A Revised Community Environmental Management Plan for the St. Croix Estuary Area to 2020

Funding Provided by
Atlantic Ecosystem Initiative
Environment Canada

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CARING FOR OUR COAST

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St. Croix Estuary Project, Inc.
March 2013

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Introduction

This plan contributes to an ongoing partnership between Environment Canada and the St. Croix Estuary Project (SCEP) to involve the people of the St. Croix region in guiding their environmental, economic and social future, as these are critically intertwined.

The St. Croix Estuary Project, Inc. was founded in 1992 under guidance and funding from Environment Canada's Atlantic Coastal Action Program (ACAP). Since 1991, ACAP has been Environment Canada's primary means to help Atlantic coastal communities take the lead in identifying and addressing environmental and development issues. Through this program, Environment Canada has partnered directly with14 ecosystem-based organizations at the watershed/estuary level and recently three ecosystem-based collaboratives at the regional level to address environmental priorities[1].

Under this partnership, ACAP organizations developed a community Comprehensive Environmental Management Plan (CEMP) to set a vision and goals for their coastal region and Environment Canada provided funding to help with their implementation. A 2002 economic analysis of this partnership showed a 12:1 return on federal investment and a significant increase in local commitment to resource stewardship[2] – a win-win situation for all partners, and for Canada.

In 2011, in an effort to streamline its program delivery, Environment Canada consolidated a number of its public outreach programs under a new *Atlantic Ecosystems Initiative* (AEI) and re-defined the ACAP program as its funding vehicle for these. This led to changes in the previous ACAP partnerships, most notably that all Environment Canada support for ACAP organizations is now linked solely to result-based projects identified in their CEMPs, on a limited and competitive region-wide basis that is linked to current Environment Canada objectives (Appendix 2).

As Environment Canada has redefined its ACAP partnership role, so have many ACAP organizations, including SCEP. Over the last decade, SCEP has retained its environmental direction but has expanded its initiatives to include a wider educational role that centers largely around the Ganong Nature Park, a 350-acre shore and tidal reserve that SCEP established on the St. Croix estuary in 2002. SCEP also now focuses exclusively on Canadian initiatives for the estuary, in recognition of its Canadian mandate and funding base, while acknowledging the St. Croix's international character and its American partners.

This document updates SCEP's original 1997 community Comprehensive Environmental Management Plan for the St. Croix Estuary Area, with a specific focus on the current decade. It retains on-going issues from the earlier document but incorporates others that have growing significance. It also seeks to support wider regional resource plans that include the international St. Croix area, including those produced by the St. Croix International Waterway Commission[3] and the Gulf of Maine Council on the Marine Environment[4].

SCEP offers this plan to the St. Croix community at large as a potential guiding document that all might deliver together. SCEP will have a role in some of the proposed actions but most of these will rely on the leadership of others. Organizations and agencies that might participate in these actions have been identified in the text.

Finally, with today's rapid environmental changes and diminishing resources to address them, this plan focuses on priority issues and actions for the current decade. SCEP hopes that, as progress is made on some of these in the next 5-7 years, other issues can be added.

The St. Croix Estuary Planning Area

This plan focuses on the Canadian waters of the international St. Croix estuary from St. Stephen to St. Andrews, including Oak Bay, and the nearshore coastal waters of Passamaquoddy Bay from St. Andrews to Bocabec, including Chamcook Harbour and Bocabec Bay. These can be found in Figure 1.

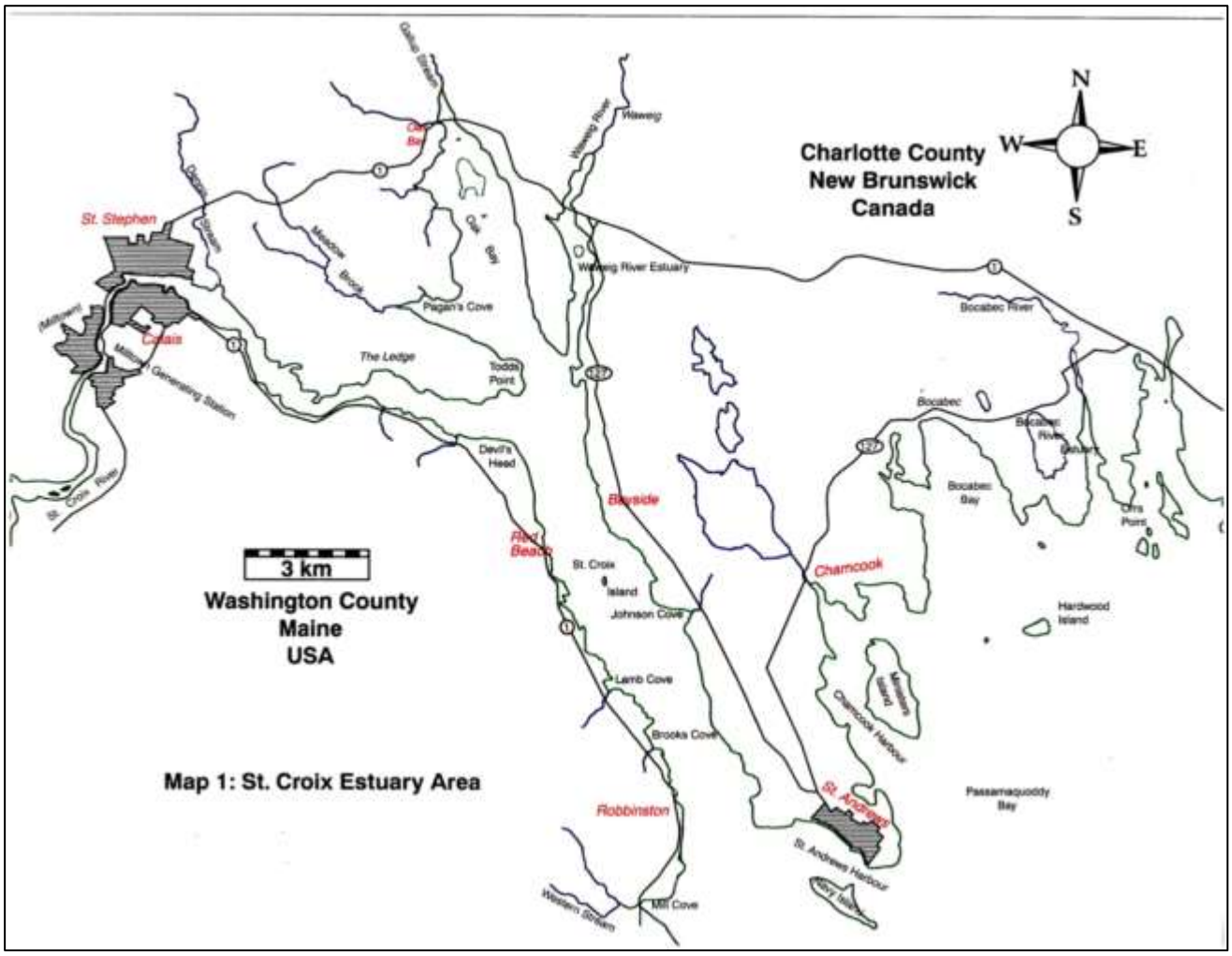

Figure 1. St. Croix Estuary area, New Brunswick and Maine.

A Vision for the Future *(revised from 1997)*

When preparing its 1997 Plan, the St. Croix Estuary Project consulted extensively with local residents about the coastal values that were important to them. Rising clearly to the top of the list was a *clean environment,* followed closely by *wildlife and marine life*, and *scenic beauty*.

Meetings, conferences and general discussions over the last 15 years have indicated that these same values remain critical today: the St. Croix's high quality of life and resilient economy continue to center on its marine and river heritage.

These values have also led to the St. Croix's designation as one of 39 national Canadian Heritage Rivers, one of 20 Maine Outstanding Rivers, and wide international recognition for its innovative transboundary management.

We find that the 1997 Vision for the St. Croix estuary area remains true, and offer it with minor modifications as a guide for future management:

We, the people of the St. Croix Estuary and nearby region, have a vision for the future – of seeing this incredibly beautiful area continue to be treated with respect and valued for its life.

