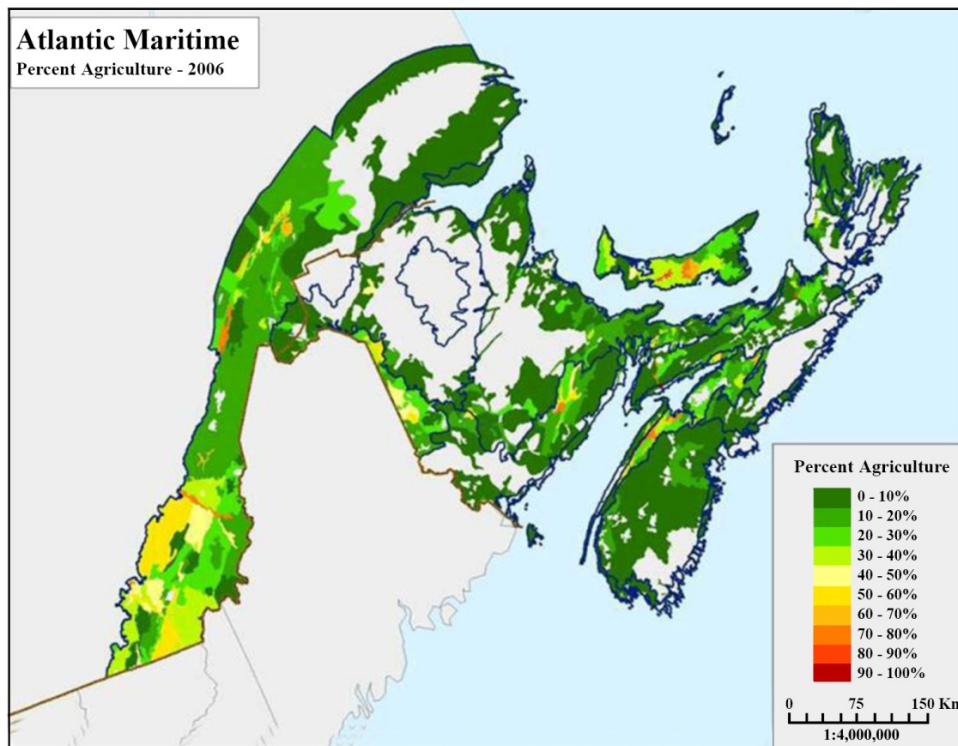


Figure 40. Percentage of land defined as agricultural in the Atlantic Maritime Ecozone[†], 2006. Soil Landscapes of Canada polygons were the base unit used for this analysis. Source: Javorek and Grant, 2011¹⁸⁴

From 1986 to 2006, the total agricultural land shrank by about 6% (from 22,000 to 20,800 km²). The share of “All Other Land” declined from approximately 49 to 47% of the total agricultural landscape. Tame Hay, the second most abundant cover type, expanded its share from 21 to 26%, while both Improved Pasture (9 to 5%) and Unimproved Pasture (9 to 6%) declined. The share of Other Crops expanded from 2 to 3%, mainly due to increased potato production on Prince Edward Island and in the Saint John River Valley (Figure 41).¹⁸⁴

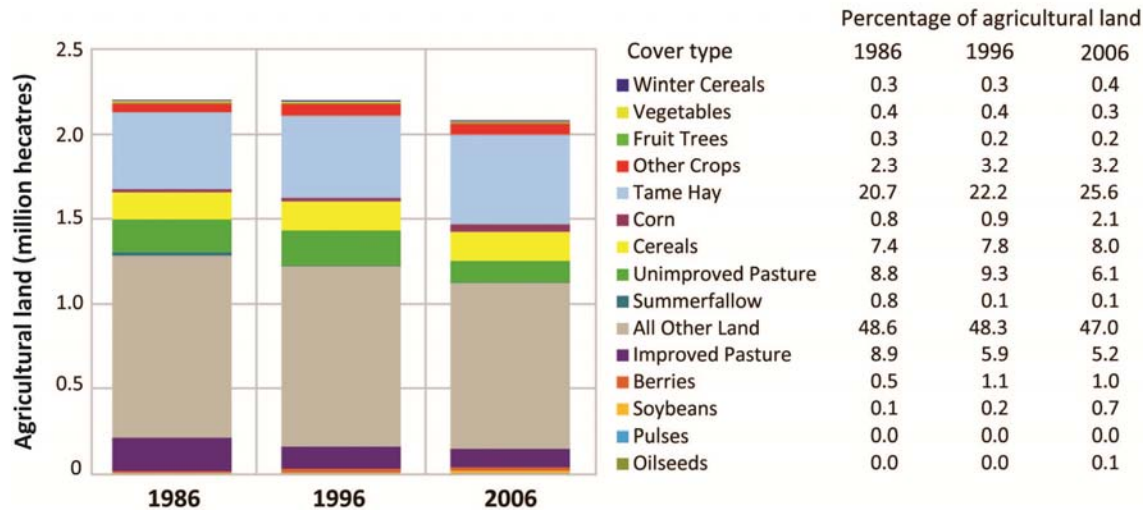


Figure 41. Total agriculture area, the amount of land per cover type (bar chart), and the relative percentage of each cover type (table) for the Atlantic Maritime Ecozone⁺ in 1986, 1996, and 2006. Source: Javorek and Grant, 2011¹⁸⁴

Wildlife habitat capacity on agricultural land

A total of 292 species (215 birds, 52 mammals, 9 reptiles, and 16 amphibians) potentially use this agricultural landscape, with 88% associated with wetland, riparian, shelterbelts, woodland, old field, and idle land (All Other Land category). The All Other Land category was the dominant land cover type making up close to half of the total agricultural land base. The capacity of agricultural landscapes to provide habitat for wildlife was calculated for the years 1986, 2001, and 2006 using a model that ranked land cover types based on potential uses (e.g., breeding and reproduction, migration, wintering) and value (primary, secondary, or tertiary) for different species into ten categories (see legend in Figure 42).¹⁸⁴ In 2006, average wildlife habitat capacity on agricultural land was rated as high despite a significant decline since 1986 (Figure 42). Between 1986 and 2006, habitat capacity decreased on 43% of agricultural land, increased on 28%, and was constant on 29% (Figure 43). Declining habitat capacity trends were associated with a number of areas reporting more intense agricultural activity. The significant decline resulted from a general expansion of the comparatively low habitat Cropland (32 to 36%) and a decline of cover types with higher value to wildlife.¹⁸⁴ Despite this decline, average wildlife habitat capacity in the AME remained high.

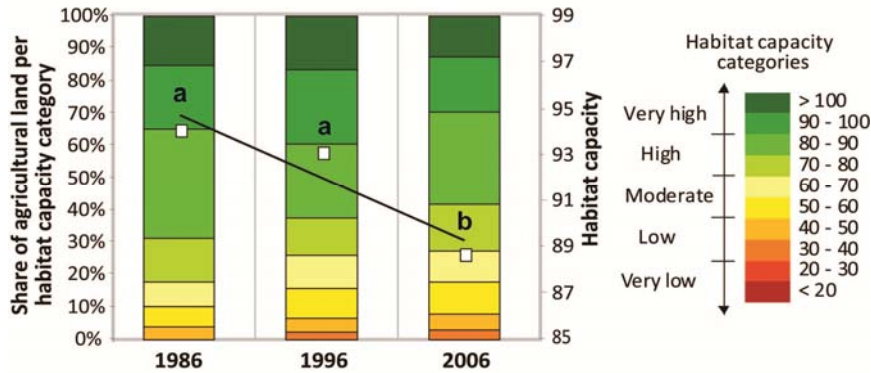


Figure 42. The share of agricultural land in each habitat capacity category (left axis, stacked bars) and the average habitat capacity (right axis, points and line) for the Atlantic Maritime Ecozone⁺ in 1986, 1996, and 2006.

