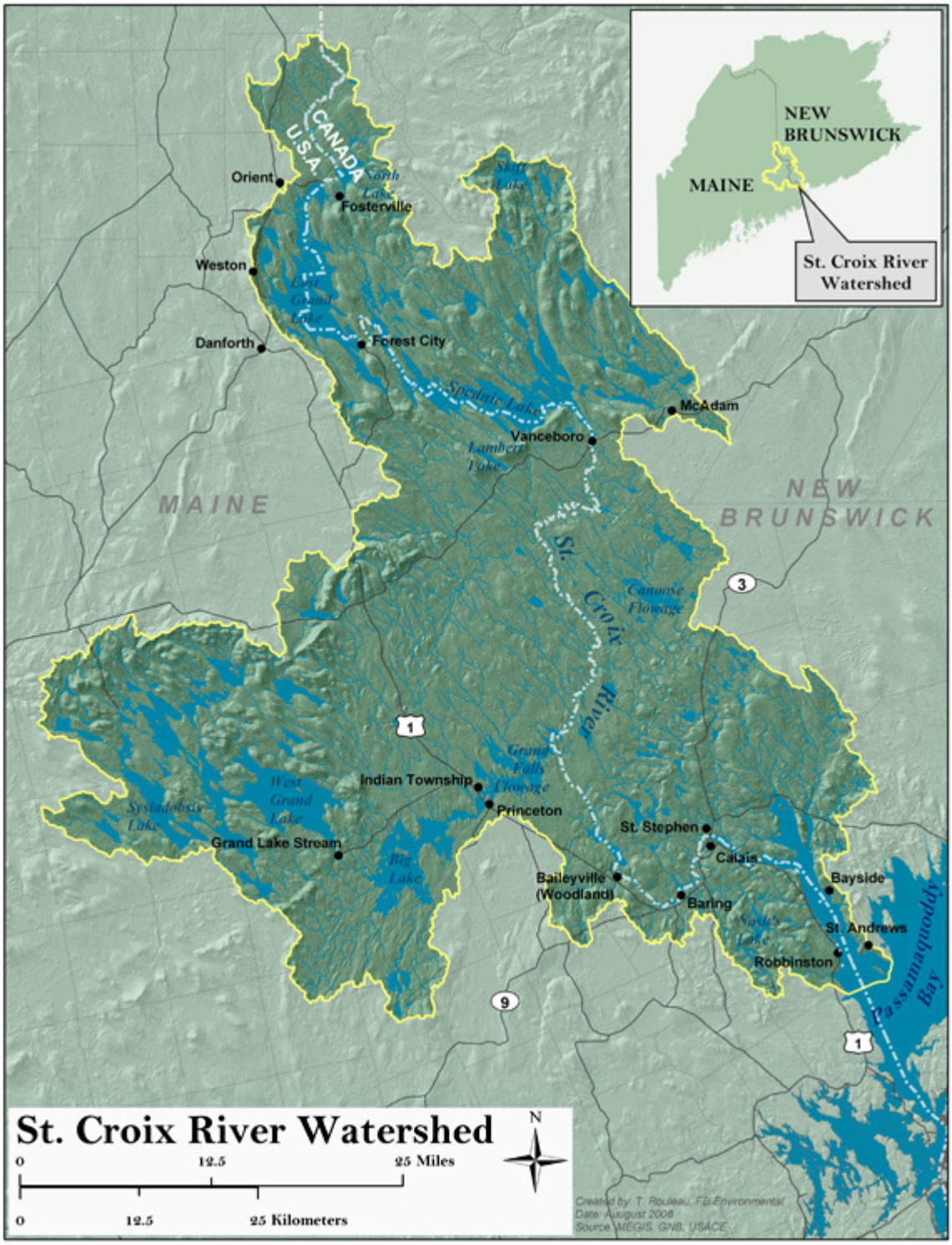
St. Croix River: State of the Watershed Report

Maine and New Brunswick

International St. Croix River Watershed Board
International Joint Commission
Canada and United States


NEW BRUNSWICK
MAINE
St. Croix River Watershed
CANADA
U.S.A.
Orient
Fosterville
Weston
Danforth
Forest City
McAdam
Vanceboro
MAINE
NEW BRUNSWICK
St. Croix River
Canoose Flowage
Indian Township
Princeton
Grand Lake Stream
St. Stephen
Calais
Baileyville (Woodland)
Baring
Bayside
St. Andrews
Robbinston
Passamaquoddy Bay
St. Croix River Watershed
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Created by: T. Rouleau, FB Environmental
Date: August 2008
Source: MEGIS, GNB, USACE

St. Croix River: State of the Watershed Report

2008

Prepared for:
International St. Croix River Watershed Board
and the International Joint Commission

Prepared by:
FB Environmental
97A Exchange St., Suite 305
Portland, Maine
04101

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Cover photo: Upper St. Croix River, courtesy of the St. Croix International Waterway Commission

Preface

The purpose of this report on the St. Croix River watershed is to help inform and educate, and to support the development of a common understanding and vision for natural resources in both

Maine and New Brunswick. It was prepared under the guidance of the International St. Croix RiverWatershed Board, as part of an effort by the International Joint Commission (IJC) to promote a grassroots, integrated approach to conserving water resources along the Canada-U.S. border. The information presented provides an overview of the current state of the river, watershed, and significant temporal trends in selected indicators. This is a preliminary compilation of available information, and does not represent a formal position taken by the Board on specific issues. It is hoped that this report, by summarizing available information and pointing to gaps in our present knowledge, will help the people of the St. Croix basin on both sides of the border to develop watershed plans, studies, and projects to address common challenges.

The Commission and its St. Croix Board welcome public input; their contact information and further details can be found at http://www.ijc.org.

Acknowledgements

International St. Croix River Watershed Board:

Canadian Section

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William Ayer, Liaison to New Brunswick Department of the Environment
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Peter Johnson, Canadian Secretary, Strategic Analysis and Policy Division, Environment Canada, Atlantic Region
Charles Leblanc, Manager, Water Quality Monitoring, Environment Canada, Atlantic Region
Robert Stephenson, PhD, Director, St. Andrews Biological Station, New Brunswick

U.S. Section

Barbara Blumeris, U.S. Secretary, U.S. Army Corps of Engineers, New England District
Colonel Philip T. Feir , U.S. Co-Chair, District Engineer, U.S. Army Corps of Engineers, New England District
Joan Garner Trial, PhD., Senior Biologist, Maine Department of Marine Resources
Robert M. Lent, PhD., Maine District Chief, United States Geological Survey
Edward Logue, Regional Director, Maine Dept. of Environmental Protection
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Richard Dill, *ME Dept. of Inland Fisheries and Wildlife*
Jeff Emory, *ME Dept. of Environmental Protection*
Tony Fletcher, *ME Emergency Management Agency*
Erin Foster, *NB Dept. of Environment*
Merry Gallagher, *ME Dept. of Inland Fisheries and Wildlife*
Stefen Gerriets, *Atlantic Canada Conservation Data Centre*
Steve Gordon, *NB Dept. of Environment*
Bill Hinkle, *ME Dept. of Environmental Protection*
Richard Jordan, *ME Dept. of Inland Fisheries and Wildlife*
Lee Kanter, *ME Dept. Inland Fisheries and Wildlife*
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Barry Mower, *ME Dept. of Environmental Protection*
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Darryl Pupek, *NB Dept of Environment*
Margo Sheppard, *Nature Trust of New Brunswick*
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Lee Sochasky, *St. Croix International Waterway Commission*
Cynthia Stacey, *Univ. of New Brunswick, Fredericton*
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Matt Walsh, *U.S. Army Corps of Engineers*
Dan Walters, *U.S. Geological Survey*
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Looking across the St. Croix River from New Brunswick to Calais.

Introduction

State of the Watershed

What Factors Influence the State of the International St. Croix River Watershed?

The St. Croix River watershed covers an area of 1,649 square miles (4,271 km^2) along the Canada and United States border between New Brunswick and Maine. The 110-mile (185 km) St. Croix River serves as a natural boundary between Canada and the United States. Because of its strategic location, the river has played a unique role in the history of Maritime Canada and the U.S. and remains important for these reasons today (CHRS 2007).

There are two principal chains of lakes in the St. Croix watershed: the east branch chain of lakes (or Chiputneticook lake system) located along the international border, and the west branch lakes, located on the Maine side of the watershed. The east branch lakes include two of the largest lakes in both Maine and New Brunswick: Spednic and East Grand Lake. The West Branch lakes include West Grand Lake, Big Lake, and others. The east and west branch lake systems converge at Grand Falls Flowage at Kellyland. From this point, the St. Croix continues for approximately 18 miles (29 km) to head-of-tide at Calais and St. Stephen where it joins with the St. Croix estuary, a 15-mile (24 km) stretch of saline water connected to Passamaquoddy Bay influenced by twice-daily, 23-foot (7 m) tides. Passamaquoddy Bay is a sub-basin of the Bay of Fundy.

The St. Croix watershed is bounded on the north by the Saint John River watershed and on the west by the Penobscot River watershed.

The St. Croix River Heritage

The St. Croix River Basin was first inhabited nearly 11,000 years ago by post ice-age populations and has been occupied by a succession of native populations since (SCIWC 1993). Historically, the river was used as a travel route to the Penobscot and Saint John river systems for many native peoples, including the Passamaquoddy, who still reside in the St. Croix basin today.

In 1604, French explorers established the first New World colony north of Florida on St. Croix Island, located in the estuarine portion of the river. The St. Croix basin was subsequently settled by the English and others who used it for lumbering, shipbuilding, milling and water power.

Today, the natural, cultural, and historical resources in the St. Croix watershed still help support the local economy. With forest land covering about 80% of the watershed land area, wood harvesting and processing is the most important industry in the St. Croix area. The watershed also provides abundant recreational opportunities and wildlife habitat (Sochasky 2007). The main stem of the St. Croix is known to canoeists, fishermen, and naturalists as one of the most pristine recreational rivers in the Northeast.

Protecting the St. Croix Watershed

Because of the cultural and historical significance of the St. Croix, and the wide variety of recreationalopportunities it provides, the river has received numerous recognitions and protections. In 1982, the St. Croix River was named St. Croix Waterway Recreation Area by a New Brunswick Order-in- Council. Additionally, in 1993, the St. Croix became the first Canadian Heritage River in Atlantic Canada. This designation placed it among a small group of waterways across the country that have been recognized formally for their outstanding role in Canada's natural, cultural and recreational heritage.

Today, water quality on the St. Croix is protected by state and provincial legislation, and the St. Croix has set precedent in the management initiatives that have been taken to ensure that its natural resource and heritage features are protected for generations to come.


Photo: St. Croix International Waterway Commission

The river passes through the Milltown section of the watershed's largest communities: Calais ME (right) and St. Stephen NB (left). In the foreground is the international bridge at Milltown and the Milltown Rapids. At center just above midline is the lowermost St. Croix dam at Milltown and the beginning of saltwater mixing.

Regulatory and natural resource agencies in both Canada and the U.S. (federal, state, and provincial) provide oversight and in many cases regulate human activities that might negatively impact the St. Croix. Because of the St. Croix's position as an international boundary, the International St. Croix River Watershed Board of the International Joint Commission (IJC) monitors the ecological health of the St. Croix River boundary waters, and ensures compliance with the IJC's Orders of Approval for structures in the St. Croix River. The IJC was established in 1909 through a treaty between the U.S. and Canada to prevent disputes related to the use and quality of boundary waters. Additionally, the St. Croix International Waterway Commission (SCIWC), an independent, international body established by the Maine and New Brunswick legislatures, assists stakeholders in the U.S. and Canada in implementing healthy waterway management.

Understanding the State of the St. Croix Watershed

This State of the Watershed report is intended to document general trends in the St. Croix River watershed and to serve as a natural resource planning document for stakeholder groups. The document covers a broad range of topics, with a focus on seven key areas:

- Socio-economics
- Land use
- Water quality
- Water quantity
- Water use
- Fish, wildlife & plants
- Air quality

Within these key areas, watershed-specific indicators are identified. Indicators are used to track the condition of a resource area over time. The indicators identified in this report provide a summary measure of overall health of the St. Croix basin and were chosen, in part, based on available data and existing research.

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Two Countries, One Watershed: Getting the Hydrologic Data in Sync

Scientists, planners, resource managers and citizens groups concerned about a river basin require environmental, social, economic and other data that are linked to specific locations in the watershed. Nowadays, such georeferenced information is captured, stored, retrieved and displayed using computer-based **geographic information system (GIS)** software.