We appreciate the intricacy and diversity of the special place where fresh water and ocean water mix to create a unique habitat – an estuary – and our good fortune to live beside one. We recognize our obligation to treat the St. Croix Estuary and its nearby coastal waters in a way that never forgets that air, land and water constantly interact.

We value the clean air and water that support the estuary region's rich diversity of habitats and species. We recognize that the biologically productive waters and shores that have maintained this diversity – along with our communities, our economy and own quality of life – will be seriously diminished if they are not better managed as an essential resource.

We are proud of our heritage, of people who have lived by and worked along these coastal waters for thousands of years. We respect the role these waters continue to play in our lives – environmentally, economically and culturally.

We support a compatible and sustainable economy: one that links our traditional coastal industries and livelihoods with new ones that complement our heritage and preserve the ecological balance that supports it all. We believe it is possible for governments to integrate environmental and economic policy, to sustain both needs, so that our children's children can continue to live here, with coastal traditions and meaningful employment.

We recognize that our waters are a public resource and that their future use has to be better managed and valued on the public's behalf in ways that protect their quality and ensure public access to their use.

We have a vision of community cooperation, and recognize that all should be involved in decisions about the future use of the St. Croix Estuary, Chamcook Harbour and Bocabec Bay.

Environmental Priority 1: Clean Water

World events and studies now show that a decline in fresh or marine water quality can dramatically and permanently affect any region's long-term economic and ecological future.

Water is the primary basis of planet we live on. Our bodies are over 50% water, which needs to be replenished constantly. Nearly all of Canadian's daily activities, and over 80% of country's economy, depend on water in some way[5].

As Canadians, we value water, we think we have an unlimited supply, we use it freely and we absolutely take it for granted[6]. Most Canadians have never experienced a day without clean, low-cost water flowing freely from their tap. But this may soon change.

The federal government reports that Canada does not have a surplus of clean water where it's needed, in southern Canada, and this must now be managed to meet longterm national supply and security requirements[7]. And while water still receives much less attention and funding than the economic sectors it supports, steps have been taken locally and nationally to protect water quality since the release of the 1997 St. Croix Estuary community Comprehensive Environmental Management Plan (CEMP).

Current Policies and Plans

In 2007, Canada acted to further on its national water policy[8,9] by initiating an Action Plan for Clean Water[10]. This launched programs to clean up large polluted waters (ex: Great Lakes), upgrade municipal wastewater systems, reduce chemical discharges, better protect and manage marine waters, and more. Last year, under this plan, Canada adopted its first national standards for sewage treatment[11].

In St. Croix estuary area, St. Stephen and St. Andrews municipal wastewater treatment plant replacements were funded in part through this Action Plan. Under a related federal program, in 2011 the Natural Sciences & Engineering Research Council of Canada (NSERC) awarded a $1.65 million, six-year grant to the University of New Brunswick to train and certify a new generation of scientists to address national and global water resource issues – hopefully with some of the earliest benefits accruing in the province.

The Province of New Brunswick's Clean Water Act and regulations protect water quality in variety of ways[12]. The updating of licencing requirements for point source ('end-of-pipe') discharges has been particularly important to the St. Croix area, resulting in improvements to municipal and commercial effluent monitoring and treatment. In 2001-2002, the province adopted regulations to better protect municipal drinking water supplies[13] and set first-time quality standards for provincial surface waters[14]. The first program was fully implemented but the second only in part: quality standards were put into effect for all provincial lakes, ponds and impoundments but not for rivers and streams. The St. Croix was expected to be the first New Brunswick watershed fully classified and managed for water quality under this regulation, in precedent-setting coordination with the State of Maine for the American side of the watershed. The classification program is under provincial review.

American and international entities also contribute to water policy on the St. Croix. The State of Maine regulates all point source discharges and many non-point pollution sources statewide, and has long-standing water quality standards[15] for all state waters – ~~a~~ fresh and marine – including those in the St Croix watershed, that it monitors and enforces. Many of these regulations carry out state obligations under U.S. federal clean water legislation.

The International Joint Commission (IJC), established by the 1907 Boundary Waters Treaty[16], has the authority to set water quality objectives, along with water level and flow requirements for a number of dams, on the St. Croix boundary waters. The IJC has a non-regulatory objective for minimum dissolved oxygen in St. Croix waters of 5.0 milligrams per litre, which is sufficient to support most native species. Observed dissolved oxygen readings have generally been in the 7-14 mg/l range.

Water Quality Monitoring

Environment Canada, the U.S. Geological Survey (USGS), the International Joint Commission and Woodland Pulp LLC (a major water user at Baileyville, Maine) collaborate to maintain a long-term water quality and quantity monitoring network for the St. Croix's freshwaters, much of which is available on the web in real time at http://me.water.usgs.gov/stcroix.html. This hydrologic network includes a recently installed (2007) year-round, water quality gauge at the Milltown dam[17] near head-of-tide, and a longer term (1972-present) seasonal gauge 1km upstream[18] that together give a good measure of the quality of the freshwater discharging to the estuary. Environment Canada and USGS also maintain water quantity (flow and level) gauges along much of the St. Croix system. The IJC (IJC) International St. Croix River Watershed Board summarizes these findings in publicly-available annual reports[19]. This IJC Board also selected, and reported on, water quality and water quantity as two of nine long-term environmental health indicators in its 2008 State of the St. Croix Watershed Report[20].

New Brunswick's Department of Environment & Local Government (DELG), the St. Croix International Waterway Commission (SCIWC), the St. Croix Estuary Project (SCEP) and local municipalities conduct periodic surface water and point-source sampling throughout the New Brunswick portion of the watershed, and most of these results are recorded permanently in New Brunswick's provincial water quality database. Since 2004, SCEP has also monitored up to 15 stormwater outfalls to the St. Croix estuary; its findings are summarized in a series of reports[21].

The international Gulf of Maine Council on the Marine Environment[22] engages New Brunswick and other jurisdictions in monitoring and improving the quality of near-coastal marine waters, as a regional priority. Since 1993, the Council has sponsored a marine contaminants monitoring program that uses blue mussel (*Mytilus edulis*) tissue to measure up to 15 contaminants in the region's coastal waters[23]. This sampling includes three St. Croix area sites, including one at SCEP's Ganong Nature Park. The long-term results are available on-line[24].

In 2006, the Council established additional indicators to track the collective health of Maritime and New England coastal waters through its EcoSystem Indicator Partnership (ESIP)[25]. The ESIP program includes three Maine-New Brunswick marine monitoring sites for dissolved oxygen and four sites for eutrophication monitoring (nitrogen, phosphorus, chlorophyll *a* and water clarity) in the St. Croix estuary area.

Fisheries, environmental and health agencies on both sides of the St. Croix border monitor water quality conditions related to aquaculture operations and shellfish harvesting. These focus largely on toxin and bacteria levels that may affect food product safety but, in the case of aquaculture, also on the effect of these commercial operations on the marine environment and native species.

All of the above monitoring programs collect vital information for long-term water quality assessment and planning, however much of this value is lost due to a lack of regular synthesis and communication to affected interests and decision makers. Only the IJC provides some regular inter-agency reporting, and this is very limited.

Overcoming this 'disconnect' between water science and management needs to be addressed collectively, by government and non-government interests on both sides of the St Croix, if water quality monitoring and protection are to work hand-in-hand, cost effectively. Establishing this functional connection through regular multi-party reporting and meetings should become a priority. The IJC International St. Croix River Watershed Board and St. Croix International Waterway Commission both have experience in coordinating multi-party reporting and meetings on St. Croix water issues.

Land-Based Point Source Pollution

While the upper St. Croix watershed has historically had excellent water quality, the lower 18km of the river and some near-shore marine waters were degraded by industrial and municipal "end-of-pipe" (*point source*) discharges for nearly three centuries that have only been addressed since the 1970s[26].

Point source pollution to the St. Croix has declined very significantly since SCEP's 1997 report. All of the area's major wastewater treatment plants (WTPs) have been upgraded or replaced and five of the smallest have been eliminated. Only 12 licenced WTPs still discharge to these waters[27] and all operate under much stricter requirements than a decade ago.

Combined sanitary sewer and stormwater line outfalls (CSOs) are a difficult point source to eliminate: the use of one pipe for both functions is a centuries-old practice and few records of these were ever kept. Data collected by local municipalities, SCEP and others has made it possible to identify and eliminate the majority of the CSOs on the New Brunswick side of the St. Croix estuary. On the Maine side of the estuary, only one CSO is still active.