Years with different letters indicate a statistically significant difference.

Source: Javorek and Grant, 2011¹⁸⁴

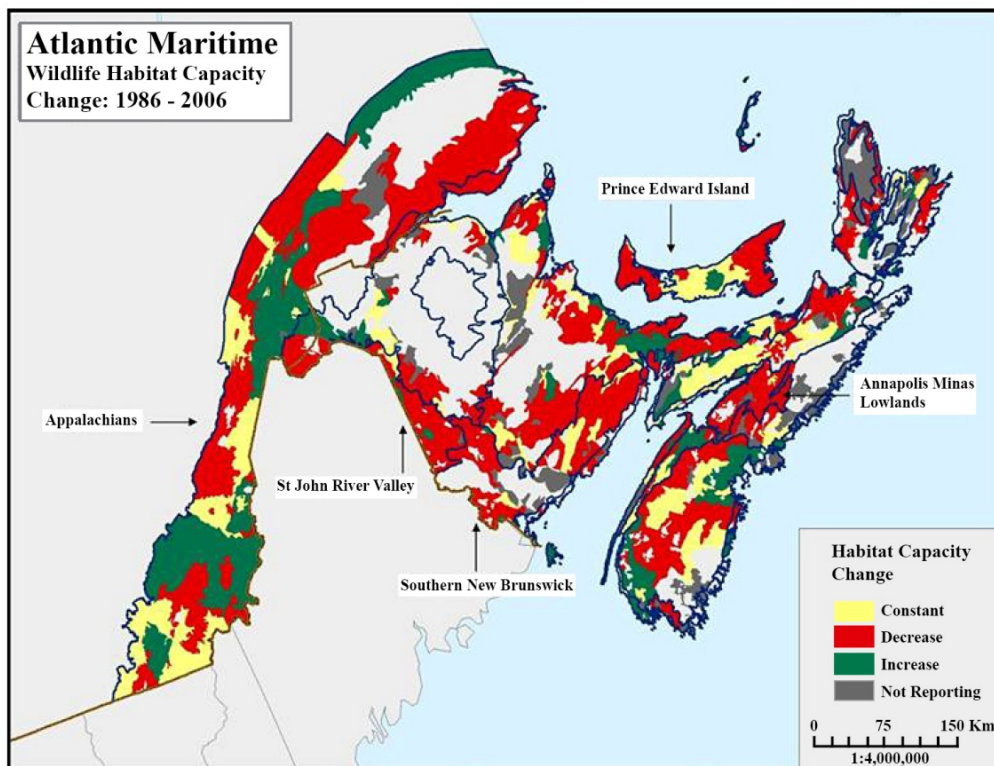


Figure 43. Change in wildlife habitat capacity on agricultural lands in the Atlantic Maritime Ecozone⁺, 1986–2006.

All Soil Landscapes of Canada (SLC) polygons with >5% agricultural land were included in the analysis.

Source: Javorek and Grant, 2011¹⁸⁴

Soil erosion on cropland

Occupying only 4% of the total land area, cropland^{vii} in the AME has some of the highest erosion risk on agricultural land in Canada due to intensive tillage and a climate that poses a high threat of water erosion of unprotected soils in some areas.¹⁸⁵ However, the risk of soil erosion declined in the AME from 1981 to 2006. McConkey *et al.*¹⁸⁵ found that 36% of the cropland was classified as having unsustainable erosion risk in 2006 (Figure 44), down from 41% in 1981. In 2006, 18% of agricultural land was at moderate to very high erosion risk compared to 20% in 1981.

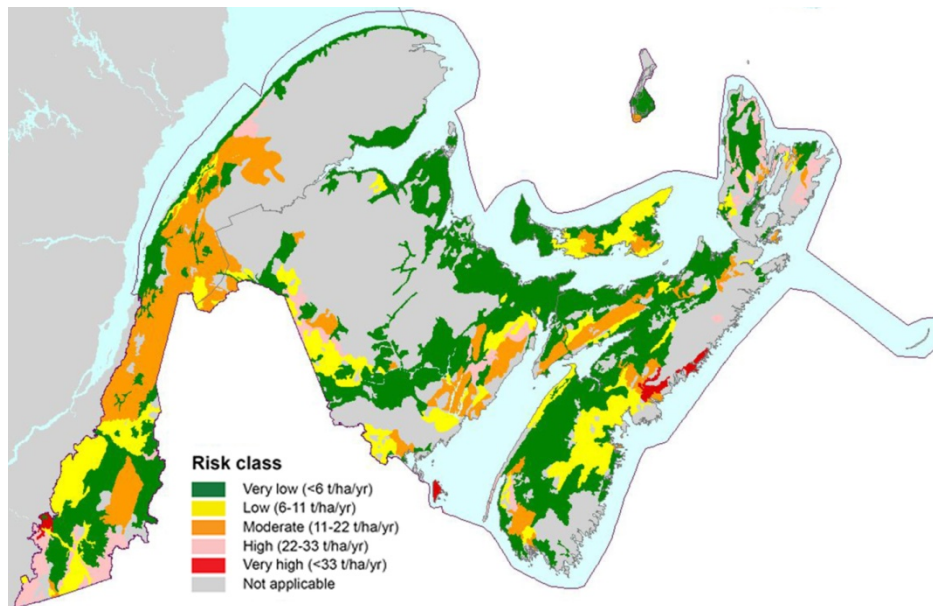


Figure 44. Soil erosion risk classes for cropland in the Atlantic Maritime Ecozone⁺, 2006. All Soil Landscape of Canada polygons containing >5% cropland were included in the analysis and entire polygons are shown on the map. Source: McConkey *et al.*, 2011¹⁸⁵

Birds of grassland and other open habitats

Grassland birds, which include birds of some agricultural habitats such as hayfield, pastures and rangeland, and birds of other open habitats, which include agricultural lands not included in the grassland category and abandoned fields, have declined significantly (Figure 45). Vesper sparrow (*Pooecetes gramineus*), bobolink (*Dolichonyx oryzivorus*), and eastern meadowlark (*Sturnella magna*) populations declined by over 75% since the 1970s. Many aerial-foraging insectivores, included in the other open habitat category, declined as a group.⁴²

^{vii} Cropland in this analysis also includes areas defined as Improved Pasture and Summerfallow in the Census of Agriculture. See McConkey *et al.*, 2011¹⁸⁵ for more information.

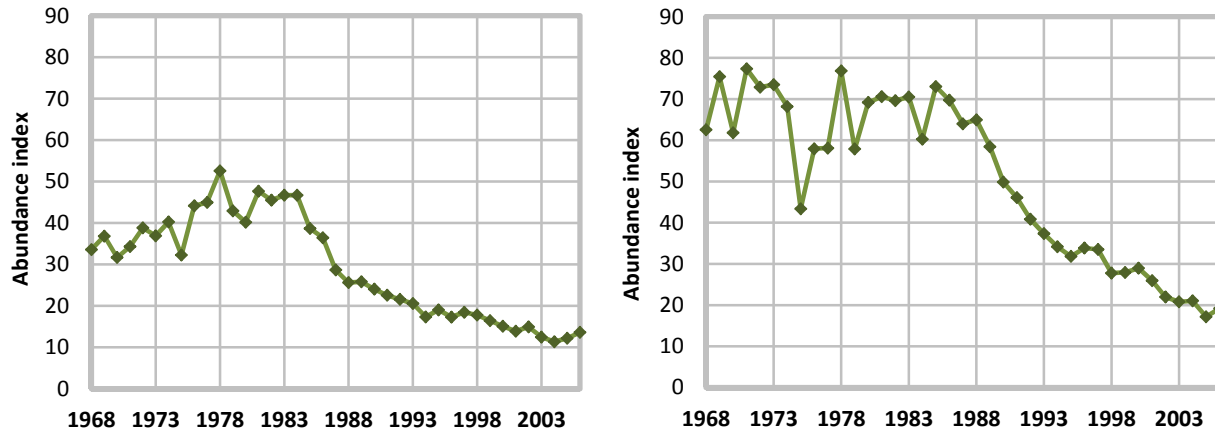


Figure 45. Annual indices of population change in bird assemblages for grassland habitat (left) and other open habitats (right) in the Atlantic Maritime Ecozone⁺, 1968–2006.