Over the years, Canadian and U.S. experts developed their GIS datasets independently, using their own names, codes, formats and maps that generally stopped at the border. The resulting data disconnects can seriously hinder attempts to develop a complete and coherent understanding of river basins that straddle the international frontier.

To remedy this, the International Joint Commission (IJC) initiated a pilot effort to pull together existing hydrologic data from the Maine and New Brunswick sides of the St. Croix basin into a single, seamless, "harmonized" GIS data product. In 2007, this resulted in the first unified maps and data sets covering the rivers, lakes, reservoirs, streams and drainage areas at a scale of 1:24,000 -1:50,000.

The datasets, readable using specialized GIS software, are available on CD from the IJC (commission@washington.ijc.org or at commission@ottawa.ijc.org) until arrangements for long-term data storage are finalized. The binational, collaborative approach to data harmonization pioneered in the St. Croix basin is serving as a model for other transboundary watersheds along the Canadian-U.S. border.

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Socio-Economic

Indicator: Population

Is Population Changing in the St. Croix River Watershed?

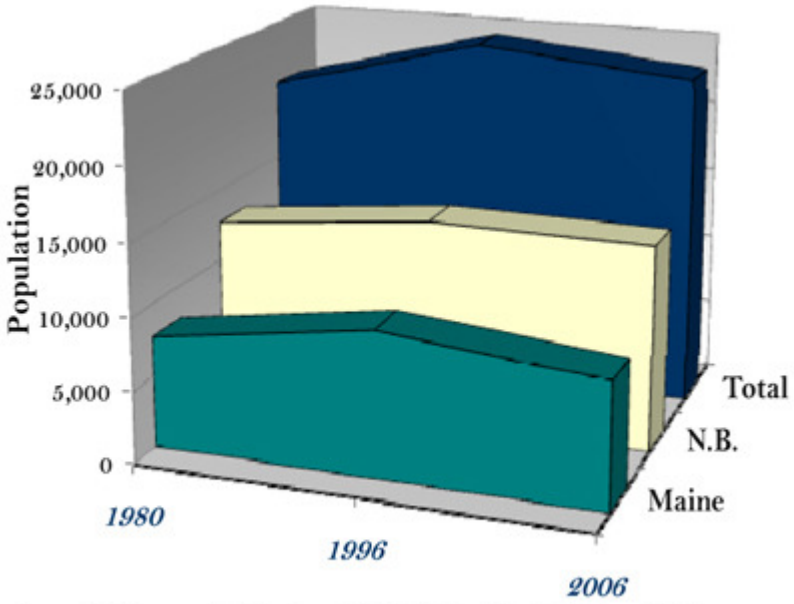
Historically, settlement patterns in the St. Croix River watershed have reflected the importance the river plays in the development of the local economy, as the most populous areas have been located along the lower main stem of the St. Croix (Environment Canada 1987). This is still true today.

There are five population centers in the St. Croix watershed: St. Stephen, St. Andrews and McAdam in New Brunswick, and Calais and Baileyville in Maine. (For the purpose of this report, population centers are defined as incorporated municipalities with populations >1000). All but one of these municipalities (McAdam) are located in the lower part of the watershed, adjacent to the St. Croix.

How does population affect watershed health?

Population size, composition and distribution can influence the range of industries, patterns of economic growth, and extent of pressure on natural resources in an area. Generally, a higher population density means greater demands on resources and the potential for greater impact on the environment. However, population is only one facet in a complex socioeconomic system, and a balance must be met between economic growth, land use, and population in order to promote a healthy watershed.

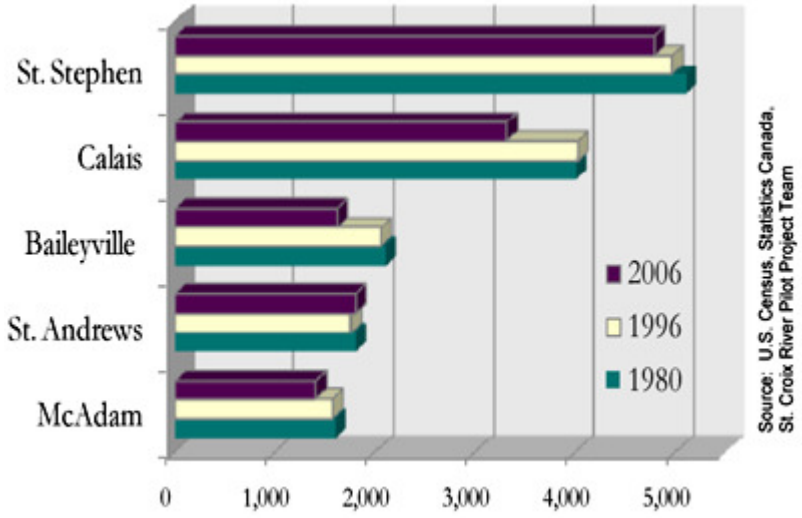
St. Croix Watershed Population*



Source: U.S. Census, Statistics Canada, St. Croix River Pilot Project Team (1987)

Although watershed population has increased overall since 1980, there has been a 6% decline population since 1996.

1996 and 2006 watershed population was estimated to be proportional to the percent area of each municipality in the drainage basin, based on U.S. Census and Statistics Canada estimates.



Although the watershed population increased overall between 1980 and 2006, populations declined in most watershed municipalities.

What are the population trends in the watershed?

Over the last 30 years, population in the watershed has increased slightly. Between 1980 and 2006, population increased by approximately 12% in both the Maine and New Brunswick portions of the watershed, and in the watershed as a whole. However, in recent years there has been a downward trend in population on the Maine side of the watershed, while the New Brunswick side has remained relatively stable. Between 1996 and 2006, the overall watershed population decreased by approximately 1,400 people, or 6%. This decline can be attributed to a declining population on the Maine side of the watershed. Over this period, the population of the New Brunswick portion of the watershed remained relatively stable while population on the Maine side declined more than 13%.

As of 2006, the total population in the St. Croix watershed was approximately 24,300. While most of the watershed is sparsely populated, over 75% of the population lives at the lower end of the watershed, within 10 miles (16 km) of the estuary. Four of the watershed's five major population centers are located here and these municipalities account for nearly half of the watershed's population. However, in recent years there has been a trend toward declining population in the watershed's municipalities, as residents move to unincorporated and waterfront areas (Sochasky 2008). Between 1996 and 2006, population declined in four out of the five population centers in the watershed. Only the population of St. Andrews increased (by approximately 3%).

What are the economic trends in the watershed?

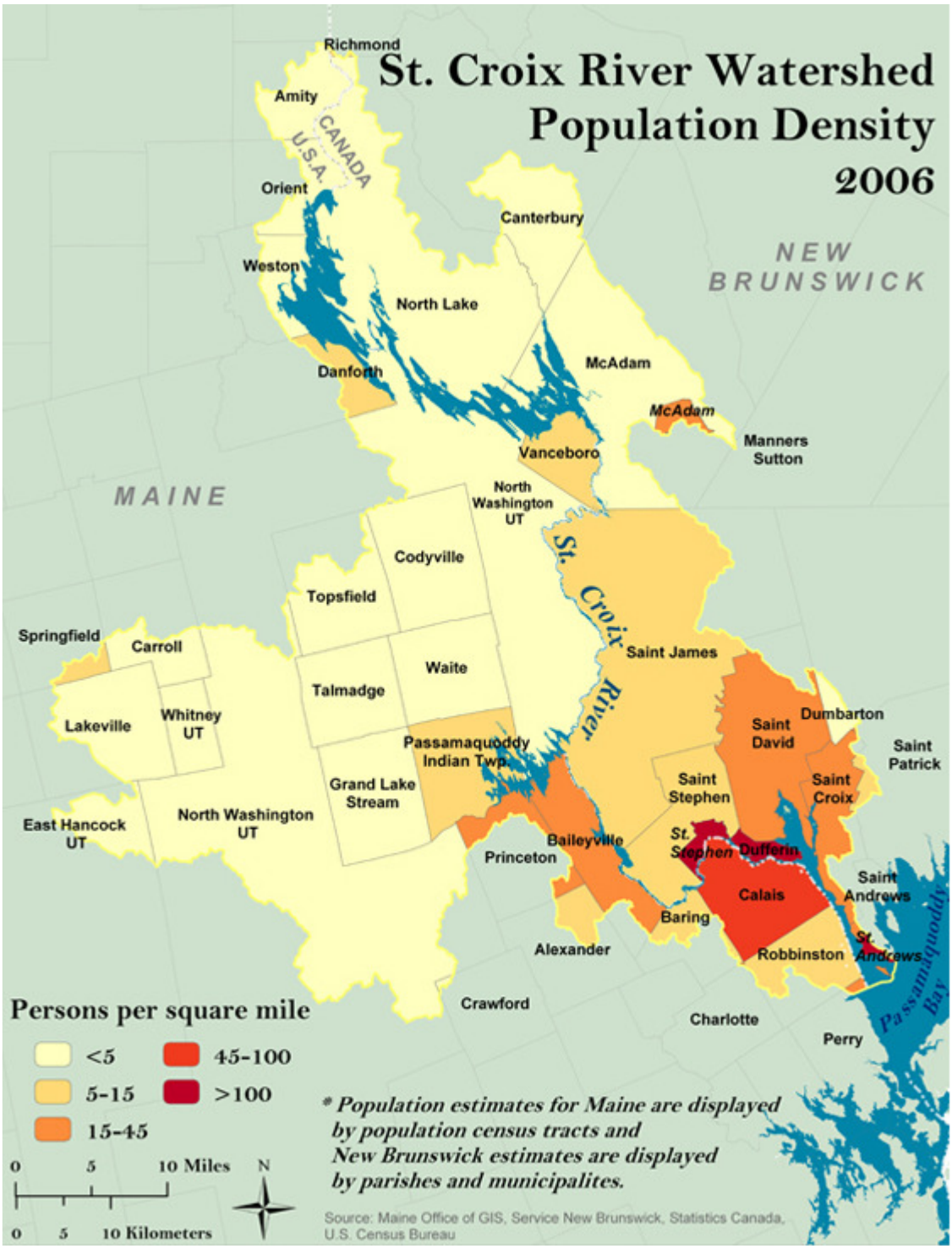
Natural resources are a driving force in the economy of the St. Croix watershed (Environment Canada1987). The harvesting and manufacturing of wood fiber is the primary resource-based employment sector. Recreation, such as hunting, fishing, cottaging, and tourism is the another. Other key sectors, primarily located in the population-dense areas near the estuary, are government and commercial services, transportation, education and other manufacturing not dependent on watershed resources (Sochasky 2008).

In the 1980s, both the Maine and New Brunswick sides of the watershed were the most economically-depressed areas of their respective state and provincial jurisdictions (Sochasky 2008). Today this is only true in Maine, where there has been a trend of declining manufacturing

jobs (Acheson 2006, Reilly 2008), an example of which is the elimination of about 150 jobs at the Domtar Mill in Baileyville in 2007 (Graettinger 2007). The economy on the New Brunswick side of the watershed has improved significantly in recent years due, in part, to regional economic growth that extends beyond the St. Croix area.

How can this information be used?

Population is intricately connected to the economic viability of the St. Croix area. The tracking of population trends can assist local government in making important decisions for land use planning and zoning, land protection, and effective use of services. The movement of residents to unincorporated and waterfront areas within the St. Croix watershed could impact the region's valuable natural resources. Careful, comprehensive planning at the local level can help decision makers protect these resources while continuing to ensure economic growth in the region including the growth of tourism as a core industry.



The highest population densities can be found in the lower part of the watershed, adjacent to the St. Croix Estuary.

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Land Use

Indicator: Land Cover

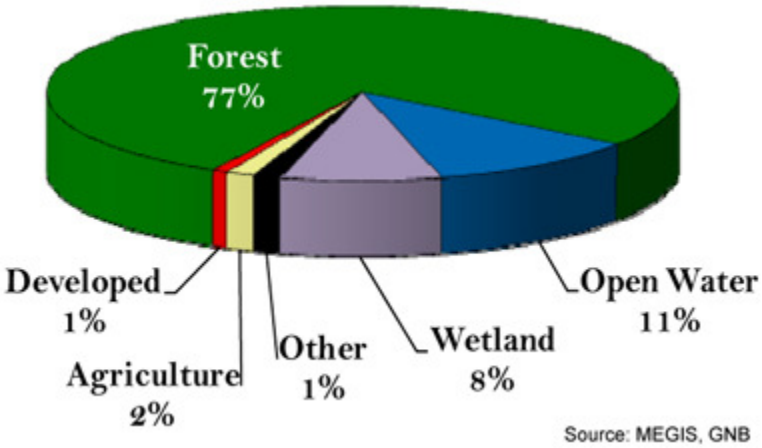
What are the Dominant Land Uses in the St. Croix River Watershed?