The major point source improvements are these:

The Town of St. Stephen replaced its two outdated WTPs in 2009 with a single efficient facility that now consistently meets provincial WTP effluent standards. This replacement, along with improvements to collection and pumping systems, and the on-going elimination of CSOs, has largely eliminated the town's historic untreated sewage discharges to the St. Croix. Six of the town's 11 known CSOs to the St. Croix have been eliminated in the last five years; the remainder are being studied and pursued[28].

The Town of St. Andrews replaced its municipal wastewater treatment plant in 2011 and now consistently meets all provincial WTP effluent standards. During this upgrade, the outdated WTPs of

two area science facilities were eliminated and their wastewater re-directed to the new town treatment system.

The City of Calais (Maine) significantly upgraded its treatment plant operation, completed major sewage lift station improvements and deactivated four of its five CSOs. These, together, have reduced the City's point source pollution to the St. Croix by over 86%.

A pulp mill located 14 km above the estuary at Baileyville (Maine) – the St. Croix's largest wastewater discharger – converted in 1998 to an elemental chlorine free (ECF) wood pulp bleaching process that eliminated bleaching as a source of potentially-toxic *dioxin* and *furan* compounds[29] reaching the St. Croix. Major improvements to other mill processes, and an ongoing water use reduction program, continue to reduce the mill's impacts. In recent years the mill has consistently met, and regularly exceeded, all Maine and U.S. federal discharge requirements.

There is still room for improvement. On the New Brunswick side, some smaller WTPs do not meet current design standards, and effluent quality criteria for most WTPs remain less stringent than on the Maine side. Disinfection of New Brunswick WTP outflows (to kill fecal coliform and other pathogens) is not yet required during the winter months, which leaves the opportunity for these to seasonally affect local clam flats and other natural resources. Removing the few remaining CSOs to the estuary would eliminate the last of what was once, before treatment plants, the primary source of St. Croix pollution.

Land-Based Non-Point Source Pollution

Pollution that can't be readily traced to a point source such as an outfall pipe is termed "*non-point source*" (NPS). This is mostly carried by rainfall or snowmelt that picks up pollutants from natural and human sources on land and deposits these into rivers, lakes and oceans, or into the groundwater. This waterborne pollution may flow long distances over the ground (where some contaminants may be gained or lost along the way) or carried rapidly in stormwater pipes.

A lesser amount of NPS pollution is caused by airborne contaminants that settle into local waters. These can come from local sources (ex: vehicle exhaust, industrial emissions and windborne dust) or from emissions carried long-range, as much as half a continent, by upper air currents. In the St. Croix area, NPS pollution also comes from aquaculture, discussed in the plan's third priority.

Land-based NPS pollution often contains many of the same pollutants as point sources – including bacteria, pesticides, sediments, road chemicals and nutrients – but is much harder to control because of its diffused sources. Current NPS pollution in the St. Croix area is largely caused by sediment runoff from construction and forestry activities, chemical runoff from roadways, seepage from faulty septic systems, and chemical and nutrient runoff from residential and agricultural areas.

In the early 2000s, stone dust carried in runoff from a major quarry at the Champlain Industrial Park raised considerable local concern, on occasion causing plumes into the estuary and a slurry buildup on the river bottom. This has largely been addressed by the installation of a settling pond. In 2008, tailings from the same operation, these stockpiled upstream of Chamcook Lake (a municipal water supply), were found to be leaching into the lake. Studies conducted by the Town of St Andrews identified a high arsenic content and sediment runoff, causing the province to order the stockpiles to be removed and the site remediated.

Most NPS pollution can be prevented or reduced, often by simple changes in current practices. Publications and web resources are available from provincial and other sources to help citizens, municipalities, businesses and others adopt "best management practices" to do this; some resources for general readers are listed at the end of this report[30].

NPS reduction projects have made a major difference on the St. Croix. In the 1990s, SCEP and SCIWC worked with landowners and agencies to eliminate the bacterial pollution from outdated septic systems that had closed Oak Bay's tidal flats to clam digging for nearly 50 years. This resulted in the conditional re-opening of 1,400 acres (566 hectares) to softshell clam harvesting in 2000. [This was short-lived, due to a lack of continued water testing, but was restored under renewed testing in 2012] In association with this project, SCIWC produced and widely distributed a homeowners' septic system maintenance guide, and placed septic system maintenance videos in every St. Croix area library, to tell landowners how to reduce bacterial seepage.

Shoreland zoning regulations (unique to the St. Croix in New Brunswick but statewide in Maine) require mandatory shorefront setbacks for construction and clearing that retain a small 'green buffer strip' along the St. Croix waterfront. This prevents much potential NPS pollution from shoreland activities from reaching the water. The province's St. Croix zoning regulation[31] establishes a 30m setback for new construction and sets limits on the removal of shoreland vegetation and trees within 10m of the water. This regulation applies to all rural shorefronts on the St. Croix's lower river and estuary; it does not apply within the municipalities.

In 2002, New Brunswick adopted a Coastal Areas Protection Policy[32] that provided for shoreland zoning similar to the St. Croix for the province's other estuary and marine shorelands, however supporting regulations have yet to be put in place. This, and additional sections of the provincial Water Classification Regulation, if implemented, could very significantly reduce NPS pollution to the St. Croix's coastal and fresh waters.

Emerging Natural Issues

Since 2010, a new water quality issue has surfaced in some New Brunswick lakes, including the St. Croix's Chamcook Lake, which provides the water supply for the Town of St. Andrews and discharges to the St. Croix estuary area. A tiny organism, *cyanobacteria* – also called blue-green algae – has existed around the globe in many forms for millennia, generally with positive or neutral effects. However, under certain conditions that are largely linked to light, temperature and nutrients, some waterborne cyanobacteria populations can sky-rocket to form blue-green floating mats on water surfaces and release toxins harmful, and potentially fatal, to wildlife and humans[33].

The algal blooms occur most often in lakes with high phosphorus or other nutrient levels (frequently due to human activities), but have started to appear in some lakes with low nutrient levels, such as Chamcook. Government agencies, universities and municipalities in New Brunswick have begun to study this phenomenon and the ways to manage it.

It is possible that climate change (i.e. warmer water and more summer sun) is altering lake conditions that formerly kept cyanobacteria populations in check. Researching the dynamics of this possible ecological shift and how to minimize potential blooms and their toxic effects on humans and native species is an urgent issue, particularly for the Town of St. Andrews. The impact is not limited

to freshwater: the deaths of sea otters off British Columbia[34] and long-known effects on marine fish in the wild and in aquaria have also been documented.

The conditions that may be encouraging cyanobacteria populations are also likely to benefit harmful bacteria, pathogens and other organisms that either occur naturally in fresh and marine waters or are carried there by pollution. While the natural occurrence of these can't be controlled, their presence in point source discharges and in NPS runoff can be. Reducing bacteria, pathogens and nutrients from these sources is likely to be important in maintaining water quality at even present levels in the future.

Marine-based pollution

Aquaculture and marine vessels are the main local sources of marine-based pollution to the St. Croix estuary. The policies, regulation and monitoring of these are very different from the water quality discussion in this section. They are addressed in this plan's Compatible, Sustainable Economy section

Clean Water Priorities for this Decade

The following are recommended priorities and actions, with prospective delivery entities noted in italics (see Appendix 1 for acronym identification).