Grassland habitats include native grasslands and some agricultural habitat such as hayfield, pastures and rangeland. Other open habitats include open country, including species of agricultural landscapes not considered in grassland. The index is an estimate of the average number of individual birds that would be counted on a randomly selected route by an average observer in a given year.

Source: Downes et al., 2011⁴² using data from the Breeding Bird Survey⁴³

Key finding 17

Theme Habitat, wildlife, and ecosystem processes

Species of special economic, cultural, or ecological interest

National key finding

Many species of amphibians, fish, birds, and large mammals are of special economic, cultural, or ecological interest to Canadians. Some of these are declining in number and distribution, some are stable, and others are healthy or recovering.

Species of particular interest within the AME include the Atlantic (Gaspésie) population of woodland caribou and Atlantic salmon. Some landbirds that use the AME have declined, in some cases due to pressures elsewhere in their migratory ranges.

In the past 150 to 200 years, some of the largest mammals were extirpated from the AME, including wolf (*Canis lupus*), cougar (*Felis concolor*), and wolverine (*Gulo gulo*).¹³⁵ Woodland caribou (*Rangifer tarandus caribou*) has been reduced to a single endangered population. The wolf's ecological niche has largely been filled by the coyote (*Canis latrans*), and that of the caribou has been filled to some degree by the white-tailed deer (*Odocoileus virginianus*). Beaver (*Castor canadensis*) were nearly extirpated 200 years ago due to overharvest, but have since recovered.

Woodland caribou

The Atlantic-Gaspésie population of the woodland caribou is an isolated relict population that formerly ranged more broadly in the AME. Prior to European settlement, woodland caribou were commonly found throughout much of Nova Scotia and New Brunswick and were present on PEI.¹⁸⁶ Extirpation from these three provinces was well underway by the 1830s. Caribou were extirpated from Nova Scotia by 1912,¹⁸⁷ New Brunswick by the 1930s,¹⁶ and from PEI much earlier. Efforts to re-establish caribou on their historic ranges in Nova Scotia failed because of fatal infections with *Parelaphostrongylus tenuis*, a brain worm carried by the more recently established white-tailed deer.¹⁸⁸

The current population is found only in and adjacent to Gaspésie National Park of Quebec.¹⁸⁹ It is at risk from predation and habitat loss, and its low numbers and restricted range make it susceptible to chance catastrophic events.¹⁸⁶ Trend data from 1983 to 2006 show an overall decline over this period, with a low population size of less than 100 individuals in 1999 (Figure 46).¹⁸⁹ In 2002, COSEWIC re-assessed the population and elevated its status from Threatened to Endangered; it is also listed on Schedule 1 of Canada's *Species at Risk Act*.

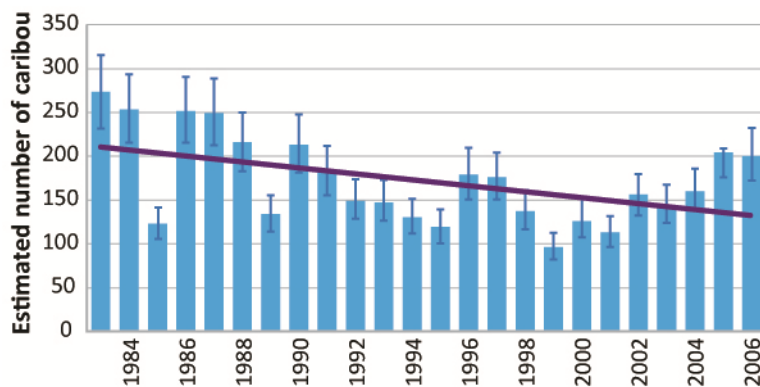


Figure 46. Trend in the estimated numbers of the Gaspésie woodland caribou population, 1983–2006. Source: Gaspésie Woodland Caribou Recovery Team, 2007¹⁸⁹ (<http://www.mrnf.gouv.qc.ca/>)

Other ungulates

Other large herbivores in the AME include moose (*Alces alces*) and white-tailed deer. Nova Scotia mainland moose have declined by 20% to about 1,000 individuals since 1970 due to human intrusion into its habitat, hunting, climate change, and disease.¹⁹⁰ White-tailed deer are a recent arrival to the Maritimes and have been expanding. They have benefited from human modifications of the forested landscape, as well as extirpations or reductions of many of their predators.¹³⁶

Atlantic salmon

Atlantic salmon are broadly distributed in rivers throughout the AME. Populations are sensitive to a number of environmental factors including predation, fishing, and the availability of breeding habitat.¹⁹¹ As was mentioned in the section (page 52), Atlantic salmon are also highly sensitive to acidity, and a high percentage of fish habitat has been lost in the region due to acid rain, with many runs in coastal Nova Scotia either extinct or heavily impacted.¹⁷⁵ Construction of dams has had an impact on salmon populations, and industrial and municipal effluents, as well as run-off from intensive agriculture, degrade water quality and reduce suitable breeding habitat for salmon. Invasive predators such as muskellunge (*Esox masquinongy*), smallmouth bass, and rainbow trout (*Oncorhynchus mykiss*) reduce juvenile salmon survival.

There is considerable variation in the status and trends in Atlantic salmon from one part of the AME to another.¹⁹² The Inner and Outer Bay of Fundy populations of Atlantic salmon were designated as Endangered by COSEWIC in 2001 and 2010, respectively.¹⁹³ All survey data from the inner Bay of Fundy indicate that river-specific populations have suffered extreme declines since the 1970s and this population faces extinction. Estimates of declines are as high as 99% over 11 years (three generations) and greater than 99.6 % over 30 years.¹⁹³ In 2003, fewer than 100 adults were estimated to have returned to the 32 rivers known to have contained salmon.¹⁹³ Historically, as many as 40,000 salmon likely returned to these rivers.¹⁹³ Although there is some uncertainty, it appears that offshore mortality of adult salmon is the primary threat to the Inner Bay of Fundy population.¹⁹³

Of 37 salmon rivers in the AME (18 in the Maritime provinces and 19 in Quebec) the five-year average population size increased in only three rivers, all on Cape Breton Island, from 1987 to 2005 (Figure 47).¹⁹² Abundance declined in all other rivers, with declines of over 95% in four rivers in the inner Bay of Fundy and a 99.8% decline in the St. Croix River in the outer Bay of Fundy. Trends in abundance vary throughout rivers in Quebec, though populations generally increased and declined in only two rivers.