Land use is one of the most important factors affecting the quality and use of streams, lakes, and rivers, collectively known as surface water. Conversion of natural areas such as forests and wetlands to other uses can degrade wildlife habitat, water quality, and ultimately the quality of life for the watershed's inhabitants. Poorly planned development may fragment natural habitats, impact rare or unique species, and increase pollutant runoff to nearby surface waters.

What are the dominant land cover types in the St. Croix River watershed?

The dominant land cover in the St. Croix watershed is forest. Forest covers over 806,000 acres (~326,000 ha), or 77% of the total watershed area. The second most common land cover type is wetland 86,000 acres (~35,000 ha), covering 8% of the watershed. Open water covers almost 14,000 acres (~5,700 ha). The remainder of the watershed land area is covered by agricultural lands (1%), roads and runways (1%), bare land (< 1%), and developed land (1%). The primary areas of developed land are located in the lower section of the watershed, adjacent to the estuary (ME GIS 2006, NB DOE 2007).

St. Croix Watershed Land Cover



Why is land cover important?

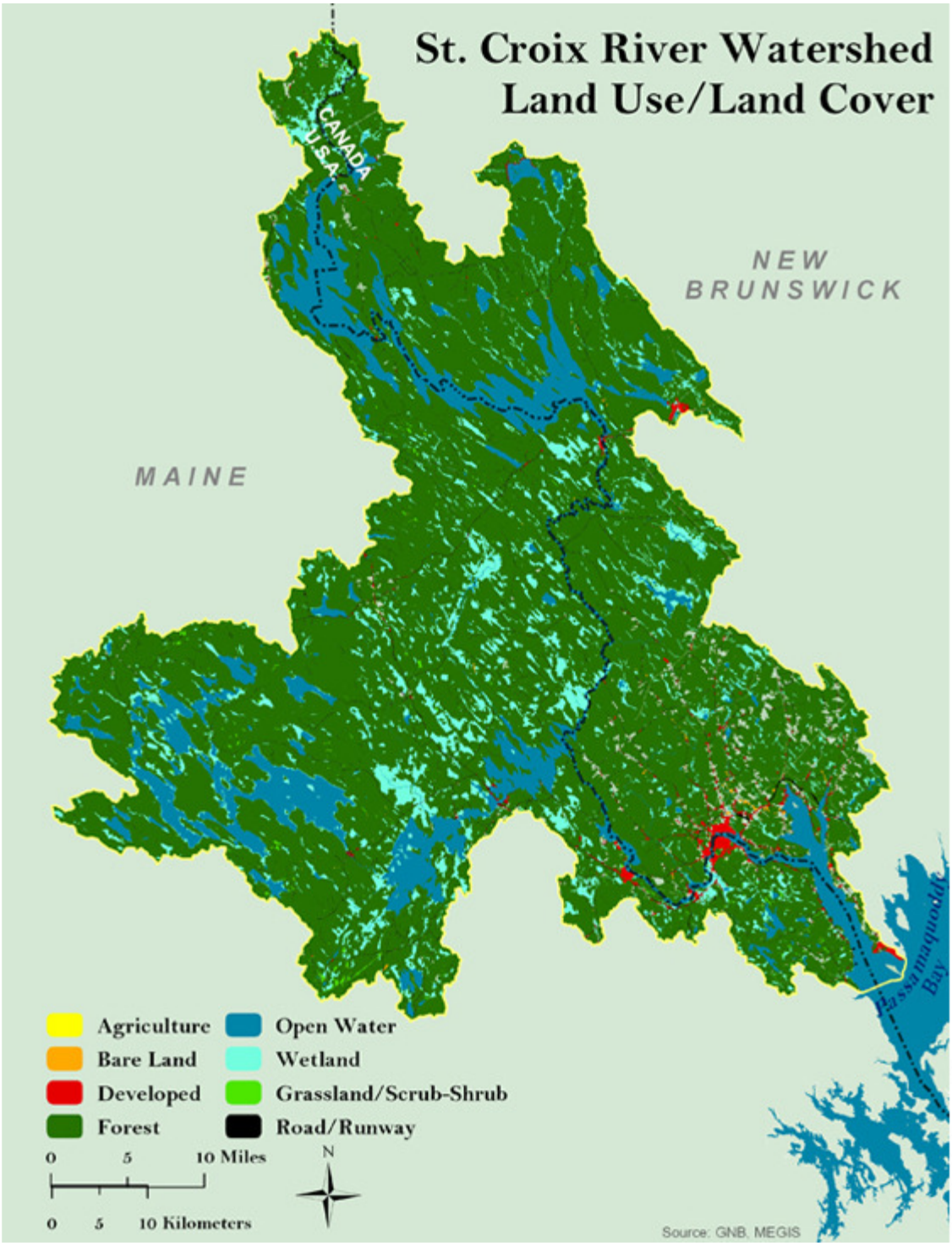
Because wetlands and forests are the dominant land cover types in the watershed, their role in overall watershed ecological health is important. Forests are critical to healthy ecosystems and contribute to the watershed's health in a variety of ways. They filter nitrogen pollution, absorb rainfall, regulate stream flow, moderate stream temperature, stabilize soils, and provide wildlife habitat. Many species require large, unbroken tracts of forest to carry out some portion of their life cycle.

Wetlands play a vital role in protecting the water quality of rivers and lakes, and provide numerous beneficial functions for humans, fish and wildlife. Wetland functions include protecting and improving water quality, providing fish and wildlife habitat, floodwater storage, river and coastal shoreline stabilization and maintaining surface water flow during dry periods (US EPA 2008). As forests and wetlands are converted to developed land, their ability to filter pollutants and the important habitat they offer are lost.

This view of the St. Croix River above Grand Falls Flowage depicts the predominant land cover types in the watershed: forest, wetland, and open water.

How does land cover influence watershed health in the St. Croix basin?

Industrial and residential development in municipalities along the lower portions of the St. Croix may affect land and water quality. However, municipalities are no longer the primary driving force behind environmental impacts in the watershed. Their point source discharges and CSOs (see Water Quality section) are known major issues that are being addressed on both sides of the watershed. Today, population and pollution are moving away from urban centers and into nearby rural areas. These areas are often situated in the lower watershed and offer commuters more amenities at lower tax rates. Development is also occurring on waterfront properties throughout the watershed, as seasonal and year-round residents can still acquire waterfront land at good value. Disparities in Maine and New Brunswick legal frameworks to deal with rural development are an important issue for the watershed (Sochasky 2008).



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Sochasky, L. St. Croix International Waterway Commission. Personal Communication. June 16, 2008.

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Land and Use

Indicator: Protected Lands

How much Land is Protected within the St. Croix River Watershed?

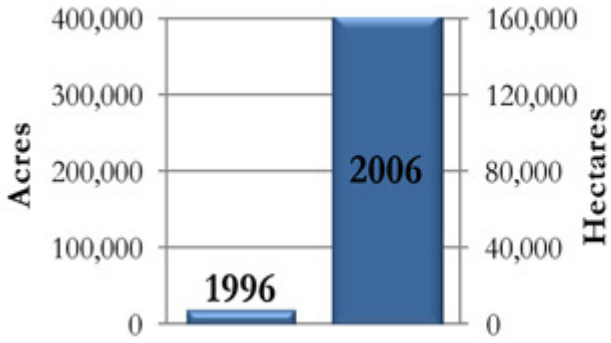
Nature is close at hand on Spednic Lake where the long fingers of Muncy Point, Maine (foreground) were deposited by retreating glaciers. The New Brunswick land at the top right forms the province's largest Protected Natural Area; nearly all of the Maine shoreline is protected by the state.

Protecting land helps ensure the long term conservation of the historical, cultural, scenic, wildlife and recreational resources in the St. Croix watershed. In addition to preserving water quality, land protection preserves rural characteristics and helps prevent downstream flooding and erosion. Land may be permanently protected as either public parks, preserve lands or as lands placed under a conservation easement that restricts development. A documented increase in protected lands over time is one measure of success in conserving fish and wildlife habitat and protecting water quality.

What is the status of permanently protected lands in the watershed?

Over 700,000 acres (283,290 ha), or 67%, of the St. Croix River watershed is under some form of protection, and approximately 42% of the watershed land is permanently protected. Of the permanently protected lands, about 80% are located in Maine. These lands are composed of state conservation lands (2%), including 3,019 acres (1,222 ha) along Spednic Lake and the Upper St.

Croix River; U.S. conservation lands (1%), which include a portion of Moosehorn National Wildlife Refuge in Baring, ME; and private conservation lands, such as those managed by land trusts (76%). Permanently protected lands in New Brunswick include provincial protected natural areas (17%), such as the Spednic Lake Protected Natural Area; Provincial Parks (2%); and non-government conservation lands (< 1%).

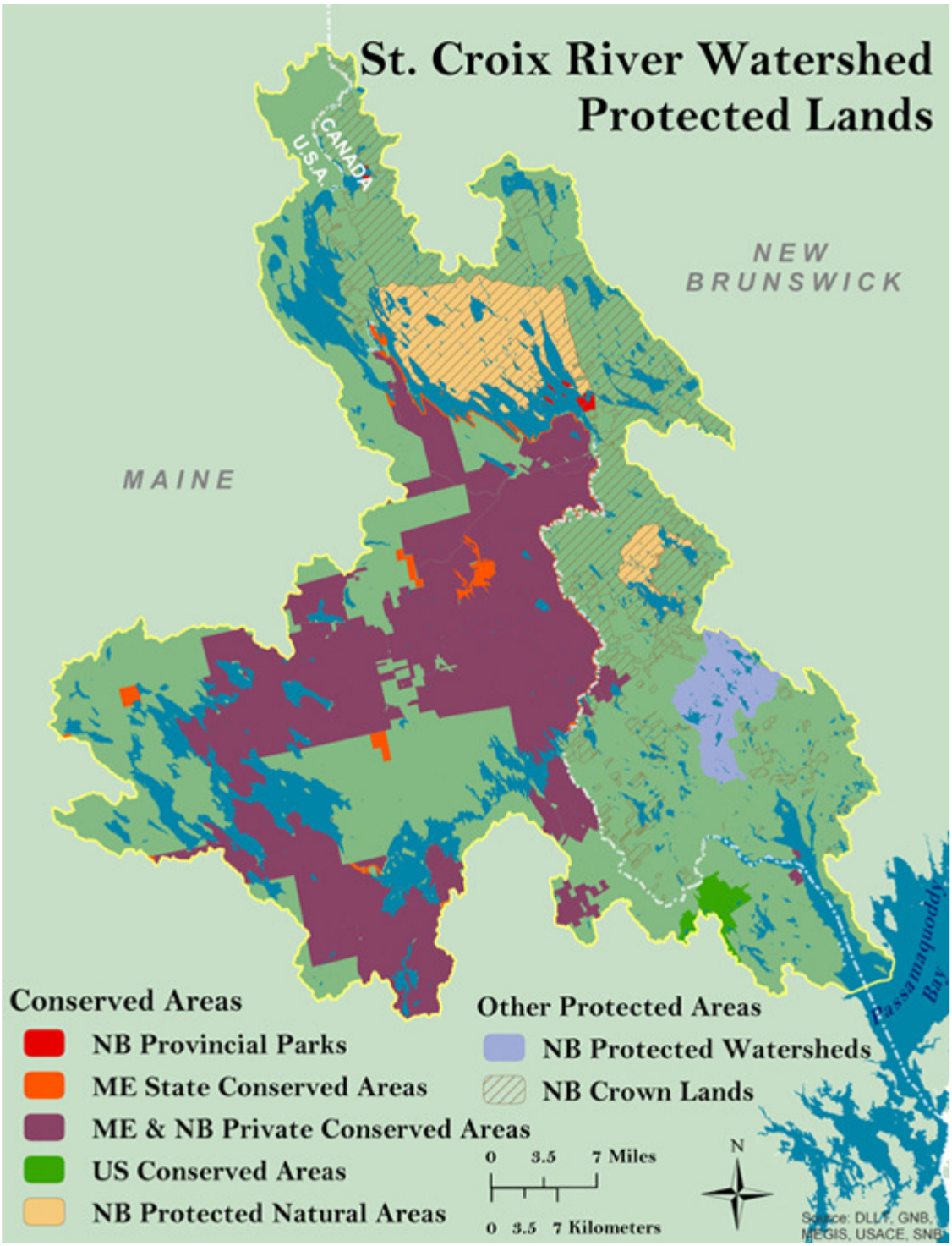


Permanently protected lands in the watershed increased 20-fold between 1996 and 2006.