#1: Monitor fresh & estuarine water quality; use the findings for long-term planning

Recommended Actions:

- Continue real-time water quality monitoring on St. Croix River mainstem, seasonally at Milltown bridge (*USGS,WPL*) and year-round at Milltown dam (*EC*); provide real-time reporting for both of these on the St. Croix hydrologic reporting website (*EC, USGS, IJC*).
- Continue real-time flow monitoring on the St. Croix River mainstem (*USGS, EC, IJC*) and on Dennis Stream, to support water quality interpretation; provide real-time reporting for all of these on the St. Croix hydrologic reporting website (*EC, USGS, IJC*).
- Implement a water quality and quantity monitoring plan for other primary tributaries to the St. Croix estuary area, to obtain data for water use, water standards and climate change planning in the most developed portion of the watershed. (*EC, DELG, SCEP, DEP, SCIWC*).
- Continue monitoring and research on the presence of cyanobacteria populations in Chamcook Lake, and on other area lakes if warranted; identify means to reduce cyanobacteria (or similar) species outbreaks and/or mitigate potential toxic effects (*DELG, DH, StAndrews, ECW, others*).
- Continue marine contaminant monitoring and reporting via the Gulf of Maine Council on the Marine Environment's Gulfwatch program (*DAFA, DMR, GOMC*). Expand interpretation and distribution of the findings to better inform economic, environmental and local interests on both sides of the border (*GOMC*). Similarly, continue contaminant, nutrient and toxin monitoring related to the aquaculture and shellfish industries, and expand interpretation and distribution of these findings (*DFO, EC, CFIA, DMR*).

- Establish a transboundary St. Croix water quality information network that will regularly summarize and distribute water quality findings to primary users and managers, and provide a forum for collaborative discussion and planning (*IJC, SCIWC, agencies, others*).

#2. Monitor and reduce land-based point source pollution

Recommended Actions:

- Continue to monitor and reduce the effects of point source discharges to the estuary area. Particularly, seek to complete the remaining storm/sanitary sewer separations, update or replace outdated smaller wastewater treatment systems, and continue to upgrade the effluent standards and performance of major municipal and industrial systems *(DENV, DEP, StStephen, StAndrews, WPL, SCEP*).
- Include information on these activities in the water quality information network process recommended in Action 1. (*IJC, SCIWC, DELG, DEP, EC*).

#3. Monitor and reduce major land-based nonpoint pollution sources

Recommended Actions:

- Encourage greater provincial and local action to reduce sediment and chemical NPS pollution from roadways and construction projects (*DOT, DELG, StStephen, StAndrews,RSC10, conservation groups*)
- Continue to monitor the effects of runoff from Bayside quarry operations, and past and present stockpile locations, on the estuary and Chamcook Lake; address these as warranted *(DELG, CCP, StAndrews)*
- Support provincial and local programs that educate, encourage, and potentially require, septic system owners to maintain their systems (*DH, DELG, SCIWC, SCEP*).
- Encourage shoreowners to adopt best management practices that minimize their impacts on adjacent waters (*DELG, SCIWC, SCEP, StStephen, StAndrews,RSC10*)
- Include information on these activities in the water quality information network process recommended in Action 1. (*IJC, SCIWC, DELG, DEP, EC*).

#4. Support government commitments to longterm water quality protection

Recommended Actions:

- Encourage New Brunswick to fully implement the resource protection objectives of its Surface Water Classification Program and Coastal Areas Protection Policy (*DELG, others*).
- Encourage the Government of Canada to expand planning and investment in strategies to ensure sufficient longterm water quality, and quantity, to meet future national requirements (*Parliament, EC, others*).

Environmental Priority 2: Climate Change

A decade ago, climate change was the subject of contested debate. Today it is a hard reality that is making major changes to the ecology, society and economy of the world as we know it.

Globally, nine of the ten warmest years on record have occurred since 2001 and significant changes in longterm weather patterns are already apparent.

When the St. Croix Estuary Project (SCEP) released the estuary's first CEMP in 1997, the only climate change concern was sea level rise. Worldwide studies now confirm that the climate impacts on our region will be far greater.

Most simply, the amount of carbon dioxide, methane and some other gases in the earth's atmosphere have increased dramatically, creating a huge blanket or 'greenhouse' that retains heat on the planet. Similar high carbon content in the atmosphere roughly 55 million years ago caused global warming that eliminated many of earth's life forms, on land and sea[35]. While humans weren't around at that time, we've been clearly identified as the cause of today's problem[36].

The primary source is more than a century of air emissions from the burning of fossil fuels – the current engine of the world's economy and transportation systems. The build-up of these greenhouse gasses (GHGs) have greatly accelerated the rate of global warming that might have naturally occurred over thousands of years and given ample time for all to adapt.

Instead we face a rapidly unfolding problem that has no quick fix. If all GHG emissions stopped today it would still take many decades for their buildup in the atmosphere to start to decline. While governments can't reshape their fossil-fuel dependent economies overnight, they are now working to reduce their GHG emissions and adopt strategies to cope with the climate change impacts that are now inevitable.

Since 1992, governments around the world have collaborated on climate change action through the United Nations Framework Convention on Climate Change, primarily under the 1997 Kyoto Protocol[37, 38], which set international targets for GHG reductions that have since been updated by a 2012 amendment[39]. Another UN body, the Intergovernmental Panel on Climate Change (IPCC)[40], brings together scientists from more than 130 countries to assess climate change impacts and adaptation responses on a worldwide basis. This panel will soon release an update of its 2007 global climate change report. Preliminary information suggests that this new report will predict that climate changes will now be faster and greater than anticipated just six years ago.

In 2007, IPCC forecast that global temperatures would rise by an average 2^{o}C in this century, a trend that may soon be revised to as high as 5^{o}C. This will have significant worldwide effects, although the rate and extent of this will vary as new information and modelling is available. The primary anticipated North American impacts will be 1) warmer air temperatures, 2) warmer ocean and freshwater temperatures, 3) a rise in sea level and 4) an increase in extreme weather events.

These environmental changes will have striking social and economic impacts that are just beginning to be felt. A number of reports summarize these well[41,42,43], however this plan focuses on the effects to New Brunswick and particularly the St. Croix estuary area.

Information on climate change impacts, costs and strategies in New Brunswick has grown since 2007 under national[44] and provincial initiatives[45], most notably under a 2008-2012 Regional Adaptation Collaborative (RAC) Agreement[46] between Canada and the Atlantic Provinces, which is being followed in 2013 by a national Climate Change Adaptation Platform. An important outcome has been the Atlantic Climate Adaptation Solutions Association (ACASA)[47], which has brought together provincial, federal, municipal, academic, non-profit and industry partners to study and develop specific solutions to climate change needs in Atlantic Canada.

Other key outcomes have been reports that detail New Brunswick climate change forecasts[48], climate change pilot project results[49], municipal planning guides[50], annual progress reports on federal and New Brunswick climate change initiatives[51,52], and indicators that track climate change in New Brunswick[53] and Canada[54] and greenhouse gas emissions provincially[55] and nationally[56].

On the American side of the St. Croix, the U.S. Environmental Protection Agency has recently released a revised 19-goal national water program strategy for climate change[57] and that nation's public health agency, the Centers for Disease Control & Prevention, has included Maine in a study of the possible impacts of climate change on human health[58], both of these supplementing Maine's state climate change activities.

What do these findings predict for our area, and what can be done to address them?

Because the causes of climate change are worldwide and long-lasting, all efforts need to be encouraged to meet – and hopefully exceed – vigorous national and international greenhouse gas reduction targets.

These efforts have to start at home. In 2011, the Canadian government revisited its international Kyoto Accord commitment and in 2012 adopted a policy under the Copenhagen Accord to reduce national GHG emissions by 17% between 2005 and 2020[59]; it is now half way to achieving this goal[60].

Local efforts will only make a small contribution to reducing global warming but these have to be pursued as well. The Department of Environment & Local Government (DELG), Environment Canada and organizations such as the N.B. Climate Change Hub offer many current household and municipal tips on reducing greenhouse gasses[61].

While a federally-sponsored public GHG reduction program (the One Tonne Challenge) was discontinued in 2007, new GHG reduction programs for Canadian municipalities and businesses are available nationally from the Federation of Canadian Municipalities[62] and the Pembina Institute[63] and for students through the Seeds Foundation[64].

Some of New Brunswick's Climate Change Action Plan programs were noted on an earlier page, and are well-captured on the Department of Environment & Local Government (DELG) website[65].

Limiting future global warming is part of the solution. The other aspect is to identify and adapt to the climate change realities that are unavoidable in this decade and this century. This proactive planning and investment in climate change adaptive policies and infrastructure will largely determine the St. Croix area's long-range social and economic future.

In this century, these climate change impacts are forecast for the St. Croix region and might be addressed in the following ways:

An average rise of year-round air temperature by 2-5^{o}C; with hotter and drier summers

The predicted effects include an earlier spring, a longer growing season, more weeks of summer weather, and less winter snowfall. This might sound good to many, but some of the implications are significant and negative.