The Miramichi River produces at least 20% of North American Atlantic salmon and more wild Atlantic salmon than any other North American river. The salmon in the Miramichi and Restigouche rivers are extremely important to overall Atlantic salmon populations because these two rivers contribute a disproportionate number of spawning fish to populations of maiden salmon that return to spawn in the rivers after spending two years at sea. Atlantic salmon abundance has declined in both rivers from 1987 to 2005 (Figure 47), although populations have shown some recovery since 2000.¹⁹²

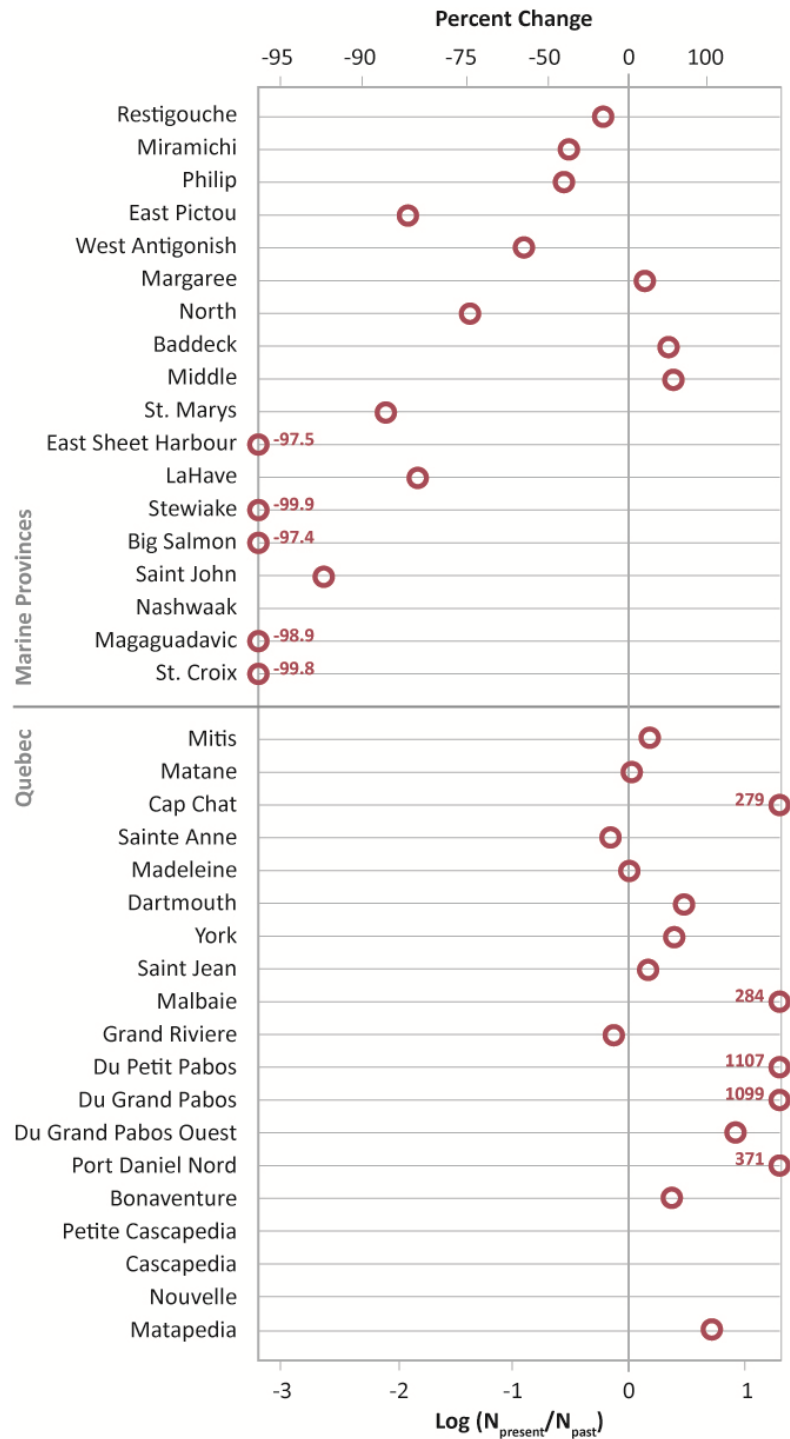


Figure 47. Changes in abundance of salmon populations for the Maritime provinces (top) and Quebec (bottom), 1987–2005.

Scale on x axis is $\text{Log}(N_{\text{present}}/N_{\text{past}})$. Each point is the change in five-year average population size. Points outside the graph's range are labelled with their value.

Source: modified from Gibson et al., 2006¹⁹²

Numbers of Atlantic salmon in rivers in PEI also declined. The fish were thought to occur in about 70 rivers in PEI prior to European settlement. By 1960, this had declined to approximately 55 rivers, and a comprehensive study in 2000–2002 found salmon in just 33 rivers. In 2008, 11 more rivers no longer had salmon and populations in 7 others were very low.¹⁹⁴

American eel

The American eel (*Anguilla rostrata*) is an example of a once abundant species that is now listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Since the 1970s, populations have declined by 99% in the upper St. Lawrence,¹⁹⁵ and less extreme declines have been observed in both the lower St. Lawrence and Gulf of St. Lawrence.^{196, 197} The long life span of American eels, combined with their vast distances of up to 4,500 km, make them vulnerable to a wide range of stressors, such as mortality in hydroelectric turbines, physical barriers such as dams, overharvesting, and habitat alteration. Climate change, resulting in changes to ocean currents that carry eel larvae from the spawning grounds, may also contribute to population declines. American eels once provided both subsistence and commercial fisheries in Canada.¹⁹⁷

In the Atlantic Maritime Ecozone+, trends in American eel populations have been mixed. Electrofishing surveys have been conducted regularly in six major rivers with available time series of data ranging from 15 to 45 years. While four rivers in New Brunswick (Miramichi, Restigouche, Nashwaak, and Big Salmon rivers) saw above average abundance in the 2000s, abundance in two rivers in Nova Scotia has strongly declined, by about 75% in the St. Marys River from 1998 to 2009 and by 86% in the LaHave River from 2000 to 2009.¹⁹⁶

Freshwater fish

Between 1979 and 2008, the number of freshwater and diadromous fish taxa classified as imperilled in the AME by the American Fisheries Society tripled from three to nine species (Figure 48, Table 11). Rainbow smelt was added as a result of improved status information while populations of striped bass and Atlantic salmon were added due to the inclusion of discrete regional populations as of 2008.¹⁹⁸

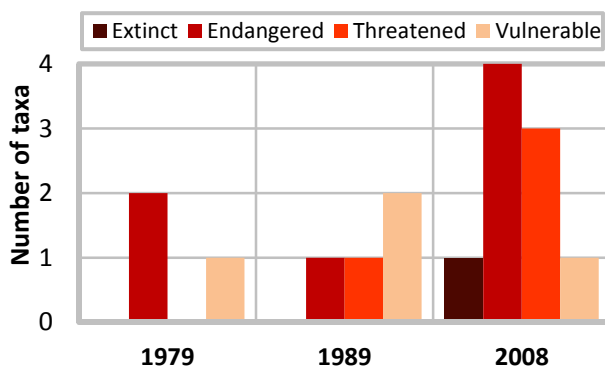


Figure 48. Trend in numbers of imperilled freshwater and diadromous fish taxa in each status category for North American ecoregions in the Atlantic Maritime Ecozone⁺, 1979, 1989, and 2008.

'Taxa' is used instead of 'species' because the list was updated to include discrete regional populations and infraspecific taxa. Previous lists may have underestimated the imperilled taxa because they did not include all designable units, only taxonomically recognized species.

Definitions of status categories differ slightly from COSEWIC and are described in Jelks et al.¹⁹⁸

Source: adapted from Jelks et al., 2008¹⁹⁸

Table 11. Identification and status of imperilled freshwater and diadromous fish taxa in the Atlantic Maritime Ecozone⁺, 1979, 1989, and 2008.

English common name	Genus	Species	1979	1989	2008
Shortnose sturgeon	<i>Acipenser</i>	<i>brevirostrum</i>	E	T	E
Atlantic sturgeon	<i>Acipenser</i>	<i>oxyrinchus oxyrinchus</i>	V	V	V
Striped bass (Bay of Fundy population)	<i>Morone</i>	<i>saxatilis</i>			T
Striped bass (Southern Gulf of St. Lawrence population)	<i>Morone</i>	<i>saxatilis</i>			T
Striped bass (St. Lawrence Estuary population)	<i>Morone</i>	<i>saxatilis</i>			Xp
Rainbow smelt (Lake Utopia, New Brunswick dwarf population)	<i>Osmerus</i>	<i>mordax</i>		V	T
Atlantic whitefish	<i>Coregonus</i>	<i>huntsmanni</i>	E	E	E
Atlantic salmon (Bay of Fundy population)	<i>Salmo</i>	<i>salar</i>			E
Atlantic salmon (Gulf of Maine population)	<i>Salmo</i>	<i>salar</i>			E

Xp = 'possibly extinct', E = 'endangered', T = 'threatened', V = 'vulnerable' as defined in Jelks et al.¹⁹⁸

Source: adapted from Jelks et al., 2008¹⁹⁸

Landbirds

All landbird species assemblages, except forest birds, declined from the 1970s to the 2000s, with the greatest declines in birds of grassland (includes species of agricultural habitats such as hayfields, pastures, and rangelands) and other open habitats (Table 12, see also Figure 45 in Agricultural landscapes as habitat section on page 60).