Between 1996 and 2006, the area of protected land in the watershed increased 20-fold. The most notable being the 370,000 acres (~150,000 ha) protected along Spednic Lake and the Upper St. Croix between 2003 and 2005 (Williams 2004). These fee and easement acquisitions protect 1,500 miles (2,414 km) of stream and river shoreline; 60 lakes and ponds with 445 miles (719 km) of shoreline; 54,000 acres (21,850 ha) of wetlands; 5% of the common loons of northern Maine; breeding habitat for more than 130 bird species including 23 species of warblers; and more than eight active bald eagle nests (CCA 2008).

What additional land protections exist in the watershed?

Although shoreland zoning is uncommon in Canada, New Brunswick has developed a zoning regulation which establishes a 30-to-100 meter (98-328 ft) no-development buffer along the unincorporated sections of the St. Croix boundary waters (Sochasky 2008). This regulation is similar to shoreland zoning standards applied by Maine. Additionally, guidelines in Provincial Crown Lands, publicly-owned forest lands held by the New Brunswick government, require a minimum 20-meter (66 ft) uncut treed buffer adjacent to waterbodies, and increased protections for areas with special wildlife, aesthetic, or historic value (NTNB 2002), including 30-meter or wider buffer zones in aesthetic and recreational areas, and >50% conifer crown closure in deer wintering areas interconnected by winter travel corridors (McAfee & Malouin 2003).



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Land Protection Milestones in the St. Croix River Watershed

1937: Moosehorn National Wildlife Refuge was purchased with Duck Stamp funds and established by Franklin Delano Roosevelt. It is one of the oldest National Wildlife Refuges and a part of the early conservation movement in America.

The United States National Park Service declared St. Croix Island a National Monument.

1975: Congress designated 7,386 acres (2,989 ha) of Moosehorn National Wildlife Refuge as a wilderness area, declaring that the area should remain undeveloped and "unimpaired" for future generations.

1984: St. Croix Island was named an International Historic Site.

1994: 1940 By Executive Order, the Maine and New Brunswick governments adopted a long-term plan for the St. Croix waterway that set a policy to provide permanent protection of the Spednic and upper St. Croix River area.

2001: Upon purchase of Georgia-Pacific woodlands in NB in 2001, the Province of New Brunswick permanently protected 9,860 acres (3,990 ha) surrounding the Canoose Flowage area and 63,966 acres (25,877 ha) along the north side of Spednic Lake.

2002: SCEP purchased a 330-acre (134 ha) parcel of land at Todd's Point, NB, including forest, field and intertidal land. It has become the first community- owned and managed nature park and the first marine park in the area.

2003: A 50-mile, 3,019-acre (1,222 ha) conservation corridor along Spednic Lake and the Upper St. Croix River was acquired by the State of Maine, completing a decade-long conservation effort to protect one of the most pristine stretches of boundary water in eastern North America.

2005: The City of Calais and the SCIWC conserved the highest headland in Downeast Maine, known as Devil's Head. In addition, the Farm Cove Community Forest, totaling 27,080 acres (10,959 ha) and the 311,684-acre (126,138 ha) Sunrise Easement were permanently protected by the Downeast Lakes Forestry Partnership.

2006: The Nature Trust of NB received one of the largest ecological gifts of its kind in Canada, a conservation easement on the 2,313-acre (930 ha) MacNichol property along the St. Croix River.

Source: Nature Trust of NB, Downeast Lake Land Trust, Woodie Wheaton Land Trust, Moosehorn NWR

Water Quality

Indicator: River, Lake & Estuarine Health

How Healthy are the Waters of the St. Croix Watershed?

Clean water is the cornerstone of life and is one of Maine and New Brunswick's most important resources. We rely on clean water for drinking and bathing; we use it to grow food, manufacture goods, and produce electricity; and we depend on it for recreational activities such as fishing, camping, canoeing and swimming. Additionally, plants and animals rely on water for their survival.

The best way to protect water is to manage it on a watershed basis — protecting both the water and the land it flows through. In order for the St. Croix watershed's water resources to provide abundant clean water into the future, water quality needs to be cooperatively protected, managed, and assessed.

What influences water quality in the St. Croix?

Water quality is influenced by natural factors including plants, geology, climate, and weather, as well as human activities such as development, agriculture, forestry, and industry, among others. Over the decades, changes in the uses of water and land in the watershed have impacted water quality.

Beginning in the late 1700's, the creation of urban centers, lumber mills, a pulp mill, tanneries, a textile mill, and other development along the St. Croix impacted river health. Large quantities of solid and liquid wastes from these and other operations led to degraded water quality in the St. Croix, where sawdust accumulations were reportedly so thick that ship movements were restricted and sawdust islands were formed. In the 1950's areas of the river bottom were covered by a slime mold as well as a black gritlike covering of coal ash slag (Beaudoin 2005).

Today, there are two primary types of pollution that pose threats to water quality in the watershed: point source pollution and nonpoint source (NPS) pollution. Point source pollution can be traced back to a specific source such as a discharge pipe from a factory or treatment plant, while NPS

pollution often comes from a number of diffuse sources within a watershed (Maine Rivers 2005).

Nonpoint Source Pollution (NPS):

NPS pollution poses a considerable threat to the waters of Maine and New Brunswick (Maine Rivers 2005) and is a major long-term issue for the health of the St. Croix watershed (Sochasky 2008). Carried by snow melt, rain water, and groundwater, NPS pollution contributes sediments, nutrients (nitrogen and phosphorus), toxic substances, and pathogens to waterbodies (Maine Rivers 2005).

In the St. Croix watershed's rural areas, major forms of NPS likely include seepage from faulty septic systems, sediment runoff from construction sites and forestry activities, chemical and nutrient runoff from roads and agricultural operations, and household and pet waste. In the highly-populated portion of the watershed near the estuary, stormwater runoff is a primary concern. Stormwater runoff is water from rain or melting snow that "runs off" across the land instead of seeping into the ground. In these areas, impervious surfaces create large amounts of runoff that picks up pollutants and flows from gutters and storm drains to waterbodies. This untreated runoff may contain litter, dust, soil, oil and grease from roads, garden waste, chemicals, and nutrients and pathogens from animal feces and fertilizers (Maine Rivers 2005).

Canoeing at Little Falls on the St. Croix River. The St. Croix is known to canoeists, fishermen, and naturalists as one of the most pristine recreational rivers in the Northeast. Photo: St. Croix International Waterway Commission

Best management practices (BMPs) is a term used to describe the most effective ways to keep pollutants out of runoff and to slow down high volumes of runoff. In 1991, the Maine Legislature enacted a Nonpoint Source Water Pollution Management Program statute (38 M.R.S.A. §410-I) to restore and protect water resources from NPS pollution. The overall aims of the State's NPS Water Pollution Control Program are: clean water, using BMPs, locally supported watershed stewardship, and compliance with applicable laws.

Point Source Pollution:

Wastewater, a point source of pollution, is discharged directly into waters of the St. Croix River watershed. The majority of outfalls are licensed for discharge into the river itself, while some discharge into tributaries, to one lake, and to the St. Croix estuary (SCIWC 2000, ISCRB 2007). These are primarily pipe discharges from municipal and non-municipal sewage treatment facilities, industrial process or cooling water, and combined sewer/stormwater (CSO) outfalls.

Wastewater has the potential to change the temperature and oxygen levels of receiving waters, and may contain bacteria, organic matter, pathogens, metals, nutrients, and hazardous chemicals, all of which can degrade receiving waters and aquatic life. All wastewater outfalls in the watershed are required to be licensed with the Maine Department of Environmental Protection (DEP) or the New Brunswick Department of Environment (DOE). Strict oversight includes annual reporting of water quality to the respective governments. When facilities operate in accordance with the permit limits, the discharge should not result in violation of water quality criteria established for the receiving waters.

Bacterial pollution has been historically high in coastal embayments over the last 40 years (SCIWC 1993), and many portions of the lower St. Croix have been closed to shellfishing since the 1980's (ISCRB 2006). Today, estuarine water quality is still compromised by industrial wastewater pollution (MacKay et al. 2003), but some recent advancements have been made. In the last decade, reductions in bacterial pollution have led to conditional re-openings of major clamming areas on the New Brunswick side of the St. Croix at Oak Bay and on the Maine side at Robbinston. These improvements have economic and social implications to the St. Croix region.

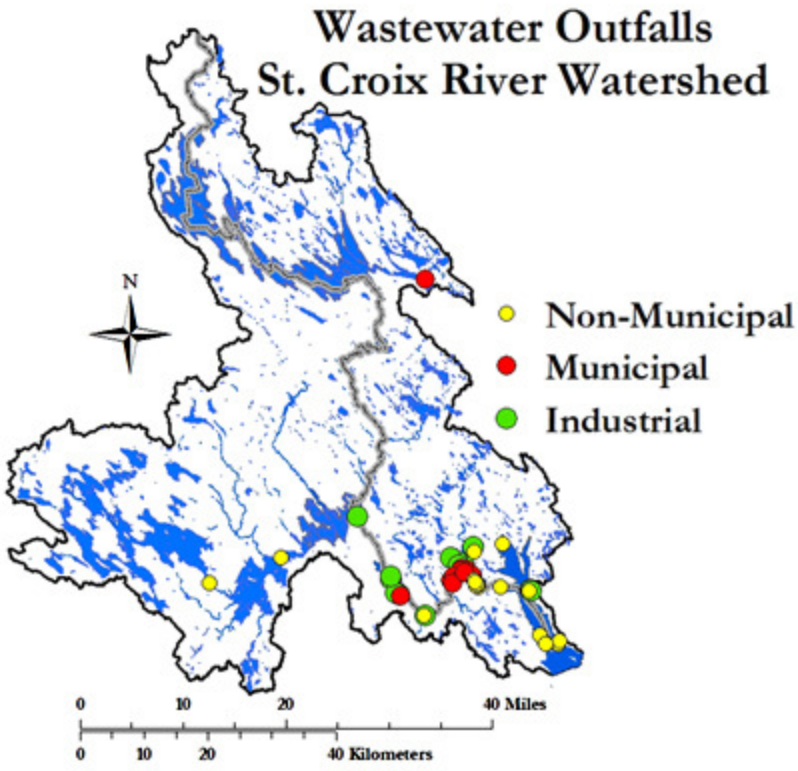
A CSO, or combined sewer overflow, is another type of discharge that should be closely monitored in the watershed. A CSO is designed to transport both sanitary sewage and stormwater in a single pipe to wastewater treatment facilities. The capacity of these systems may be exceeded in periods of heavy rainfall or snowmelt, resulting in direct discharge of untreated wastewater (sewage) into nearby waterbodies. The City of Calais, which has 5 CSOs, has embarked upon a 10- year plan, begun in 1997, to eliminate their CSOs. As a result, there has been a reduction of CSO events from pump stations of approximately 89% since 2003 (Hafford 2007). There are currently 28 CSOs in the St. Stephen sewer system with 11 located along the riverfront (Godfrey 2007). The town also has a plan, which is being carried out as resources become available, to eliminate CSOs from their sewer system. Given the high costs associated with the elimination of CSOs, efforts to deal with this issue are being made over a long-term planning horizon.

How is water quality monitored?

There are several water quality monitoring stations on the St. Croix. The U.S. Geological Survey (USGS) maintains a real-time water quality monitoring station on the lower river at Milltown from June through end of September each year, and Environment Canada recently established two real-time monitoring stations: one at the outlet of the Forest City Dam (East Grand Lake) and one at the Milltown Dam. Periodic sampling is also conducted at stations on the lakes and river by New Brunswick DOE, Maine DEP, SCIWC, and volunteers.