While sea breezes will continue to buffer the coast from most of the days of extreme summer heat (40^{o}C+) expected to have major health impacts inland, there will be a need to keep people and equipment cool enough to function efficiently. This will come at a financial and environmental cost. The anticipated higher use of air conditioners will cause energy consumption that increases greenhouse gases and may result in summer-time power "brown-outs" or system failures due to spikes in electrical demand. To avert this, the region will need to consider the design and mechanical alternatives for cooling that are already used in warmer regions.

The predicted hotter, drier summers may also cause seasonal water shortages for uses other than essential ecological functions (i.e. aquatic habitat and natural evaporation) and for drinking – this at the time of year when water demand is at its highest. These shortages are expected to affect both surface and groundwater supplies.

Because the region's social and economic goals hinge on a clean, abundant and low-cost water supply, some adjustments will be needed. Information is available from communities across North America and the world that have already been making investments in policies and infrastructure to conserve water without significantly affecting lifestyle, and often realizing longterm capital savings[66] in the process. Prime options for the St. Croix area include installing low flow toilets and other household fixtures; converting to drought-tolerant lawns, gardens and golf courses; using landscape features like rain gardens, rain barrels and vegetative strips to retain natural rainfall; and educating the public to reduce unessential water use in homes and businesses.

A one meter rise in sea level this century, and additional meters in the following century – combined with even higher water levels during coastal storms

The climate change that is already occurring will lead to a net sea level rise that has not been experienced in the 12,000-year human history of the St. Croix region.

The St. Croix's history and future expectations have always been based on a coastline similar to today, but this will change. For example, under current climate change predictions, by the end of this century the St. Andrews town wharf will be underwater on the highest tides of the year, as will some other waterfront structures.

As the sea level rise projections advance from one meter in 2100 to upwards of 3-4 meters by 2300, *if realized*, these will eventually put much the St. Croix estuary's built heritage and traditional enterprises underwater. This will re-shape the local towns and rural communities to new coastal boundaries and dramatically affect current economic mainstays such as tourism.

This ongoing sea level rise will be compounded by the more intense storms anticipated with climate change, which can create storm surges that raise water levels 1-2 meters *above* the natural tide mark[67].

The greatest risk of coastal flooding will come when the highest tides of the year coincide with an intense storm that generates a storm surge and high waves (from the sea) and heavy rainfall (from the land). The region's benchmark for extreme coastal flooding is the October 1869 Saxby Gale, which combined the season's highest tides, hurricane winds and a two-meter storm surge to wreak major destruction on Bay of Fundy communities and shipping.

In 2001, using the Saxby Gale's characteristics as a guideline, the St. Croix Estuary Project (SCEP) applied then-current predictions of sea level rise and storm surge to generate 'worst-case' coastal flooding maps for the Passamaquoddy Bay area[68]. By the end of this century, these forecast that severe storm conditions, combined with the higher sea level, would cause major flooding damage to the commercial waterfront cores of St. Andrews and St. Stephen and to many shoreland homes and businesses throughout the region, and would put at risk a number of bridges and causeways that are essential to local transportation.

Since SCEP's research in 2001, new tools to model sea level rise and coastal flooding potential have been developed for Canadian communities and piloted in the Atlantic Region under the federal/provincial Regional Adaptation Collaborative Agreement (RAC) and the Atlantic Climate Adaptation Solutions Association (ACASA). New information also indicates that the extreme coastal floods that previously occurred every 100 years on the New Brunswick coast could happen as often as *every year* by the end of this century[69].

There is no way to turn back this "tide of change", but its effects can be reduced. Updated sea level and storm surge modelling for the St. Croix region is needed immediately to allow for mapping of future coastal flood zones under different scenarios. This mapping can support municipal and regional planning to begin to minimize the impact of rising coastal waters on the area's future. These adaptation plans will need to particularly address changes to land use, buildings, transportation infrastructure and emergency preparedness in the re-drawn coastal flood zones.

<u>An increase of 9-11% in annual precipitation, much of this in heavy rainfalls</u>

Extreme rainfalls are already occurring. A 180mm rainfall in the St. Croix area in December 2010 caused an estimated $10 million in losses to residential, municipal, commercial and transportation infrastructure, in addition to revenue losses to the affected businesses and residents. St. Andrews experienced a 122mm rainfall in October 2012 that caused temporary downtown flooding.

These incidents illustrate the inability of current infrastructure to handle future high rainfalls and point to the rising costs and risks to public safety that will result if this is not addressed.

Flood damage is now the leading cause of insurance claims in Canada, currently costing $1.68 billion/year[70]. As insurance companies reassess whether to continue to insure properties that are now becoming flood risks, the Insurance Board of Canada (IBC) is developing a computer tool to help municipalities assess and address stormwater infrastructure shortfalls so that they can reduce future insurance claims. The cities of Fredericton and Moncton are part of this IBC pilot project[71].

A number of Atlantic Canada municipalities have also carried out climate-driven rainfall and sea level rise risk assessments through the RAC pilot program[72]. Nova Scotia has taken a proactive position on climate change by requiring all provincial municipalities to have an Integrated Community Sustainability Plan[73] by 2010 and a Municipal Climate Change Adaptation Plan[74] by 2014 in order to share in the $55.9 million/year available to them from the federal Gas Tax Fund[75] for infrastructure projects. New Brunswick has a voluntary program that encourages communities to develop sustainability plans[76].

SCEP is working with the Towns of St. Stephen and St. Andrews to secure funding in 2013 for climate risk assessments that will help these communities begin climate change adaptation planning in the St. Croix region.

Changes in traditional marine species

Traditional marine species will be affected by the changed currents, habitats and food chains that will result from warmer water, sea level rise, increased ocean acidity, and lowered ocean salinity at a global level from polar ice cap melt and a local level from heavy coastal rain runoff[77]. These will have major ecological and economic effects.

Three brief examples:

In the last few years, a dramatic early season increase in soft-shelled adult lobsters has led to concern and research in Nova Scotia and Maine about the impact on their multi-million dollar lobster fisheries. Lobsters shed their shells in order to grow and it takes months for an adult's new shell to fully harden. These soft-shell lobsters are too fragile to be shipped to prime live sale markets and are being re-directed instead, in large numbers, to lower-demand, lower-priced cannery products. Fishery revenues have been affected and fewer lobstermen may remain in the industry. Traditional lobster dinners may be replaced by lobster chowders. Two climate change factors – warmer waters and the ocean acidification that makes it more difficult for lobsters to absorb the calcium they need to harden their shells – are cited as the cause[78].

Rising ocean temperatures off the North Atlantic Coast are expected to drive the tiny, planktonic crustacean *Calanus finmarchicus* from these waters by as early as 2050[79]. *Calanus* is the region's most abundant marine zooplankton and a key part of marine food chains[80]: its loss would directly affect already-depressed mackerel, herring, cod and haddock stocks and some whale populations (including the endangered Right Whale[81]). Its loss might also have a secondary effect on ocean acidification. The world's oceans currently absorb about one-third of all the carbon dioxide produced by global warming activities; some of this is transferred to marine food chains and the rest contributes to ocean acidification. *Calanus* eat carbon-rich phytoplankton near the ocean surface and remove much of this carbon to the deep ocean during seasonal migrations, a function that would diminish with the species[82].

Higher water temperatures also promote some highly undesirable species, including the algae that is responsible for the 'red tide' that regularly closes regional shellfish beds due to its toxicity to humans[83], and the Infectious Salmon Anemia (ISA) virus that has led the aquaculture industry to increase pesticide use in an effort to avoid salmon mortalities[84].

These examples give just a glimpse of the intricacy and interconnectedness of the marine ecosystem that supports life – including ours – along this coastline.

Action can be taken to reduce future impacts, including:

The updated coastal mapping suggested earlier for land-based planning could be used equally for ecological planning, to identify and set aside new habitats that will be critical to key ecological and economic marine species in the future.