Table 12. Trends in abundance of landbirds for the Atlantic Maritime Ecozone⁺, 1970s to 2000s

Species Assemblage	Trend	P	BBS Abundance Index				
	(%/yr)		1970s	1980s	1990s	2000s	Change
Forest	-0.4%		221.6	218.3	208.1	187.1	-16%
Shrub/Successional	-0.6%	*	160.2	141.9	137.1	134.9	-16%
Grassland	-3.5%	*	39.9	38.2	19.5	13.3	-67%
Other Open	-3.5%	*	64.8	67.0	36.3	22.6	-65%
Urban / Suburban	-0.6%	*	179.7	162.0	157.3	154.9	-14%

P is the Statistical significance: * indicates $P < 0.05$; n indicates $0.05 < P < 0.1$; no value indicates not significant

Change" is the percent change in the average index of abundance between the first decade for which there are results (1970s) and the 2000s (2000-2006).

Source: Downes et al., 2011⁴² using data from the Breeding Bird Survey⁴³

Key finding 18

Theme Habitat, wildlife, and ecosystem processes

Primary productivity

National key finding

Primary productivity has increased on more than 20% of the vegetated land area of Canada over the past 20 years, as well as in some freshwater systems. The magnitude and timing of primary productivity are changing throughout the marine system.

The Normalized Difference Vegetation Index (NDVI), calculated from remote sensing data, is an indicator of the amount and vigour of green vegetation present on a landscape. Changes in NDVI are a proxy for changes in primary productivity. From 1985 to 2006, NDVI values increased for 33,408 km² (16.5%) and decreased for 720 km² (0.4%) of the AME.⁷ The largest areas with increasing NDVI values were mixed forest along the Gaspé Peninsula and on Cape Breton Island (Figure 49).

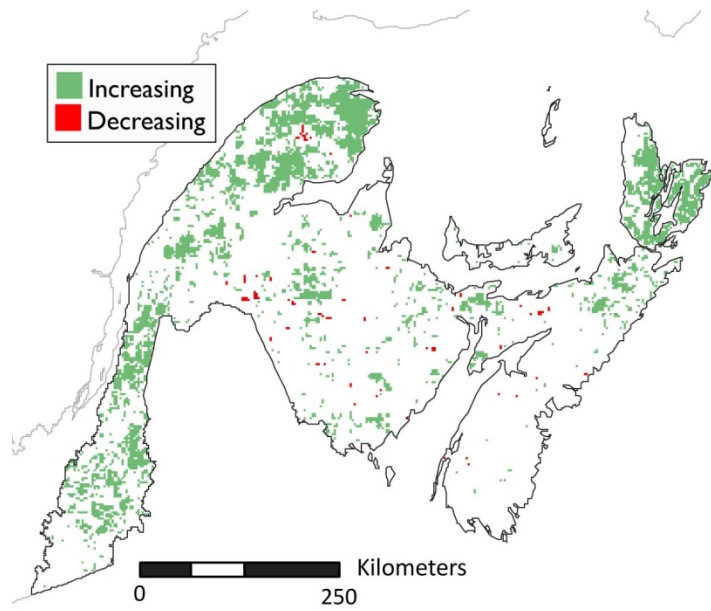


Figure 49. Change in the Normalized Difference Vegetation Index for the Atlantic Maritime Ecozone⁺, 1985–2006.

Trends are in annual peak NDVI, measured as the average of the three highest values from 10-day composite images taken during July and August of each year. Spatial resolution is 1 km, averaged to 3 km for analysis. Only points with statistically significant changes ($p < 0.05$) are shown.

Source: adapted from Pouliot et al, 2009¹⁹⁹ by Ahern et al., 2011⁷

Changes in NDVI can be attributed to climate change, land cover change, and land use or other management changes.⁷ Increasing trends in parts of the AME may be associated with commercial logging that has increased the proportion of broadleaf trees, but more detailed studies would be needed to confirm this hypothesis. Because of the high proportion of deciduous and mixed deciduous forests in this ecozone⁺, NDVI values were in a higher range, close to the saturation point, making subtle changes difficult to detect.¹⁹⁹⁻²⁰¹ In addition, the result of NDVI analyses in southeastern Canada (including the AME) are sensitive to the period being analyzed. Earlier time periods (such as 1982 to 1999) are more likely to show extensive increasing trends²⁰²⁻²⁰⁵ while analyses of more recent periods (such as 1985 to 2006, as analyzed here) show less extensive positive trends or even some areas of negative trends.^{199, 206, 207} More detailed land cover and vegetation productivity studies would be necessary to fully understand these trends.

Natural disturbance

National key finding

The dynamics of natural disturbance regimes, such as fire and native insect outbreaks, are changing and this is reshaping the landscape. The direction and degree of change vary.

Natural disturbances include extreme weather events, fire, and insect outbreaks. Although fire was important within the AME historically, severe weather events and insect outbreaks are the dominant disturbance types today due, in part, to effective fire suppression. Spruce budworm is the most influential forest insect.

Extreme weather events

Since the AME borders the Atlantic Ocean, it is especially vulnerable to hurricanes and other tropical storms tracking up North America's Eastern Seaboard. The winds and tidal events associated with these storms can also lead to storm surges and flooding.

Tropical storms and hurricanes

The frequency and severity of tropical storms and hurricanes has increased over the past three decades.²⁰⁸⁻²¹¹ The average number of tropical cyclones—that is, hurricanes, tropical storms, and tropical depressions—per year was 8.7 from 1900 to 1999, 9.9 from 1950 to 1999, and rose to 11.8 from 1991 to 2000, the highest 10-year average on record (Figure 50).²¹¹ Other recent studies showed that the duration of tropical-storm events in the Atlantic region has increased by about 60% since 1949 and the annual peak-wind speed increased by about 50%.¹⁰³ Since 1975, the total dissipation of power (an index of a hurricane's potential destructiveness) has doubled.²¹²

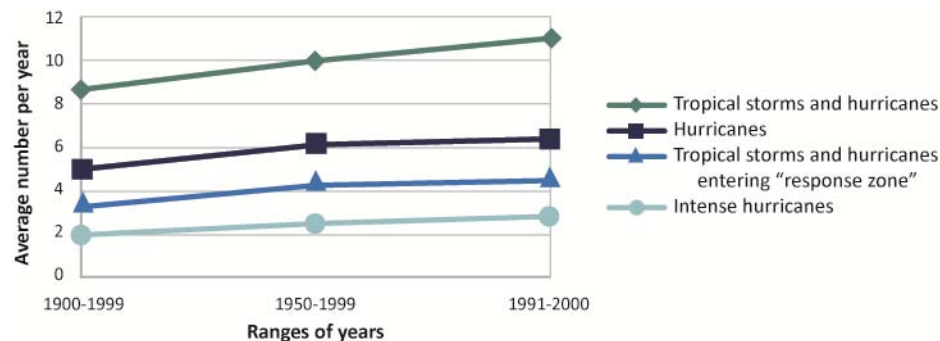


Figure 50. Trends in the average number of tropical cyclones in the Atlantic Basin, 1900–1999, 1950–1999, and 1991–2000.