In addition to the above monitoring efforts, several recent studies have been conducted in the watershed:

- In 1998 and 1999, the SCIWC collected data at 93 sites on the New Brunswick side of the watershed for the province's water classification program.
- In 2003, the St. Croix Estuary Project (SCEP) completed an extensive study on the historic and current environmental health of the St. Croix estuary, which included a water quality assessment. (McKay et al. 2003).
- In 2004, Maine DEP collected water quality data between Woodland Dam and Milltown Dam with the goal of updating an existing water quality model developed in 1986 for the St. Croix River (Miller 2005).
- In 2006, the U.S. Environmental Protection Agency conducted a Sediment Oxygen Demand (SOD) study on the St. Croix River. (SOD is the rate of dissolved oxygen consumption in a waterbody due to the decomposition of organic matter in bottom sediment. High SOD may lead to oxygen depletion.) Of the four sites monitored, no stations were in the high SOD range (Bridges 2006).



How is water classified in the watershed?

Maine has had a water classification system since the 1950's. The system, which has four standards for rivers and streams (AA, A, B, C), three classes for estuarine and marine waters (SA, SB, SC), and one class for lakes or ponds (GPA), is based on numerical standards for dissolved oxygen (DO) and bacteria (E. coli), and narrative standards for aquatic life. Watercourses are managed in order to meet the goals set for each class. As a water body attains a class, it is further protected under an antidegradation provision in the law.

In 2000, New Brunswick adopted a surface water classification system compatible with Maine's system and at that time classified St. Croix lakes and drinking water supplies. The province expects to complete its classification of all remaining St. Croix waters in 2008 (Burtt 2008).

St. Croix River water quality:

Today, water quality on the main stem of the St. Croix River is generally good, especially when compared to historical water quality data from the 1970's. Dissolved oxygen (DO), a common indicator and classification standard for freshwater rivers, has been monitored at the Milltown, Maine sampling station since 1972. Mid-summer readings below 3 mg/L were recorded as recently as 1975. Monthly mean levels of DO in the past decade have not fallen below 6 mg/L. Over the past three years, monthly DO levels have remained above 6.5 mg/L. Data have also been collected historically for pH, and average monthly readings have remained fairly constant at 6.8. Data collection efforts have increased in recent years with the introduction of real-time water quality analysis conducted by Environment Canada at New Brunswick stations at Milltown Dam and Forest City. Parameters measured include specific conductance, pH, turbidity, dissolved oxygen, and total nitrate.

Lake water quality:

The lakes of the St. Croix watershed have experienced a variety of uses over the last century. During the 1800s, many of the St. Croix's lakes were dammed and controlled for seasonal log driving (Beaudoin 2005). Today, these lakes are managed to provide hydropower storage while supporting natural, residential, and recreational uses.

One tool used to measure the overall health of lakes is the **Trophic State Index** (TSI), which ranks lakes based on biological productivity. A lake's biological productivity, or the ability of the lake to support algal growth, fish populations, and aquatic plants, is determined by a number of physical and chemical characteristics, including the availability of essential plant nutrients (nitrogen and phosphorus), algal growth, and depth of light penetration. The TSI, used by the Maine DEP, determines the trophic state of a lake using a combination of Secchi Disk Transparency (SDT), Chlorophyll-a (Chl-a), Total Phosphorus (TP) data, and other factors. The TSI ranks lakes from 0 to over 100, with higher numbers representing increasing productivity and typically poorer water quality.

TSI's have been calculated for some of the lakes in the St. Croix River watershed, including Big Lake: 46; E. Grand Lake: 27-45 (six different monitoring locations); Nash's Lake: 29; Pleasant Lake: 36; and Spednic Lake: 46-54 (7 different monitoring locations). None of these lakes have reported TSIs over 60, indicating little algal growth and good to excellent water quality (ME DEP 2007).

Lake Maine and New Brunswick Classification St. Croix River System

Segment Name	Maine Classification	NB* Classification
Tributaries of St. Croix River, entering above outlet of Spednic Lake	Class A	Class A
St. Croix River Main stem, from outlet of Spednic Lake to Spednic Falls	Class A	Class A
Grand Lake Sream and tributaries	Class A	N/A
Musquash Stream and tributaries	Class A	N/A
Big Lake at Peter Dana Point	Class A	N/A
Tomah Stream and tributaries	Class AA	N/A
St. Croix River and tributaries above Grand Falls	Class A	Class A
Minor tributaries of St. Croix River between Grand Falls and tidewater	Class B	Classes A, B and C
St. Croix River Main stem, from Grand Falls to Woodland Flowage	Class A	Class A
Woodland Flowage to Calais	Class C	Class C
Calais to Passamaquoddy Bay	Class SC	Class C
Minor tributaries of St. Croix River estuary, entering tidewater in Calais and Robbinston	Class B	Class A, B and C

All reaches of the St. Croix River attain assessed standards.

*Proposed

St. Croix Estuary water quality:

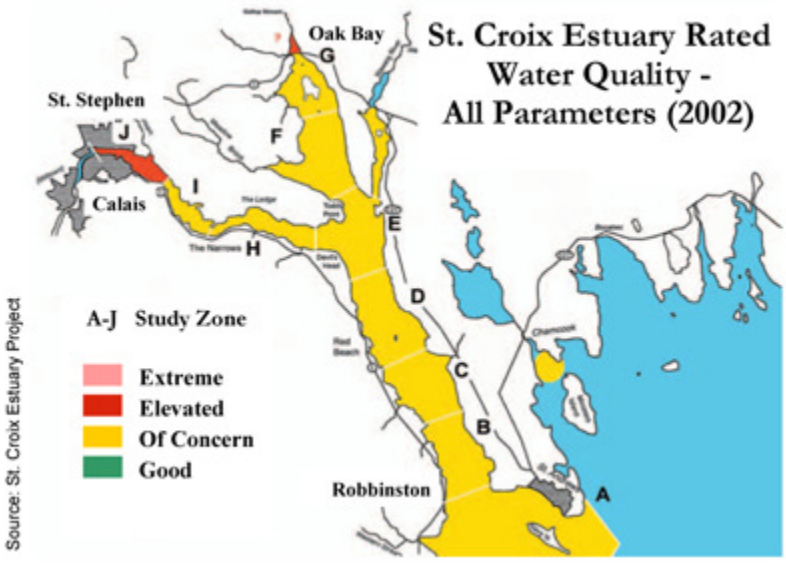
During the 1960's, as a result of pulp waste discharged directly to the St. Croix, the health of the St. Croix Estuary declined dramatically and the commercial fishery in the lower estuary all but disappeared. When improvements were made at waste treatment facilities in the 1970's, the health of the estuary began to improve (MacKay et al. 2003). Yet, the estuary is still affected by pollution today. According to data collected in 2002, the majority of the estuary is rated "Of Concern" by the St. Croix Estuary Project, while the pollution level of the estuary near the major population centers of St. Stephen and Calais (as well as Oak Bay) is ranked "Elevated". Pollutants that are affecting the St. Croix River estuary include elevated levels of nutrients (nitrogen and phosphorus), bacteria, and metals (MacKay *et al*. 2003).

Bacterial pollution has been historically high in coastal embayments of the estuary such as Oak Bay (SCIWC 1993), which was closed to clam digging in the 1950s. Only limited harvesting is permitted today. According to the SCEP, tests conducted at several locations in St. Stephen in recent years have revealed very high levels of Escherichia coli (E. coli) bacteria levels. The city is working to remediate polluted outfalls (Graettinger 2008).

What can be done to protect and improve water quality into the future?

The task of improving and protecting water quality in the St. Croix River is currently well coordinated by agency partners. Goals that should help advance these efforts include:

- Setting objectives for coordinated transboundary water quality monitoring and data management.
- Developing complementary Maine and New Brunswick water quality standards (in progress).
- Reviewing existing, and developing additional, indicators of aquatic health (indicator species for estuarine and marine environments).
- Integrating land and water use management with water quality objectives.
- Conducting watershed surveys to identify sources and "hotspots" of nonpoint source pollution.
- Utilizing the results of these surveys, expanding nonpoint source pollution reduction programs in the watershed.
- Implementing comprehensive stormwater management activities in the population centers.



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Water Quantity

Indicator: Dams

How do Dams Affect Water Quantity in the St. Croix Watershed?

The St. Croix River watershed has a cool, semihumid continental climate, with an average annual precipitation of 43" (109 cm). Variability in precipitation for the St. Croix is typical of the region. Recent annual precipitation ranged from a low of 26" (66 cm) in 2001 to 60" (152 cm) in 2005. The amount of runoff in any year is directly related to precipitation. Average monthly stream flows are also quite variable, with the lowest flows occurring in the summer, and highest in the spring.

Photo: D. Adams, Domtar

At 50 feet, Grand Falls is the tallest dam in the watershed.

How many dams are there, and what are their uses?

With an estimated 25 billion cubic feet (708 million cubic meters) of useable storage in the major reservoirs, the St. Croix River watershed is an ideal place for businesses that require water to operate. Water is stored in an extensive system of natural lakes and manmade reservoirs providing water yearround for aquatic habitat, recreation, and business uses (see Water Use section for more information).

Some of the first dams appeared in the lower part of the river in the 1700's, and in the middle and upper region in the 1800's, including at Sprague's Falls, Grand Lake Stream and Vanceboro (Beaudoin 2005). With the log-driving industry in full swing through the 1800's, many impoundments were created to control the flow of logs to the sawmills, and canals were built near the outlet of several dams to route logs to tanneries for debarking. At its peak, there were more than 50 impoundments in the watershed.

Today, there are an estimated 38 impoundments in the watershed, including six major dams (see table below). In addition to the major dams, Domtar also owns three other operational dams in the watershed: Canoose, Clifford, and Sysladobsis. While no formal watershed-wide survey exists of impoundments in the watershed (Beaudoin 2007), it is estimated that there are at least 22 more in Maine, and another 10 in New Brunswick.

Major Dams on the St. Croix River

Name	Water Body	Built	Current Use	Storage (% of total)	Owner	Watershed Area	Height	Lenght	Minimum Flow
Forest City Dam	East Grand Lake	1908	Hydropower storage	17%	Domtar	138 sq. mi	16 ft.	500 ft.	75 cfs
Vanceboro Dam	Spednic Lake	1836	Hydropower storage	42%	Domtar	400 sq. mi	22 ft.	500 ft.	200 cfs
West Grand Dam	West Grand Lake	1836	Hydropower storage	26%	Domtar	224 sq. mi	13 ft.	485 ft.	100 cfs
Grand Falls Dam	St. Croix River	1915	Hydropower facility	n/a	Domtar	1320 sq. mi	50 ft.	1135 ft.	n/a
Woodland Dam	St. Croix River	1906	Hydropower facility	n/a	Domtar	1350 sq. mi	46 ft.	1350 ft.	750 cfs
Milltown Dam	St. Croix River	1881	Hydropower facility	n/a	NB Power	1460 sq. mi	24 ft.	600 ft.	n/a

How are the major dams operated?

Water in the upstream lakes and main stem of the river is regulated and managed in order to balance competing uses including the environment, recreation, and business. Minimum flows have been established for several of the dams as well as maximum and minimum water levels for the storage reservoirs. The six major dams are operated consistent with various orders and agreements with some or all of: the International Joint Commission (IJC), Federal Energy Regulatory

Commission (FERC), Maine Department of Inland Fisheries and Wildlife (MDIFW) and the Maine Department of Environmental Protection (ME DEP). Canadian and New Brunswick agencies do not have specific operational agreements regarding these dams.

The major dams in the watershed serve two main purposes. They act as either 1) run-of-the-river dams that use natural flow and elevation to generate electricity, or 2) dams that store water in large reservoirs to ensure continuous flow past hydroelectric turbines despite seasonal fluctuations in natural flow.

If the river were not regulated, the monthly distribution of runoff from precipitation would be more variable, summer flows and water levels would be lower, spring freshets would be higher, and some reservoirs would revert to free flowing river. During periods of low precipitation, natural flows would generally be lower than regulated flows (Environment Canada 1988).

At over 220,000 acre-feet, Spednic lake (behind the Vanceboro Dam) has the largest storage capacity of any of the managed lakes in the system.

What affect do the dams have on watershed health?

Extensive studies have shown that unique interrelationships exist between flora and fauna and the lake ecosystems where they live (Domtar 2005). These studies suggest that changes to the annual fall-draw cycle could result in a number of ecosystem effects including: either increased or decreased shoreline erosion; a reduction in the number of aquatic species that depend on certain water levels at certain times of the year; changes to fringe wetlands at the edge of lakes; transformations of wetland systems; and changes to available fish spawning area and water quality as a result of reduced stream flow (Beaudoin 2005).