Fisheries research, in the past largely focused on existing commercial stocks, could place more emphasis on tracking climate changes to temperature regimes and food webs; on reviewing the composition and management of fish stocks further down the coast; and on exploring ways that some marine species might be used to counteract climate changes[85] – all to anticipate and prepare for the region's fish and commercial fisheries of the future. The EcoSystem Indicator Partnership (ESIP), established through the Gulf of Maine Council on the Marine Environment, offers a web-based platform for reporting regional trends on six marine indicator themes, including aquatic habitat, climate change and fisheries and aquaculture. This and other Council programs can provide wider assistance with scenario development and planning.

Changes in traditional land-based and freshwater species

Warmer land and freshwater temperatures, along with shifting seasonal and rainfall patterns, will alter some of the natural cycles and native species that Atlantic Canadians take for granted.

Particularly affected will be the flora and fauna that can't move to more suitable locations: some of these will decline and some will disappear. In particular, forest, field and marsh composition will change as conditions begin to favor more temperate tree, plant and pest species. The effects will range from changes in harvestable timber stands to habitat for resident and migratory birds, all of which are now being studied.

Some resident cold water native fish species, such brook trout, will also continue to decline and be replaced by warm water fish.

These changes may negatively affect a number of local economic mainstays including forestry, traditional sportfishing and hunting related tourism. Depending on summer water supplies, sea breezes and the sea level rise, these changes may benefit local agriculture and coastal tourism.

As in the marine environment, adaptive planning can help to reduce the negative effects and take advantage of positive ones. A major federal study[86] gives high priority to proactive, long-range wildlife, forestry and land use policies; protection of critical habitats and species; public education and action; and biodiversity retention through interconnected parks and protected areas.

St. Croix Climate Change Priorities for this Decade

The following are recommended priorities and actions, with prospective delivery entities noted in italics (see Appendix 1 for acronym identification).

#1: Take action to reduce greenhouse gas emissions

Recommended Action:

- Encourage regional, national and international programs to adopt, and actively pursue, vigorous greenhouse gas reduction targets (*All*).
- Engage in programs that encourage individual and institutional involvement in greenhouse gas reduction (*DELG, EC, StStephen, StAndrews, RSC10, conservation and community groups*).

#2: Implement policies and programs to conserve water use, especially in the summer months.

Recommended Action:

- Pursue municipal and industrial water use reduction and conservation programs to ensure an adequate year-round water supply under an anticipated growth in the number of users/uses, and more frequent drought conditions (*StStephen, StAndrews, Champlain Industrial Park, major water users*).
- Adopt personal water reduction practices, especially if dependent on a direct well water supply (*Individuals, families*).

#3: Initiate longterm adaptation plans to address sea level and stormwater increases

Recommended Action:

- Obtain current detailed contour mapping for the St. Croix coastal area, for use in modelling future sea level rise and flood scenarios (*StStephen, StAndrews, RSC10, DOT).*
- Using these maps and other data, conduct vulnerability assessments for 50-90 year sea level rise and stormwater/flood scenarios. Develop municipal, rural and transportation adaptation plans that initiate policies and actions to start addressing these emerging conditions in a timely and cost-effective manner (*StStephen, StAndrews, RSC10, DOT).*
- Continue funding programs that assist with planning and adaptation for climate change (*NRCan, EcoAction, ETF, ENB, GTF, FCM*)
- Encourage New Brunswick to adopt additional policies and incentives for municipal and industrial climate change planning, drawing on examples from other jurisdictions *(DELG, DED, DOT, ENB).*

#4: Track changes to ocean conditions and species that signal longterm ecological trends; initiate proactive conservation and management plans to adapt to these changes

Recommended Action:

- Increase monitoring, analysis and *integrated* reporting of changes in marine temperatures and currents, critical habitats and lower food chain species, alongside commercial fish stocks (*DFO, DAAF, HMSC, ESIP*).
- Establish a task force, possibly through the Southwest New Brunswick Marine Advisory Committee[87] or Bay of Fundy Ecosystem Partnership[88] to develop 30-50 year scenarios for potential area marine conditions and species composition. Encourage the use of these scenarios to initiate proactive government policies and plans to a) conserve future critical

habitats and food chains and b) prepare for a transition to future commercial fisheries (*SWNBMAC, BoFEP, DFO, DAAF).*

#5: Monitor climate change impacts on land and freshwater based species that have significant implications to the local ecology or economy; initiate proactive conservation and management plans to adapt to these changes

Recommended Action:

- Increase monitoring, analysis and *integrated* reporting of changes in soil and freshwater temperatures, critical habitats and of species that are key indicators of climate change or have primary roles in the local ecology or economy (*DNR, DAAF, forestry interests, fish/wildlife interests).*
- Establish a regional or provincial task force to develop 30-50 year scenarios for potential area climate conditions and species composition. Encourage the use of these scenarios to initiate proactive government policies and plans to a) conserve future critical habitats and food chains and b) prepare for a transition to future species of flora and fauna that will dominate the area, and their implications to the region's lifestyle and economy (*DNR, DAAF, forestry interests, fish/wildlife groups, universities, conservation groups).*

Environmental Priority 3: Compatible, Sustainable Economy

Marine resources have been the mainstay of human enterprise on the St. Croix for over 12,000 years and will, hopefully, continue to be so for centuries to come.

Successive St. Croix generations have relied on coastal waters for three primary benefits: marine harvests, water transportation and the human affinity to the shore. The current-day versions of each of these continue to support a significant part of the local economy and maintain a valued, traditional coastal identity.

New Brunswick faces an on-going challenge to develop economic opportunities that will employ, and retain, its next generations. Other St. Croix area plans[89] have recorded very clear support for new opportunities that might add to, not detract from, the region's traditional marine-based economy and the environment that supports it.

Long-term planning for a regional economy whose various sectors are both sustainable and compatible will take the combined efforts of government, industry, municipalities and residents. It should be pursued, but is outside the scope of this plan.

This plan, with a focus on environmental priorities for the current decade, revisits the issues raised in SCEP's 1997 Community Environmental Management Plan (CEMP) about a number of resource uses, summarizes the changes that have occurred and suggests action for the near term.

Atlantic salmon aquaculture

Starting from a single experimental site in 1978, salmon aquaculture in Charlotte County has grown into a nearly $200 million industry that is now a mainstay of the local economy and an important part of New Brunswick's and Canada's seafood export trade[90]. Its nearly 1,500 direct and indirect jobs allow many local people to stay, work and raise their families here at a time when regional out-migration is the norm.

Eight Atlantic salmon sea cage sites, one active hatchery and a large fish food production plant are all located in the St. Croix estuary area and – by virtue of tidal flow and community connections – much of the rest of the aquaculture industry affects this area also.

Atlantic salmon aquaculture is an intensive food production process that – like those for beef, pork and chicken – relies on informed government and public decision-making to set sustainable, balanced economic and environmental goals. Canada has created a 2011-2012 National Aquaculture Strategic Action Plan[91] and is now issuing annual aquaculture sustainability reports[92] that indicate that the industry is on a solid, long-term track, however many of these indicators are production or market based. This outlook is countered by some independent studies[93] and reports[94] that indicate that the current industry may not be as benign or sustainable as government reports would suggest.

The issues raised in the 1997 CEMP continue to exist and are briefly updated below, however they may become a moot point for the St. Croix estuary area by the end of this decade. Rising summer water temperatures in Passamaquoddy Bay – climate change driven – are climbing closer to

the lethal limit for cold-loving salmon and are making salmon aquaculture in the bay increasingly unviable. Some salmon aquaculture sites have already been abandoned. All eight remaining sites in the St. Croix area are currently empty and, on the current site rotational cycle will remain so until at least 2015, and possibly permanently. However, there are active salmon aquaculture sites elsewhere in Passamaquoddy Bay and along the Fundy Isles whose effects are carried into the St. Croix estuary area by ocean currents.

Two impacts identified in the 1997 CEMP regarding salmon aquaculture – fish escapes and high nutrient levels – have been reduced but not eliminated.

The escape of aquaculture strains of salmon from hatcheries and sea cages poses potential risks to native salmon stocks, including the spread of parasites and diseases, competition for spawning sites and, through interbreeding, changes to the genetic makeup of wild fish that can reduce their future survival[95,96]. Improvements in sea cage design and containment practices have reduced the frequency of these escapes, but they still occur. Some research has been done into producing sterile strains of aquaculture salmon that, if they escape, cannot breed. Few, if any, wild salmon still exist in St. Croix estuary area rivers, eliminated by other causes in the last decade, but small wild populations still survive in some nearby rivers in New Brunswick and Maine[97].