Source: Environment Canada, 2002²¹¹

Storm surges and flooding

Storm surges and flooding are often associated with hurricanes and tropical storms and result from increased marine-wave action and heavy rainfall. They can have significant impacts on coastal ecosystems, including soil erosion and vegetation loss (see also Coastal section on page 29). Susceptibility to storm surges varies widely in the AME: some areas are likely to be more severely affected than others, depending on the nature of the coastline and degree of exposure (Figure 51).

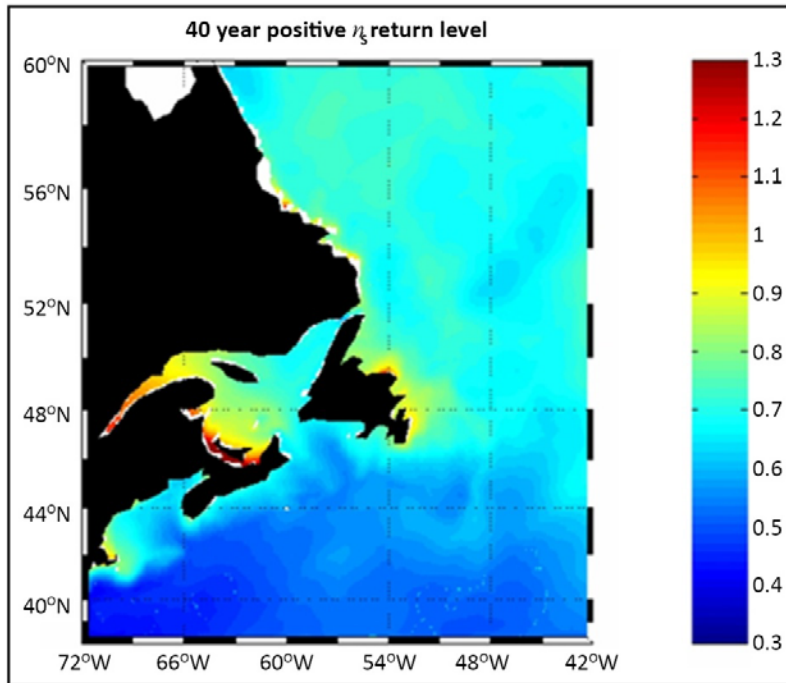


Figure 51. Storm surge maxima return level on the Atlantic coast of Canada based on the 40-year hindcast.

Hindcasting is a method of developing a model by testing it to see whether it accurately predicts past observations. The coloured bar indicates the 40-year positive surge return levels in metres. The most extreme surge events are expected to occur in the coastal regions highlighted by the warmest colours. Source: Bernier et al., 2006²¹³

There were no comprehensive trend data on storm surges for the whole AME, however, a case study of storm surges in Charlottetown, PEI, indicate an increased severity and frequency in storm surge events between the 1940s and 1980s with surges over 90 cm becoming increasingly frequent (Figure 52). Since ice appears to have a damping effect on storm surge severity, storm surges and wave erosion may become more severe in a warmer climate, with reduced ice in the Gulf of St. Lawrence (see Ice across biomes section on page 37).¹⁰⁷

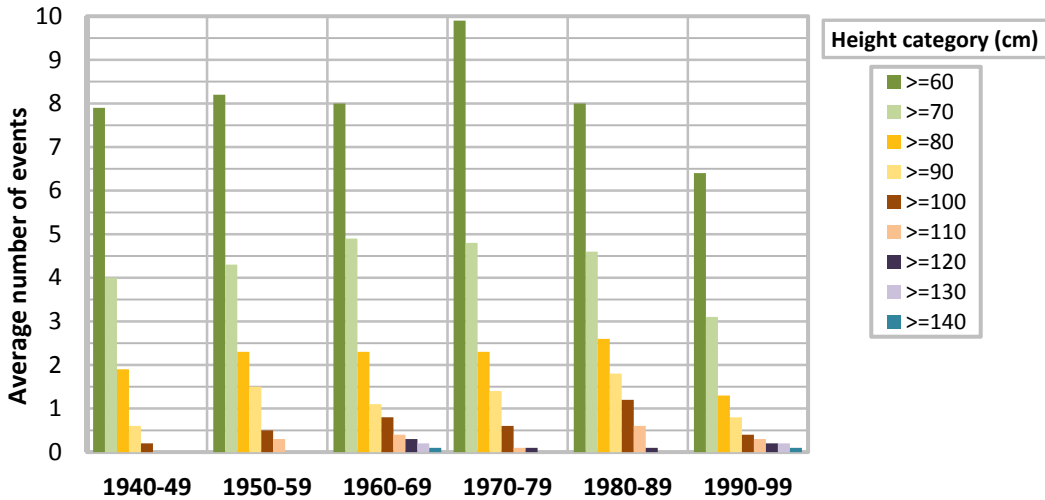


Figure 52. Average number of storm surges per year above the threshold, by decade, at Charlottetown, PEI, 1940s–1990s.

Source: adapted from Environment Canada in Forbes et al., 2006¹⁰⁷

Fire

Wildfires historically played an important role in forest dynamics in the AME, although at a much smaller scale than many other parts of Canada.^{214, 215} Records from the 17th and 18th centuries suggest that lightning strikes regularly burned large areas of forest.²¹⁶ Today, fires are more numerous but smaller. The increased number of fires is due to the prevalence of human-caused fires. On average, between the 1960s and 2000s, 86% of fires were human-ignited.²¹⁵ However, the extent of area burned has been reduced through early detection and active fire suppression.

Since the 1950s, large forest fires (those greater than 2 km²) have not been a common or significant natural disturbance. From 1959 to 2007, an average of only 34 km² (0.02% of the AME) burned annually (Figure 53). Years with no large fires were common. Area burned was low due to fire prevention, early detection, and rapid suppression. Overall, total area burned was lower in the 1960s and 1970s, higher in the 1980s and 1990s, and lower again in the 2000s.²¹⁵

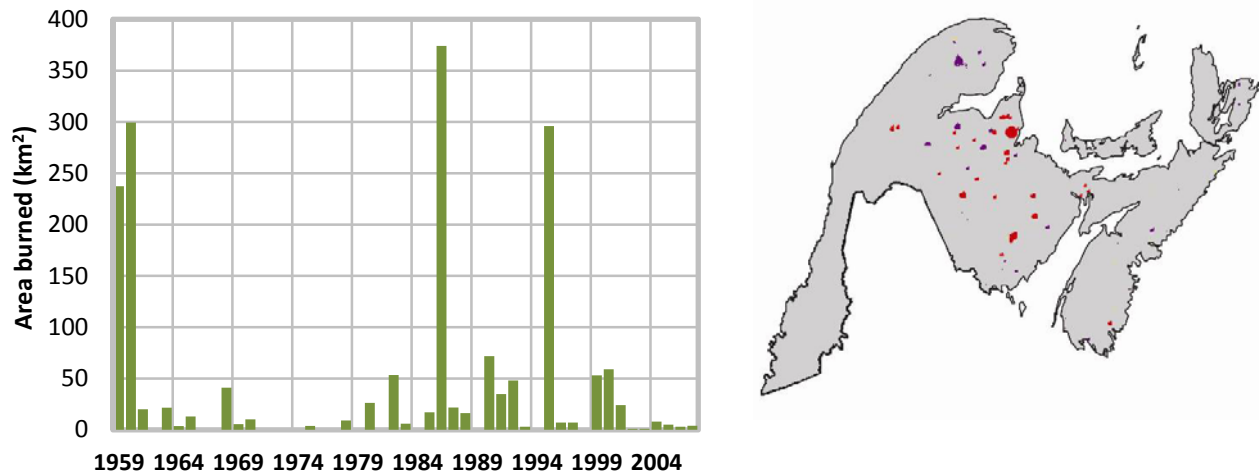


Figure 53. Total annual area burned by large fires (>2 km² in size) from 1959 to 2007 (left) and distribution of large fires from the 1980s to present in the Atlantic Maritime Ecozone[†]. On map, red is 1980s, purple is 1990s. Fires from 2000s (up to 2007 included) are too small to show. Source: Krezek-Hanes et al., 2010;²¹⁵ data from 1959–1994 from the large fire database (Stocks et al., 2003)²¹⁷ and data from 1995–2007 from remote sensing.