Significant reduction and virtual elimination of abundant migratory fish runs has been documented

on the river. Over the years, management strategies have been geared toward the construction, maintenance and design of fishways that would help restore alewives and other migratory fish to their native spawning grounds above the dams.

Concerns about water quality, fisheries, flood control, hydropower generation, lake water levels, and optimal flows for summer recreation have been at the forefront of issues in the watershed. Information sharing by St. Croix water users is important to multiple use management. The St. Croix International Waterway Commission hosts a semi-annual St. Croix Water Forum for this purpose.

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Water Uses

Indicator: Recreation

How Have the Uses of the St. Croix Changed Over Time?

Industrial use of the St. Croix River began in the 1700's with the construction of dams, initially for log driving and milling and then, beginning in the early 1800's, to power manufacturing facilities and towns. The water and forests in the watershed have supported several commercial and industrial operations over the last three centuries, including saw mills, a pulp and paper mill, a

cotton textile mill, tanneries, fish hatcheries, ship yards, and marine ports. These historical uses placed a burden on the water quality of the river, streams, lakes and estuary (see Water Quality Section).

What are the current uses?

Evidence of past uses of the St. Croix persists. The effects of the log-driving era are still felt today as 50- 200 cords of four-foot pulp wood are removed from the river at Woodland and Grand Falls dam every year (Beaudoin 2005).

Today, the main uses of the St. Croix are industrial, municipal and recreational. Industrial and municipal uses include hydropower production, cooling water, wastewater and stormwater assimilation, and shipping.

Hydro-electric Power Generation in the St. Croix Watershed	
Name	**Capacity**
Grand Falls Dam	9.5 MW
Woodland Dam	11.6 MW
Milltown Dam	3.9 MW

Domtar Inc. operates multiple dams on the St. Croix, and uses their energy to help run its pulp mill in Baileyville. The Woodland Mill is known worldwide as the manufacturer of premium quality northern hardwood pulp, with a daily average pulp production of 1,100 tons, which is shipped through the Port of Eastport or shipped by rail and truck to customers throughout the world (Maine Pulp & Paper 2008). New Brunswick Power generates power at the Milltown Dam and sells power to the grid.

The total hydro-electric capacity on the river is about 25 megawatts (MW). Power is generated at run-ofthe- river facilities; water stored in the upper reservoirs is used to assist with power generation and maintenance of minimum flows in the river.

Recreational Uses

The large land base, series of interconnected lakes and streams, and tidewaters provide opportunities for recreational fishing, boating, canoeing, swimming and other sports, along with wildlife viewing on the St. Croix. Hiking, cross-country skiing, snowshoeing, wildlife viewing and camping are popular land-based activities. A number of campgrounds and boat accesses throughout the watershed, and a series of primitive campsites along the boundary waters, serve the recreational public.


Photo: T. Barker, USACE

The St. Croix is a popular canoeing destination, offering a good mix of white and calm water.

The St. Croix region is thought to represent the highest density of employment in the sporting camp and guiding businesses in Maine (Jordan 2007). Sport fishing alone generates valuable federal and state tax revenue from the sale of fishing

tackle, fuel, licenses, food and lodging.

Sport fishing in the St. Croix area has been popular since the 1800s when visitors would hire guides to take them to Grand Lake Stream. Today, its economic value remains high, bringing in $5.45 million annually based on 75,000 angler-days, with the economic contribution of an angler-day of fishing estimated at $72.61 (Jordan 2007).

It is estimated that at least $1 million comes from Grand Lake Stream alone. $2.2 million, or half of the total economic value of sport fishing, is derived solely from smallmouth bass fishing, based on their catchability and long season compared to other fish such as landlocked salmon or trout (Jordan 2007).


Photo: M. McInerney

Number of Anglerdays on Lakes in the St. Croix Watershed

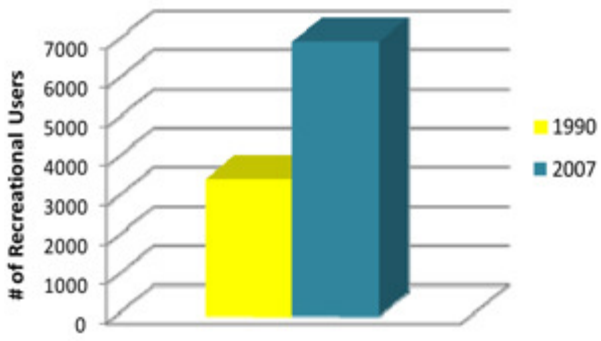
Lake	Angler-days
East Grand Lake	36,000
West Grand Lake	10,500
Big Lake	4,500
Grand Falls Flowage	3,600
Spednic Lake	3,200
Grand Lake Stream	1,500
West Musquash Lake	1,450
Pocumcus Lake	400

Estimates above include surveyed waters only. Including estimates from non-surveyed waters, total angler-days are approximately 75,000 (Jordan 2007).

Is recreational use increasing?

Outdoor recreation is gaining popularity in the St. Croix region and may be the fastest growing water use in the St. Croix watershed. In fact, recreation is second only to wood harvesting and processing as the waterway's most important resource-based industry (SCIWC 2007).

Canoe Recreation on the St. Croix River 1990-2007 A 1999 survey of recreational users revealed that canoes are the most common type of craft used on the waterway, and that canoeing was the primary reason that users chose the St. Croix (Stacey & Daigle 2001). Canoeing opportunities exist for all skill levels on both the lakes and the river. One can choose a day trip on a lake, paddle the undeveloped backcountry in the upper watershed, or canoe a full 90 miles of boundary waters over a period of 7-10 days.



A full season survey by the SCIWC in 1990 identified 2,879 canoeists using the upper St. Croix River. Allowing for users missed, the Commission estimated the total number of canoeists that year to be between 3200-3500. Anecdotal information available to the Commission suggests that the number of users in 2007 was more than double that figure, with the largest increase in the past 5 years (Sochasky 2007). Concerns about environmental effects from increased use point to the need for a follow-up user survey to more accurately track increased recreational use over time, and to help develop management plans for future use.

Future Management Considerations

The Maine-New Brunswick management plan for the St. Croix International Waterway has several policies to address recreational use in the watershed. Specific actions focus on long-term protection of Spednic Lake and the upper river; ensuring adequate public access sites and facilities; identifying and addressing recreational user conflicts; managing existing fisheries for quality and sustainability; expanding boating facilities and services at the upper and lower ends of the waterway; and encouraging additional low-impact water recreation.

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Fish

Indicator: Alewives

What is the Status of the Alewife Population in the St. Croix River Watershed?

The St. Croix River is home to 44 fish species, including 11 sea-run and 36 freshwater species. Three species (Atlantic salmon, rainbow smelt, and alewives) are known to have both sea-run and freshwater strains (Cronin *et al*. 2002). The principal freshwater fisheries in the St. Croix are for native salmonids (lake trout, landlocked salmon, brook trout) and non-native species (smallmouth bass, white perch).

Two types of alewife (*Alosa pseudoharengus*) occur in the St. Croix River system: anadromous and landlocked. Landlocked alewives, a recently introduced fish, spend their entire lives in large lakes. Anadromous alewives, a native species, spawn in freshwater but spend most of their lives at sea. According to a 2006 study, these two life forms are genetically distinct (Willis 2006). Since being introduced in the mid-1990's, landlocked alewives have increased in the upper part of the watershed. Over the decades, the number of anadromous alewives has declined.

Historically, the St. Croix River supported large runs of anadromous species, including alewives, which ascended the river system nearly to its headwaters (ISCRB 2005). As a result of pollution and the construction of dams, the significant reduction of anadromous fish runs was documented on the St. Croix as early as 1825 (Flagg 2007).

Why are anadromous alewives important?


Photo: SCIWC

Anadromous alewives are an important part of the St. Croix River ecosystem.

Anadromous alewives are important to the ecology of freshwater, estuarine, and marine environments. They are an indispensable nutrient source for freshwater ecosystems, providing nutrients in the form of eggs, excreted materials, and carcasses (Nedeau 2003). Ospreys, bald eagles, cormorants, loons, and great blue herons feed on migrating alewives each spring, at a time when many of these birds are nesting and rearing chicks. Alewives also provide an alternative food source for fish-eating birds at the same time juvenile Atlantic salmon are migrating downriver, and provide protective cover for upstream migrating adult salmon. Young-of-theyear alewives are a food source for game fish during the spring, summer and fall. Additionally, the alewife is the only known vertebrate host for the freshwater mussel *Anodonta implicata* (alewife floater), an important filter feeder that

removes large amounts of algae, zooplankton, bacteria and sediments from the water (Nedeau 2003).

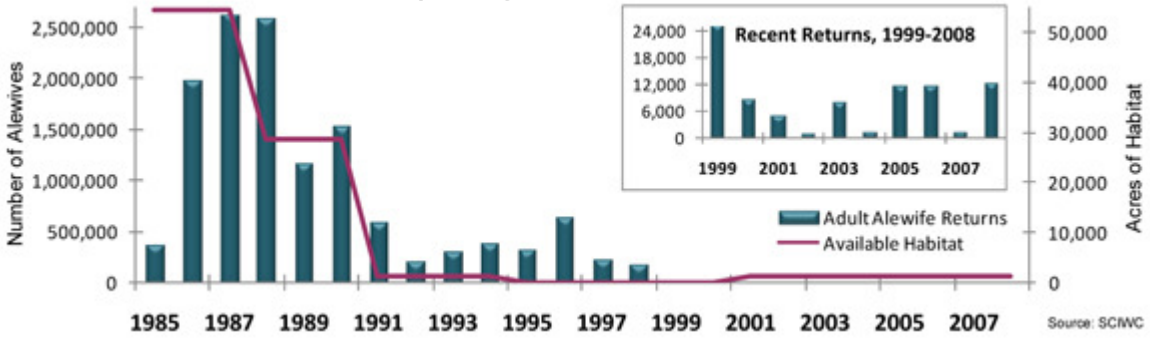
What is the history of anadromous alewife management in the watershed?

Alewife management strategies in the watershed historically have been geared toward the design, construction, and maintenance of fishways to allow passage around dams. Prior to 1980, an old fishway at Milltown allowed only limited passage of alewives. In 1981, the completion of a new fishway at Milltown Dam, together with modern fishways constructed in 1964 at Woodland and Grand Falls, greatly improved alewife passage on the St. Croix and resulted in a resurgence of the anadromous alewife population (Flagg 2007). Anglers began to see schools of alewives below the West Grand Lake Dam and in Spednic Lake. Between 1981 and 1987, alewife returns increased from 169,000 to 2,625,000.

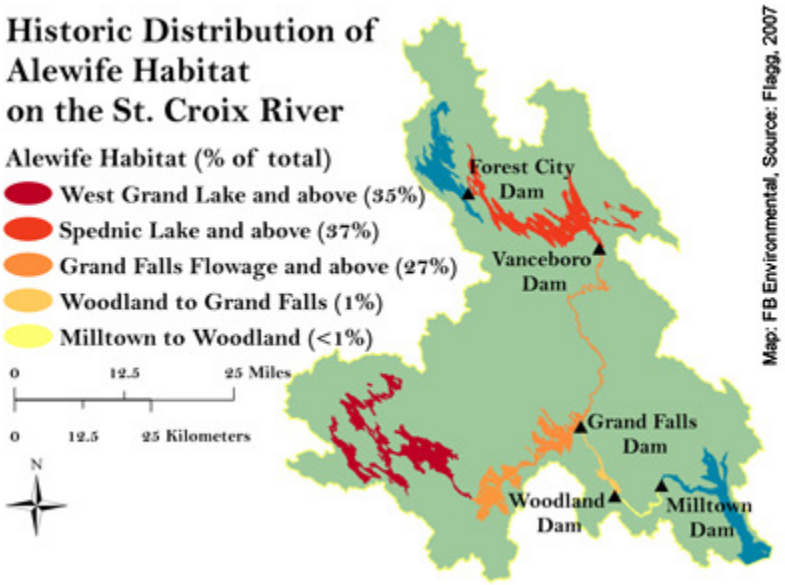
This alewife resurgence coincided with a drastic decline of smallmouth bass in Spednic Lake, and raised concerns that the increased alewife population might be impacting smallmouth bass. As a result of these concerns, alewives were blocked from Spednic in May of 1987 and, as part of an assessment program aimed at developing a long-term alewife management plan, alewives were temporarily blocked at Grand Falls in 1991. In 1995, the State of Maine enacted emergency legislation to close both the Woodland and Grand Falls fishways to migrating alewives. After these closings, the St. Croix alewife population fell from a high of 2.6 million fish in 1987 to a low of only 900 returning adults in 2002.