Intensive farming of any species leads to localized impacts from high levels of animal excretion, respiration and feed waste. In the case of aquaculture sites, in the past, the build-up of fish feces and uneaten food underneath cage sites has physically and biologically altered the sea bottom, with direct effects on native species. Studies found this effect to be very localized and largely reversible within months of cage removal[98]. In recent years, this impact has been significantly reduced through a site rotation system that fallows sites on a regular basis (to allow the bottom to recover), improvements to fish food formulas and feeding methods (to reduce food waste and fish feces), and – on an experimental basis – by rearing other species such as mussels and seaweeds below salmon cages where these can feed off the wastes and generate a second marketable crop[99].

Nutrients from feed and fish feces also remain in surface waters where they – along with now warmer water and sunlight – create perfect growing conditions for marine algae and other waterborne species that thrive on a high nitrogen diet. Among these is *Alexandrium*, a native marine plankton that, under the right conditions, can explode in numbers to create the 'red tide' that closes shellfish harvesting areas due to its paralytic shellfish poisoning toxins[100] and has, on at least one occasion in 2003, been believed to cause aquaculture and wild salmon deaths[101].

Actions taken to reduce aquaculture waste buildup on the sea bottom have also reduced nutrient buildup in the waters above it. The industry cannot entirely eliminate these but can continue to develop new best management practices to make improvements.

The nutrient-enriched waters created by aquaculture operations also encourage outbreaks of sea lice (a fish parasite) and Infectious Salmon Anemia (ISA – a disease that can be fatal to salmon) that the industry combats with pharmaceutical drugs, some of which also find their way into the marine environment.

The wider ecological effects of pharmaceutical drug use continue to be a major issue. These are still largely unknown but recent incidents show that more research and greater precautions are needed to reduce ecosystem impacts. For example, the insecticide *cypermethrin*, permitted for

controlled use against sea lice at Maine salmon farms but banned from Canadian sites, is known to kill lobsters, planktonic crustaceans and some other marine species[102]. Highly-publicized lobster deaths at Deer Island in 1996[103]and off Grand Manan and Deer Island in 2009-2010[104] have been directly traced to *cypermethrin* exposure, and charges were laid against Canadian aquaculture firms for alleged illegal drug use in both instances. There is speculation that these are not isolated incidents, nor has this been the only unauthorized chemical in use, however there is limited monitoring to confirm or deny this. The effects of aquaculture pharmaceuticals on the marine ecosystem continue to be studied by scientific and academic organizations but will now have limited federal attention: Fisheries & Oceans Canada is eliminating its toxicology section that formerly carried out much of this research, in April 2013.

Aquaculture sites also create an intense breeding ground for some natural threats to Atlantic salmon and other species that would otherwise be minor and in natural balance. The two most significant of these are sea lice and Infectious Salmon Anemia (ISA). Sea lice are a minor natural parasite that can burgeon in numbers when given the opportunity to thrive on their tightly-packed hosts at an aquaculture site. The drugs that combat sea lice are one issue (noted above), however the sea lice that float outward from the aquaculture sites also pose a separate and significant threat to young wild salmon as they head to sea: just a few attached sea lice can result in young wild salmon mortality[105]. Similarly, the ISA virus, carried away from cage sites by water currents, may infect wild salmon, Atlantic cod and Atlantic herring as they travel past these sites[106].

The salmon aquaculture industry currently receives federal and provincial compensation for market losses when it must destroy fish that have tested positive for ISA. This compensation totalled $40.5 million in 1996-1997 after the first major ISA outbreak and one estimate puts 2012 compensation at $26 million[107]. In mid-2012, the Canadian Food Inspection Agency (CFIA) changed its ISA policy, allowing nearly 240,000 ISA-positive salmon to continue growing at a Nova Scotia aquaculture sites and then be shipped to New Brunswick for processing for market. In January 2013, CFIA announced that eradication of ISA by killing infected fish was no longer a viable option and it would instead pursue greater measures, such as vaccines, to prevent ISA outbreaks[108].

Atlantic salmon aquaculture has played a major role in the region's economy for the last 35 years but it seems clear that better research and integrated policy-making are needed if this be truly compatible and sustainable over the long term. This has been explored in a preliminary way by academic and resource interests[109,110] and should be pursued more actively by all, including governments.

Rockweed Harvest

Rockweed or knotted wrack, *Ascophyllum nodosum*, is the Fundy region's most abundant seaweed. This large green-brown seaweed can grow up to 2-3 meters in length and live for 12-15 years in the mid to low portion of the tidal range. It is attached to rocks (hence the name) and has long, strap-like fronds with small air bladders that make it to float upward, creating an underwater 'forest' that provides an intricate ecosystem to support a very wide range of marine species during some or all of their lifecycle[111].

Rockweed has been harvested for centuries, largely for local use as fertilizer. It was first suggested as a local commercial industry in 1792[112] but was only developed in 1995[113]. Locally, it

now employs up to 55 seasonal harvesters, plus other seasonal and year-round land-based personnel. The raw weed, before value-added processing, is valued at roughly $40 million annually. Extracts from the seaweed are used to produce food, agricultural and biochemical products that are marketed world-wide.

Acadian Seaplants Ltd. (ASL) receives an annual licence from Fisheries & Oceans Canada (DFO) to carry out this harvest under a Rockweed Fisheries Management Plan agreement between ASL, DFO and the N.B. Department of Agriculture, Aquaculture and Fisheries. The licence currently allows for an annual harvest of up to 17% of the harvestable rockweed biomass (volume) in established sectors – presently 13,000 tonnes for all of Southwest New Brunswick – under strict harvest management, resource assessment and reporting requirements. These include hand-harvesting only (mechanical harvesters are prohibited in New Brunswick but not neighboring jurisdictions), at least 13cm of the plant stem to be left uncut, and specific harvest sites and closed areas that are established to protect other species. In addition, ASL maintains its own program of best management practices[114] that extend beyond its license requirements.

The 1997 CEMP identified a number of early concerns about whether a commercial-scale harvest could be managed in a way that would have minimal impact on the local marine ecosystem and wider ocean food chains.

Studies conducted in 1995-1997, 1999, 2004[115] and 2005[116] examined physical changes in harvested rockweed beds at select locations. The 2005 study drew direct comparisons with 1999 findings at five locations, including two in the St. Croix estuary area (Digdeguash Harbour and Chamcook Harbour). In the combined results for all sites, average rockweed bed density, biomass and plant length were 3-5% less compared to six years earlier, but individual sites showed an increase in some of these. The study concluded that harvesting, environmental factors and site-specific conditions might all be contributing to changes in rockweed beds and that more studies should be made to clarify the roles of each of these factors.

Less, as yet, is known about the potential ecological effects of rockweed harvesting. Preliminary studies in the industry's 1995-1997 pilot phase had an initial look at linkages to invertebrate, waterfowl and fish populations. More recently, in 2012, the Huntsman Marine Science Centre completed the first of a proposed three-year study of the earliest marine fish life stages (eggs and larvae) that drift in the waters of Passamaquoddy Bay. This will include comparisons between populations located near or distant from aquaculture and rockweed harvesting sites. While current research in Nova Scotia and Maine may offer some insights, more in-depth studies into the intricate role of rockweed beds in the local marine ecosystem are needed to confirm if, and how, its harvesting can be both sustainable and compatible here.

Marine Transportation

The Port of Bayside[117], on the St. Croix estuary, is one of New Brunswick's five marine ports. Built in 1968 to serve a major tuna cannery, which closed in 1991, the port has re-invented itself to serve a number of cargo needs including bulk shipments, container traffic, frozen foods and agricultural products. It now offers year-round, deep water docking for up to three large vessels and two smaller vessels. Up to 70 ocean-going ships a year have used the port in the past, although slow

markets have reduced this to about 40 recently. The port is also used regularly by fish food carriers serving the local aquaculture industry.

The 1997 CEMP identified concerns for oil spill response, ballast water discharge, ship's waste disposal and the possible leaching of *tributyltin* (TBT) from anti-fouling paints used on marine hulls and equipment into the water, where it can seriously affect lobster and shellfish populations.