For some forests in the AME, fire has historically played an important role in the stand dynamics of forests, impacting tree species composition, age-class distribution, and patterns of succession.^{214, 218} For example, in Nova Scotia, fire maintained forest diversity in pure Jack pine (*Pinus banksiana*) stands in Cumberland County and black spruce/white pine stands in the St. Mary's River area. Over time, fire suppression is expected to reduce forest diversity in these areas.²¹⁹

In some ecosystems, repeated fire disturbance is important because it limits tree growth. Loss of soil fertility and hardpan formation in the soil profile caused by fires, combined with the allelopathic effect of heath-like vegetation on coniferous species, can create open woodland ecosystems with stunted trees, as in the barrens of southwest Nova Scotia. Natural fires have helped to maintain the Annapolis Valley heathlands.¹³⁴

Large-scale native insect outbreaks

Insect outbreaks are among the most frequent natural disturbances in the AME and the most common natural pathway for forest regeneration. Like fires, insect outbreaks also strongly influence a forest's successional dynamics (growth, in-growth, and mortality).²²⁰ However, unlike fires, insect outbreaks usually result in individual tree or small-patch replacement, rather than the loss of large stands.¹⁶

Spruce budworm

Spruce budworm, which is native to North American boreal and mixedwood forests, is the most influential forest insect in the AME.^{16, 221} Outbreaks occur somewhat synchronously over extensive areas,²²² but the duration of outbreaks varies regionally. Typically, periods of high

defoliation last 5 to 25 years.^{221, 223} Recurring spruce budworm outbreaks play an important role in shaping forest ecosystems. They influence the residual forest stand's species composition, age-class distribution, successional dynamics, and forest condition.^{20, 223-225} In addition, because spruce budworm and other insect outbreaks occur frequently and cover large areas, they affect the forest's carbon flux.²²⁴

There is no consensus on whether frequency and severity of outbreaks is changing. Some studies have found that the frequency of budworm outbreaks has increased,^{221, 222, 226} while others have not found trends, especially when longer time scales were considered. For example, Boulanger and Arseneault²²³ found that the outbreak frequency in eastern Quebec was stable from 1500 to 2000, with a return-interval of between 30 and 48 years (Figure 54).

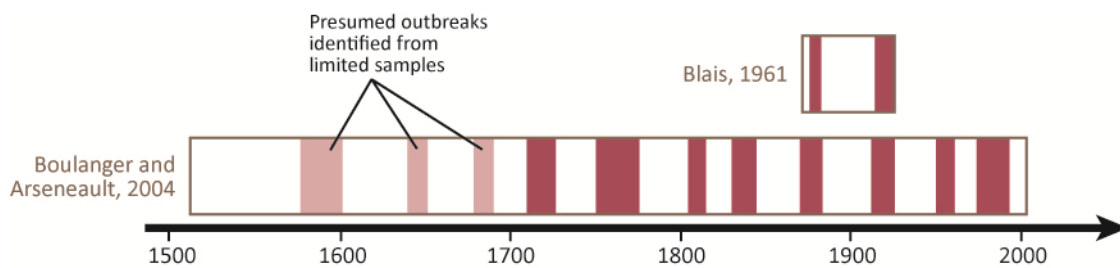


Figure 54. Intervals of spruce budworm outbreaks in eastern Quebec identified during previous reconstructions based on tree-ring chronologies, 1500–2000.

Source: adapted from Boulanger and Arseneault, 2004²²³

Some studies suggest that the severity of attacks increased during the 20th century.^{227, 228} In contrast, severity of attacks decreased in New Brunswick from 1949 to 2007 (Figure 55).¹³⁷ This decline could have resulted from insecticide applications to combat spruce budworm outbreaks. Between 1972 and 1993, aerial insecticide was applied in New Brunswick on close to 50% of the moderately and severely infested areas, which reduced defoliation significantly.²²¹

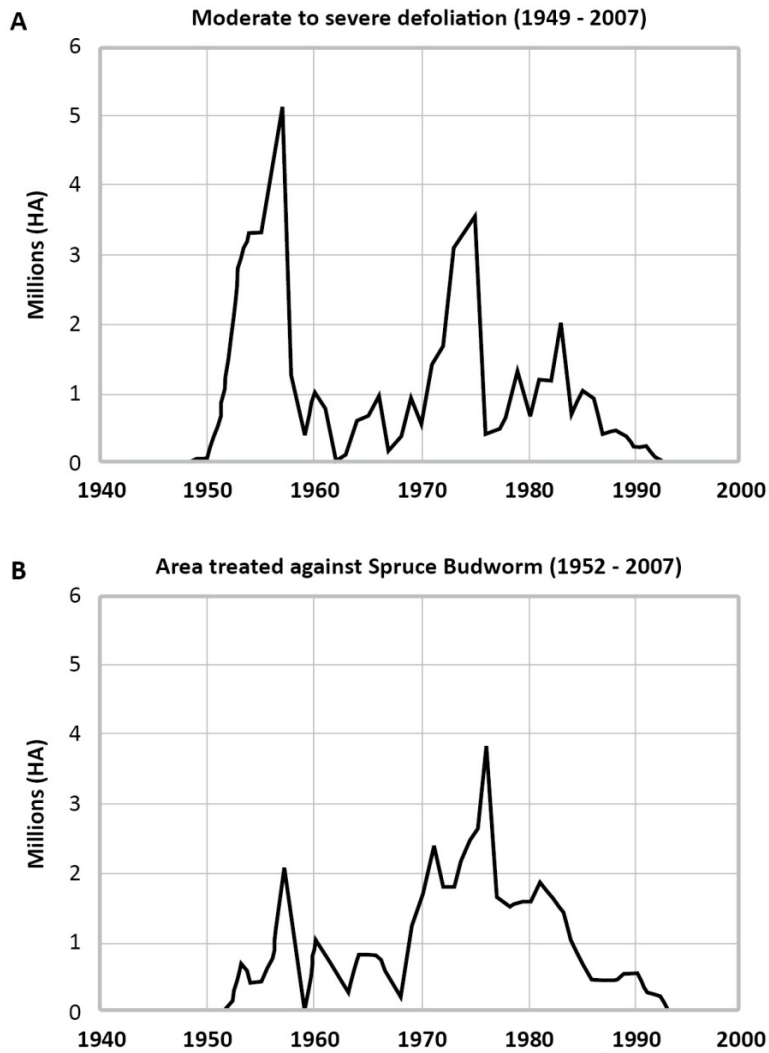


Figure 55. Trend in (A) spruce budworm defoliation in New Brunswick, 1949–2007, and (B) the area treated with pesticides, 1952–2007.

Source: modified from Carter et al., 2008¹³⁷

Detectable changes to the severity and frequency of insect outbreaks across the range of the eastern spruce budworm were attributed to changes in forest harvest practices, reduced frequency of fire due largely to fire suppression, increased insecticide spraying, and less reliability in outbreak records reconstructed from historic periods.^{16, 134, 223}

Food webs

National key finding

Fundamental changes in relationships among species have been observed in marine, freshwater, and terrestrial environments. The loss or reduction of important components of food webs has greatly altered some ecosystems.