The Milltown Dam was not subject to the 1995 legislative action and, beginning in 2002, the Canada Department of Fisheries & Oceans began trucking alewives from the Milltown fishway 16 kilometers (10 miles) upstream to the Woodland Flowage where they were released to spawn. This effort allowed the alewife run to rebound to about 12,000 in 2006 (Flagg 2007).

St. Croix Alewife Spawning Habitat and Adult Returns, 1985-2008



Starting in 1996, alewife returns reflect the spawning success of the larger numbers of fish that were able to pass through the new fishway built in 1981. The inset shows recent (1999 to 2008) low returns.



Large runs of alewives once ascended the St. Croix nearly to its headwaters to spawn. Today, less than 2% (Milltown to Grand Falls) of the total spawning habitat is available to alewives.

What have we learned about anadromous alewives in the St. Croix in recent years?

Recent studies have focused on the interactions between alewives and smallmouth bass. A 10-year inter-agency study on Lake George during the 1990s concluded that alewives had no negative impacts to the overall water quality, zooplankton community, or recreational fisheries in the study area (Kircheis *et al*. 2004). Similarly, a 2006 study using data collected by the Maine Department of Inland Fisheries and Wildlife showed that the presence of alewives did not harm smallmouth bass size (length, weight, condition) or growth; alewives were not significant predators on smallmouth bass; and competition for food between the two species was not significant (Willis 2006).

What is the future of anadromous alewives on the St. Croix?

In March of 2008, the Maine Legislature's Marine Resources Committee heard testimony on LD 1957, an act to overturn the 1995 state law closing fishways at the Woodland and Grand Falls Dam to anadromous alewives. While the original bill would have provided access to 52% of the spawning habitat available in the 1980s, an amended bill was passed, opening fish passage at the Woodland Dam only and restoring alewives to just over 2% of that habitat. The Maine Department of Marine Resources, the Department of Inland Fisheries and Wildlife, and the Passamaquoddy Tribal Government will be working collaboratively over the next year in the hope of resolving the issues that resulted in the changed legislation. The Joint Standing Committee on Marine Resources will continue to monitor these efforts.

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Top

Wildlife & Plants

Indicator: Bald Eagles

What can Bald Eagle and Other Unique Species Tell Us About Watershed Health?

The bald eagle (*Haliaeetus leucocephalus*), a revered symbol of Native Americans and a national symbol of the United States since 1782, has been considered a barometer of environmental quality and a flagship species for endangered species conservation since the 1970's.

Photo Credit: Mark McCollough

Bald eagle populations have been rebounding in numbers, and expanding their range overall for about 25 years in the St. Croix Watershed.

Why is it important to monitor bald eagle populations in the St. Croix?

Bald eagles are top-level predators that consume a varied diet consisting primarily of fish. They will also consume birds (primarily waterfowl), turtles, snakes and other small animals and carrion (carcasses). Eagles require a good food base, perching areas, and adequate nesting sites with little to no human disturbance near rivers, lakes, estuaries and

marshes. Because of their varied diet, their range of habitats, and their relatively long life-span (15-25 years in the wild), eagle studies tell us a lot about the health of our natural resources including the quality of the air, water and soil.

Environmental Toxins Past and Present

There are number of documented environmental toxins that have been shown to affect eagle populations. The most well known is DDT, which was used in Maine's working forests for several decades to control spruce budworm and other forest insect pests (McCollough 2007). DDT controlled more than just insects, poisoning aquatic plants, fish and birds that eagles prey on. Bioaccumulation of DDT up the food chain interfered with the eagle's ability to produce strong shells, resulting in eggs that would break or fail to hatch. These detrimental effects led to a crash in the bald eagle population in North America.

The ban on DDT in 1972 in the U.S. was a major turning point for bald eagle recovery. Today, other chemicals such as mercury continue to affect bald eagle populations, especially in the northeast. Sources of mercury include dredged river sediments, mining, and atmospheric deposition from coal fired power plants (Desorbo & Evers 2005, McCollough 2007).

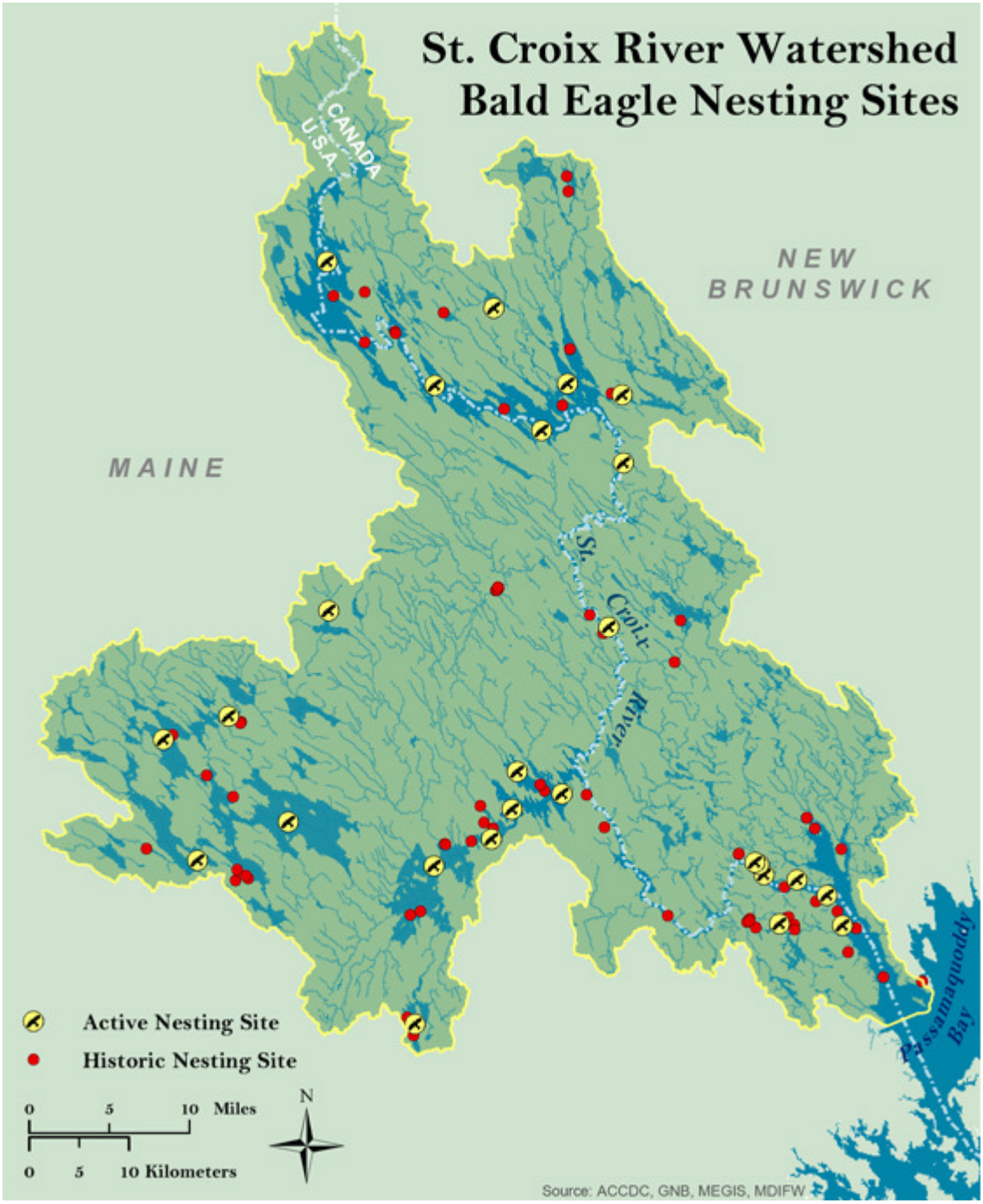
Eaglet sampling throughout Maine in 2001-2004 revealed that blood mercury was higher in Maine than other bald eagle populations sampled in the U.S. In fact, the St. Croix watershed was listed as a distinct mercury "hotspot", with significantly higher mercury exposure (as estimated by mercury concentrations in feathers) than comparison lakes. Out of feathers sampled in 42 eagle territories across the state, those collected near Sysladobsis Lake had the highest levels of mercury (Desorbo & Evers 2005).

WHAT PROTECTIONS EXIST FOR BALD EAGLES?

The bald eagle has been protected in the U.S. since 1940 under the Bald and Golden Eagle Protection Act. The law made it illegal to kill, sell or possess the species. Following the ban on DDT, the bald eagle was listed as Regionally Endangered in New Brunswick in 1976, and Endangered under the U.S. Endangered Species Act in 43 states, including Maine, in 1978.

In 1988 Maine amended their Endangered Species Act adding habitat protection (Essential Habitat). This amendment helped protect an area within 1/4 mile (402 meters) radius of eagle nests. New Brunswick followed Maine's lead in 1996, adding habitat (Critical Habitat) to the list of protections for eagles. These new rules have helped protect both current and historic nesting sites and feeding areas for the bald eagle.

Despite federal delisting of the bald eagle from its status as Threatened in the U.S. on June 5, 2007, it will remain protected by the Bald and Golden Eagle Protection Act, and the Migratory Bird Treaty Act. The eagle is still considered Threatened under State law in Maine, and Regionally Endangered in New Brunswick.



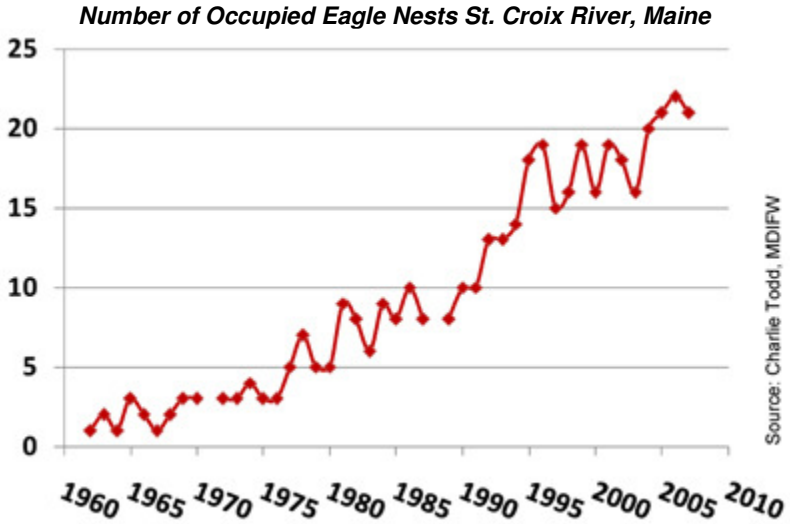
Have bald eagles made a comeback in the St.Croix watershed?

Current data from Province of New Brunswick shows at least 14 bald eagle nests within the watershed, with at least 50% of those nests known to contain breeding eagles. This is a huge improvement over just 15 pairs of breeding eagles in all of New Brunswick 30 years ago (Stocek 2000). Similarly, trends in Maine point to a mere 7 nesting pairs of eagles in the St. Croix River watershed in 1978 compared to 20 nesting pairs in 2007 (see graph to right).

Eagles concentrate where food is seasonally abundant and accessible. Historically, large aggregations of foraging eagles from outside the watershed (primarily young and non-breeding eagles) followed droves of spawning alewives up the St. Croix River every spring.

These large eagle aggregations are now a thing of the past following Maine's dam closures to migrating alewives. Today, a small population of resident eagles are found feeding on alewives below Grand Falls every spring (Todd 2007). Despite changes in alewife populations, the breeding eagle population has not been set back over the past 25 years (Todd 2007). However, the number of nesting eagles in the St. Croix seems to have plateaued and is not progressing much despite being close to the traditional stronghold for the species in Passamaquoddy Bay (Todd 2007).

There is no question that laws to protect these species and their habitat have helped improve eagle populations in the St. Croix. Yet, there are a number of potential reasons for the slower increase of the bald eagle population compared to other regions: the cool climate and acidic soils typical of the Northeast has slowed the breakdown of DDT; mercury and other environmental toxins are persistent in the watershed; and the closing of fishways to anadromous alewives has changed the dynamics of eagle populations.



Twenty nesting pairs of bald eagles were documented in the St. Croix River Watershed by Maine DIFW in 2007.