There was limited information on changes in trophic dynamics and population cycles in the AME. The loss or reduction of top mammalian predators can result in substantial changes to food webs. Historically, wolves were the largest mammalian predator but they were extirpated from New Brunswick and Nova Scotia sometime between 1870 and 1921.²²⁹ American martens (*Martes americana*) were extirpated from southern Quebec and PEI, and black bear (*Ursus americanus*) and lynx (*Lynx canadensis*) were also extirpated from PEI.

At the same time, coyotes expanded their ranges into the AME (Figure 56) and replaced wolves as the top predator. Across eastern North America, including the AME, coyotes have exerted a strong “top-down effect” on forest ecosystems;²³⁰ they directly reduced the abundance of prey which indirectly reduced the abundance of smaller carnivores such as red foxes (*Vulpes vulpes*).²³¹ By reducing the abundance of smaller carnivores, coyotes also indirectly increased the number of birds, creating a positive relationship between coyotes and scrub-bird populations.

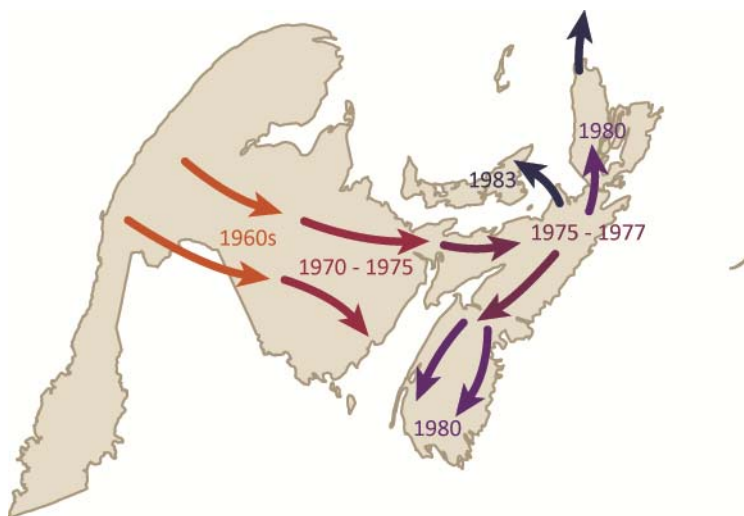


Figure 56. Chronology of colonization of a portion of the Atlantic Maritime Ecozone⁺ by the eastern coyote from the 1960s to the 1980s.

Source: Moore and Parker, 1992²³²

THEME: SCIENCE/POLICY INTERFACE

Key finding 21

Theme Science/policy interface

Biodiversity monitoring, research, information management, and reporting

National key finding

Long-term, standardized, spatially complete, and readily accessible monitoring information, complemented by ecosystem research, provides the most useful findings for policy-relevant assessments of status and trends. The lack of this type of information in many areas has hindered development of this assessment.

Although localized ecological studies and a few long-term data sets exist, information gaps made it difficult to determine ecological trends in the AME. Coordinated monitoring of biodiversity in the AME was generally lacking. More data were available for economically valuable species and biomes such as Atlantic salmon and forests, as well as certain species at risk such as woodland caribou. Information was lacking for protection and stewardship of private land.

Strengths

- Population trends for migratory birds.
- Occurrence and population trends for Atlantic salmon.
- Some populations of invasive non-native species.

Critical gaps identified

- Wetland trend data.
- Information on status and trends for non-vascular plants and invertebrates.
- Trend data on the coastal biome for the AME.
- Changes in trophic structures are poorly documented, particularly lacking for lakes.
- Ecological impacts of many invasive non-native species.

Key finding 22

Theme Science/policy interface

Rapid change and thresholds

National key finding

Growing understanding of rapid and unexpected changes, interactions, and thresholds, especially in relation to climate change, points to a need for policy that responds and adapts quickly to signals of environmental change in order to avert major and irreversible biodiversity losses.

Due to the underlying geology of the AME, aquatic ecosystems have less capacity to buffer acid and, consequently, a lower threshold for ecosystem damage from atmospheric acid deposition

than is found in other parts of Canada. As levels of acid deposition exceeded buffering capacity in lakes and rivers, Atlantic salmon populations and the number of salmon-bearing rivers in Nova Scotia rapidly declined. Moreover, impacts may persist longer than previously thought; rivers have not recovered with reductions in acid deposition, suggesting that these rivers are now in an alternative stable state (see Lakes and Rivers key finding on page 7).

Remaining forests in the AME are simpler, less diverse, and younger as a result of forest management practices (see Forests key finding on page 6). The landscape has also been highly fragmented by resource and road development, reducing the area of intact ecosystems. It is unclear to what extent these changes have contributed to the loss of native species, such as large mammals. However, in many parts of the AME, it is likely that a threshold of development and fragmentation has been reached where some species (e.g., caribou, black bear) could not survive if re-introduced.

One possible reason for rapid changes is that damage to ecosystems may accelerate because of the interaction of stressors. This is especially relevant for climate change. For example, coastal erosion in the AME is increasing, threatening wetlands, beach, and dune ecosystems. Development and hardening of the foreshore have made coastal ecosystems more susceptible to erosion. Rise in sea level, reduced sea ice, and more tropical storms in the Atlantic Ocean, all related to climate change (see Coastal key finding on page 7), accelerate the rate of erosion. Climate change may also make ecosystems more vulnerable to invasion from non-native species (e.g., warm-water fish species) and insect outbreaks, and increase the susceptibility of native species to diseases and infections.

CONCLUSION: HUMAN WELL-BEING AND BIODIVERSITY

Over the last 400 years, the AME has had primarily a resource-based economy based on forestry, fishing, agriculture, mining, and, more recently, tourism. Although many of these industries are dependent on healthy, functioning ecosystems, industrial development has also had a large influence on the status and trends of AME ecosystems. In some cases, forestry, development, climate change, and acid deposition have impaired the ability of these ecosystems to continue to provide important goods and services.

Although forests still cover 80% of the landscape, forestry, fire suppression, and insect outbreaks have reduced species diversity, altered species composition, and shifted the age structure of forests towards younger stands. Remaining forests have also been highly fragmented by roads affecting forest-dwelling species. Caribou in the AME consist of a single, remnant endangered population and the moose population has declined. Many of the top mammalian predators, such as wolves, American marten, black bears, and lynx, were extirpated from all or most of the AME as a result of combined pressure from habitat changes and historic hunting.

Coastal ecosystems have also been impacted by industrial, urban, and cottage development. Some of the highest rates of wetland loss have been in coastal wetlands. The loss of beaches, dunes, and eelgrass meadows has reduced the suitability of coastlines as habitats for some species, such as shorebirds. Coastal ecosystem loss has also increased the vulnerability of the coastline to erosion from sea-level rise and storm surges, with associated hazards to human life and property. Port activities have introduced invasive non-native species, leading to declines particular tree species and economic impacts, for example, to timber production.

Freshwater lakes and rivers have been altered by climate-driven changes (e.g., changes in flow regimes, changes to ice freeze and thaw dates), the presence of dams, and excess nutrient runoff from agriculture. The AME has some of the most acid sensitive terrain in Canada and, as a result of historic acid deposition, many Atlantic salmon runs have been lost. Introduced fish species have altered food webs and aquatic community composition, as have didymo blooms. The impacts of climate change, although projected to be lower in the AME than other Canadian ecozones⁺, will exacerbate these changes.

Food production in the AME is mostly confined to PEI, Nova Scotia's Annapolis Valley, and New Brunswick's Saint John River Valley. Due to the expansion of cropland, agricultural land has become less capable of supporting wildlife. The AME has some of the highest residual soil nitrogen values and, due to its climate, some of highest soil erosion risks in Canada. However, soil erosion risk on agricultural lands in the AME has declined.

Changes to natural disturbance regimes include the suppression of fire, increased disturbance by extreme weather events, and insect outbreaks. As in many of the ecozones⁺ in Canada, it is difficult to gauge the impacts to biodiversity, natural disturbances, and ecological processes due to a lack of comprehensive long-term monitoring.

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