Top

Wildlife & Plants

Wildlife and Plants

What unique animal species live in the St. Croix watershed?

There are 9 species of wildlife protected by endangered species laws in the St. Croix watershed. One of these, the Tomah mayfly, was believed to have gone extinct in the 1930's. In 1978, the mayfly was rediscovered by a University of Maine researcher at Tomah Stream in Codyville. Since

Tomah Stream is home to one of the rarest mayflies in the world.

then it has been found at 15 sites in Maine, but it is still considered one of the rarest mayfly species in the world (MDIFW 2008). The Tomah mayfly spends most of its life as a nymph in small rivers and streams bordered by large areas of seasonally flooded sedge meadow. Changes to these ecosystems, as well as spraying of pesticides, dredging, damming, or introduction of non-native plants or fish would be detrimental to this species.

In addition to the species noted above, the St. Croix estuary supports hundreds of marine animals, including jellyfish, bivalves, crustaceans, sea cucumbers, sea urchins, flatworms and migrant fishes. Studies of species distribution in the estuary in 2001-2002 indicate a narrowing in the distribution of and reduction in the number of species compared to 1977-1978. These changes point to the need for improved water quality in the St. Croix estuary (MacKay *et al*. 2003).

Rare Wildlife Species in the St. Croix Watershed		
Common Name	**Latin Name**	**Location**
Endangered		
Red Knot (Bird)	*Calidris canutus*	NB
Black Tern (Bird)	*Chlidonias niger*	ME
Eastern Cougar (Mammal)*	*Puma concolor couguar*	NB
Canada Lynx (Mammal)*	*Lynx canadensis*	NB
Bald Eagle (Bird)*	*Haliaeetus leucocephalus*	NB
Threatened		
Bald Eagle (Bird)	*Haliaeetus Leucocehalus*	ME
Common Nighthawk (Bird)	*Chordeiles minor*	NB
Chimney Swift (Bird)	*Chaetura pelagica*	NB
Tomah Mayfly (Mayfly)	*Siphlonisca aerodromia*	ME
Pygmy Snaketail (Dragonfly)	*Ophiogomphus howei*	ME/NB

** Regionally Endangered in New Brunswick*

What about rare plants and natural communities?

The St. Croix is home to more than 50 species of rare plants. However, unlike the laws that protect wildlife in the watershed, there are no specific protections for rare plants in Maine or New Brunswick. Fortunately, many of the rare plant species occur in large wetland habitats that receive

Only two populations of the Showy Lady Slipper have been documented in the watershed.

some protection under environmental regulations in Maine (Cameron 2007) and New Brunswick.

At least 39 different species of marine plants (35 algae and 4 lichen) commonly occur in Passamaquoddy Bay. A survey by the St. Croix Estuary Project in 2001- 2002 located 12 of these species within the intertidal zone of these waters, down from 17 species in 1978. While some marine plants appear to be recolonizing parts of the upper estuary near St. Stephen and Calais, researchers have determined that the diversity of these marine plant species has declined over the past 25 years (MacKay *et al*. 2003).

The St. Croix is also home to seven rare wetland communities, four different types of bog ecosystems, two types of fen ecosystems, and a stream shore ecosystem. Two of the bog ecosystems are ranked "threatened" by the Maine Natural Areas Program, while the others are "of special concern".

Listed Plant Species in the St. Croix Watershed	
Common Name	**Latin Name**
Endangered	
Vasey Rush	*Juncus vaseyi*
White Adder's-mouth	Malaxis monophyllos
Threatened	
Showy Lady's-slipper	*Cypripedium reginae*

What management strategies can be used to protect these species?

Today, ongoing threats to wildlife, plants and sensitive ecosystems in the watershed include loss of habitat from road building, waterfront development, and forestry activity.

While endangered and threatened wildlife species and their habitat are protected by law under endangered species legislation in the U.S. and Canada, non-listed species are not. Conservation and management of nonlisted rare plant and animal species in the watershed require individual management strategies due to different habitat requirements and breeding strategies.

The Maine Landowner Incentive Program (LID) is being used in Maine to protect rare and endangered plants and natural communities by offering a variety of tools to landowners, including funds for conservation easements, cooperative management agreements and habitat management activities on private land (MNAP 2007). These and other strategies to protect unique natural features should be part of a long-term management strategy for the St. Croix.

A common thread for all of these species is clean water, and limited human disturbance.

Conservation easements and other forms of land conservation will help preserve suitable habitat for these species. Some of these strategies appear to already be working, since four rare and special concern aquatic plant species in the watershed were delisted in 2006 (Beaudoin 2008).

CLIMATE CHANGE IN THE ST. CROIX REGION

Climate change refers to any change in climate over time, whether due to natural variability, or as a result of human activity. The changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation, and in land surface properties alter the energy balance of the climate system. Observational records and climate projections provide evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems (Bates *et al*. 2008).

How has climate changed in the St. Croix region?

Over the last century, the average global temperature has increased by about 1ºF (~ 0.6ºC) likely in part due to increasing greenhouse gases from human activities. Research conducted (Wake 2006) for the northeastern United States and Canadian Maritime region indicate that annual average temperatures have increased approximately 1.4º F (~ .8ºC) since 1900. The average rate of temperature increase over the last 33 years is three times higher than for the entire century. Regional data over this time period, while somewhat variable, also suggest increased average annual precipitation, increased extreme precipitation events, increased sea level rise, decreased snowfall, and earlier ice-out dates for lakes and rivers.

How could it impact the watershed in the future?

Reports on West Grand Lake reveal earlier ice-out, resulting in high river flow one to two weeks earlier than in the past (Hodgkins 2007). A sea-level rise may affect the St. Croix Estuary, particularly sensitive marsh ecosystems. Drier summers and falls could mean lower river flows, which could affect species composition, hydropower generation and recreation, and may increase the risk of forest fires. Higher storm frequency and intensity could increase erosion and flooding as rivers adjust to changing runoff volumes. Public infrastructure such as dams, culverts, and stormwater drainage systems could be impacted by climate change. These factors indicate a potential need for more locally-focused efforts to address impacts, adaptation, and mitigation of climate change in the St. Croix region.

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Top

Air Quality

Indicator: Air Pollution

What is the State of Air Quality in the St. Croix River Watershed?

A wide variety of air pollutants and air issues affect the natural functioning of watershed ecosystems: the quality of the soil and water are significantly affected by acid rain and its contributing pollutants; the health of wildlife is compromised by pollutants such as mercury; vegetation health and productivity are harmed by a variety of pollutants, including ground-level ozone; and human health is affected by air pollution, smog in particular.

Where is air quality measured in the St.Croix watershed?

Monitoring air quality helps us to better understand the impacts of both localized and long-range sources of pollution. There are four air quality monitoring stations situated near or within the St. Croix River watershed.

What are the types and sources of air pollution in the watershed?

St. Croix Watershed Air Quality Monitoring Stations and Parameters		
Site	**Monitors/Programs**	**Indicators Measured**
Huntsman Marine Science Centre (HMSC), St. Andrews, NB	HMSC & NB Department of Environment	ozone, particulate matter, mercury
Canterbury, NB	NB Department of Environment	ozone, particulate matter, acid rain
Moosehorn National Wildlife Refuge, Baring, ME	U.S. Fish & Wildlife Service (FWS)	particulate matter
Sipayik, Perry, ME	Passamaquoddy Tribe	ozone

Ground-level ozone and ***particulate matter*** are the primary components of smog. Ozone forms in the air when emissions from motor vehicles, lawn mowers, power plants, and industry react with heat and sunlight. Particulate matter (PM) is airborne particles made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles. Particles that are 10 micrometers in diameter or smaller are able to pass through the throat and nose and enter the lungs. Fine particles less than 2.5 micrometers are produced when any fuels are burned, whether by trees in forest fires or by gasoline in automobiles. Particulate matter and ozone are linked to serious health problems including chronic bronchitis, asthma, and heart and lung disease. Other effects of these pollutants include reduced visibility in the case of PM, and crop damage and greater vulnerability to disease in some tree species in the case of ozone (GNB 2005, US EPAb).

Acid rain is a general term referring to wet and dry deposition that becomes acidified when air pollutants react with water in the air to form strong acids. The main sources of these acid-forming

pollutants are vehicles, industrial facilities, and power-generating plants (US EPAa 2007).

Mercury is typically released into the air when coal is burned to produce electricity at power plants, or from sources such as hazardous waste, among others. Once released into the air, mercury may end up in the ground or water. Biological processes transform the mercury into an organic form that bioaccumulates in fish, ultimately accumulating up the food chain and exposing humans and animals to mercury when they eat contaminated species.

Emissions that cause air pollution typically travel long distances across state and national borders. Air pollution in the St. Croix watershed is affected by local emissions and the emissions from upwind industrial regions in the Midwest U.S., southern Ontario and Quebec, and the Washington and Boston regions of the U.S. (GNB 2005, US EPAa 2007).

Mercury contamination has been found in some Maine lakes and ponds, resulting in a state-wide fish consumption advisory for pregnant women and children under 8 years of age.

What is the status of air quality in the watershed?

Ground-level Ozone is measured at the Canterbury and St. Andrews sites in New Brunswick and the Perry site in Maine. Results from the most recent available data (2005) show that the Canterbury and St.Andrews sites had no exceedances of the 1-hour National Ambient Air Quality Objectives (NAAQO) standard (82 parts per billion (ppb)), or Canada-wide standard (65 parts per billion, based on an 8-hour averaging period). Over the entire period of monitoring (1997-2005), the St. Andrews site has never exceeded the 1-hour standard, and the 1-hour standard has only been exceeded at the Canterbury site during two hours since 1995, one hour each in 1998 and 1999 (GNB 2005). At the Perry site, monitoring data from 2005 to 2008 shows no exceedances of the U.S. standard (80 ppb, based on an 8-hour average) (ME DEP 2007, US EPAb 2008). However, when compared to the more stringent Canadian 1-hour National Ambient Air Quality Objectives (NAAQO) standard, there were 3 exceedances over the three-year period. Overall, monitoring results show a very slight trend toward increasing ozone levels (just over 2 ppb) over the period of 1980-2005.

Particulate matter is measured at the Canterbury and St. Andrews sites in New Brunswick and at the Moosehorn site in Baring, Maine. Monitoring results at the Canterbury and St. Andrews sites show that levels of PM are consistently lower than levels at other sites in New Brunswick. During the most recent available monitoring year (2005), neither site exceeded the Canada-wide standard for PM (30 micrograms per cubic meter).

Particulate matter at Moosehorn NWR has been monitored with an aerosol sampler since 1991. A video camera also records visibility conditions at the site. Measurements of PM components are used to calculate the visibility impairment, based on what is called the "deciview haze index". One deciview is approximately the smallest amount of change in visibility impairment that a person can detect visually. Results show that air pollution is impacting Moosehorn. Haze from pollution reduces visibility in the wilderness area and occasional smoke plumes from nearby industry drift into the area (VIEWS 2008).

Acid rain, expressed as the deposition of sulfate, has been monitored at Canterbury since 1993. According to monitoring results from 1993 to 2005, acid rain peaked in 1993 and then declined in subsequent years, until another peak in 2005, the last year records were available. Although acid deposition has generally declined since the 1990's, it is still a concern for the area (GNB 2005).

Mercury monitoring has been conducted at St. Andrews since 1995. Although Canada has no environmental guidelines for mercury, monitoring data may be used to look for patterns or trends over time. Monitoring results at the St. Andrews site show an overall decline in mercury concentrations in both ambient air and precipitation over the sampling period (Temme *et al*. 2007).

Hazy and clear day photos captured at Moosehorn National Wildlife Refuge by Camnet, a real-time air pollution visibility camera network.

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Contact Information

International St. Croix River Watershed Board:

Bill Appleby, Canadian Co-Chair
Director, National Service Operations Division
Environment Canada
16th Floor, Queen Square
45 Alderney Drive
Dartmouth, NS B2Y 2N6

Colonel Philip T. Feir, U.S. Co-Chair
U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

International Joint Commission:

U.S. Section Office
Frank Bevacqua
Public Information Officer
2000 L Street, NW
Suite #615
Washington, DC 20036
bevacquaf@washington.ijc.org

Canadian Section Office
Bernard Beckhoff
Public Affairs Advisor
234 Laurier Avenue West, 22nd Floor
Ottawa, ON K1P 6K6
beckhoffb@ottawa.ijc.org

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