Based in part on these concerns, a local marine oil spill response plan was developed in 2000 by Passamaquoddy Bay user groups and the Canadian Coast Guard. This resulted in a community-based oil spill response manual[118] and the creation of depots for spill response equipment at strategic locations around the bay, including at the St. Andrews Biological Station, on the St. Croix estuary. This plan, now outdated, is scheduled for revision in the near future.

At the international level, the Canadian and U.S. Coast Guards are parties to a Joint Marine Pollution Contingency Plan that ensures coordinated planning and response to marine spills that could affect the boundary waters. For the Bay of Fundy / Gulf of Maine region since 1974, the two Coast Guards have tested their joint preparedness through full-scale oil spill exercises every two years under a CANUSLANT sub-agreement[119]. Most recently, the 2007 and 2013 CANUSLANT exercises focused on spill response affecting the St. Croix estuary area. These exercises involve the Coast Guards, other government agencies and local organizations.

In the last eight years, marine transportation risk assessments have also been carried out for the Bayside Port[120] and for proposed liquified natural gas (LNG) tanker terminals[121] on the Maine side of the St. Croix estuary. All of these assessments identified potential accident scenarios, calculated the risks involved, and examined means to avoid or mitigate these. The Bayside study led to a recommendation that pilots be compulsory on large vessels transiting to and from that port, a practice that is already required by the Bayside Port Authority (in 2012, the Atlantic Pilotage Authority agreed that this local requirement was sufficient). The U.S. tanker studies identified potential transportation hazards that have led Canada to ban the entry of these vessels through Canadian waters.

As for the other issues raised in 1997, the Canadian Government has since enacted legislation that prohibits foreign ballast water discharge in Canadian territorial waters[122] and has banned the use of TBT as a marine preservative[123], addressing these concerns. Also, research shows that foreign ships generally dispose of their wastes at other ports and rarely seek this service at Bayside, but when they do, the sewage is hauled to the City of Saint John treatment facilities and solid waste to the region's solid waste facility where both are disposed of in accordance with international protocols.

Champlain Industrial Park / Bayside Quarry

Co-located with the Bayside Port, the provincially-owned Champlain Industrial Park offers an opportunity to expand the St. Croix's marine-based economy. The St. Croix International Waterway Commission's 1993 waterway plan identified this as an ideal location for the Province to demonstrate techniques for "heritage compatible" sustainable development[124].

In 1998, the Province entered into a longterm lease and development agreement with a private developer to remove 24 million tons of granite from a steep waterfront section of the industrial park that would, over 30 years, create 103 acres of new, level, serviced land. At the midpoint of this

agreement, only five acres have been fully completed and there have been significant issues, over time, with noise, dust and runoff. These have abated somewhat in the last two years due to a slowdown in rock extraction as a result of weak markets, and relocation of the rock crushing equipment to a lower elevation on the site.

In late 2008, the developer approached the Province for an agreement to develop a second 30-50 year quarry on another section of the industrial park. At the time, it prepared a completed landscape design for the first quarry and visual simulations of the phased rock extraction from the second quarry. The second quarry was not approved and the designs were withdrawn. At this time, the only visual and environmental buffering considerations are from a 30 meter deep unexcavated 'berm' that separates the quarry from the waterfront.

As more of this site is, quite literally, 'carved in stone' each year, time is running short to implement a landscape concept that will ensure that the finished industrial park fits with the character of the area and offers an attractive, functional setting for new, marine-based businesses.

Traditional Fisheries

The St. Croix estuary area continues to support some traditional commercial fisheries, has lost a number of these and may regain others.

A share of Southwestern New Brunswick's traditional American lobster and Atlantic sea scallop fisheries take place in the estuary area. The regional lobster fishery alone has fairly recently been valued at $37 million a year[125].

Historic herring, cod, haddock and flounder stocks have largely disappeared, and their fisheries with them. The last St. Croix Atlantic salmon, from a restoration program that concluded in 2006, was recorded in 2008[126].

Local softshell clam harvesting, another traditional fishery, may be on the rebound. The estuary's Oak Bay includes 1400 acres (566 hectares) of tidal flats that support roughly 80% of the area's softshell clam (*Mya arenaria*) resource. Oak Bay clam harvests once exceeded 90 metric tons a year but these ended in the early 1950s, when the clam beds were closed due to bacterial pollution. Pollution reduction efforts resulted in the re-opening of the clam beds to conditional harvesting in 2000 however this was reduced to more restrictive depuration harvesting in 2002, due to reduced funding for water and clam quality testing. This testing resumed in 2012 and the Oak Bay clam beds were re-opened to conditional harvesting at that time[127].

A 1997 study[128] estimated that Oak Bay could support up to 200 commercial clam diggers and add $1-2 million to the local economy, while also preserving the Maritime cultural tradition of digging a 'feed of clams' for the home table. This study proposed that Oak Bay be used to pilot a sustainable softshell clam harvest policy for New Brunswick that might include harvesting periods and targets, stock assessments, stock development, and funding mechanisms for testing costs. It would be a valuable option to pursue.

There may be an opportunity to revive another traditional fishery by the end of this decade. Alewife or gaspereau (*Alosa pseudoharengus*), are a native sea-run fish that, like Atlantic salmon, split their lifecycle between freshwater (where they spawn) and saltwater (where they grow to maturity). In earlier centuries, the St. Croix supported one of the region's largest alewife runs and

commercial fisheries. Dams and pollution all but ended these by the early 1900s but subsequent improvements to both, allowed St. Croix alewife numbers rebound into the millions in the 1980s and harvesting began again.

However, sport fishing interests on the Maine side of the St. Croix perceived alewives as a threat to their fishery for the introduced smallmouth bass and, in 1995, convinced the Maine Legislature to block alewife passage at two lower St. Croix dams that are under state control. This kept St. Croix alewives from reaching 98% of their historic spawning habitat and reduced their return to just 900 fish by 2002.

At the time of this plan's writing, the Maine Legislature is considering the removal of the last of its St. Croix alewife spawning barriers. If this occurs, the St. Croix alewife population is expected to rebound and an initial commercial fishery may be possible as early as 2025. A managed, sustainable St. Croix alewife harvest will benefit the region's commercial lobster fishery (alewife are critically needed for affordable lobster bait) and support other historic marine employment and economic opportunities. A restored alewife run will also feed a wide range of other traditional commercial fish species (ex: cod and haddock) that have been in decline and may yet recover, as well as many freshwater fish, birds and mammals.

There is an emerging concern for another historic, commercial St. Croix sea-run fishery resource, the American eel (*Anguilla rostrata*). Sea-run eels have a reverse lifecycle to Atlantic salmon and alewives: they spawn in the ocean and return to their home freshwaters to mature. Historically, adult eels were harvested for export and local markets, and for sport fishing bait. More recently, a very lucrative international market has developed for the tiny juvenile eels (elvers) as these swim inland from the ocean. Eels are a prized delicacy in many parts of the world, particularly Asia where the demand for these far outweighs the supply from steeply declining native eel stocks. In 2012 Asian brokers were paying up to $2,600 per pound for American elvers, which are exported to the Far East for culture to market size.

The American eel was recently considered for listing as a threatened species in the United States and has been identified as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Given the high market prices, an intense elver fishery has developed on the Maine side of the St. Croix River in recent years. Should a similar fishery emerge on the New Brunswick shore, the St. Croix eel numbers could be seriously depleted. Coordinated transboundary monitoring and management will be needed maintain a sustainable eel population and fishery.

A Model for Integrated Resource Management

Much of what was once the "open ocean" is becoming crowded as more users compete for marine locations and resources. This is particularly true of coastal waters that are within easy reach of land.

The waters of the St. Croix estuary area are now used for international and local marine shipping, commercial fishing and harvesting, tourism, recreation, aquaculture and saltwater supply – and other uses may soon arise. These uses need to remain in balance with each other, and with the expectations and values of area residents, while still preserving the longterm health of the marine ecosystem

Planning and decision-making for these uses has traditionally been based on single interests – such as the location of shipping lanes or fishing grounds – but integrated ecosystem-based management models are being implemented to allow collective decision-making about marine space and use allocations that can best, sustainably, meet longterm ecological, social and economic needs.

Since 2004, just such a model has been under development for a 5,600 square kilometer section of the lower Bay of Fundy that includes the St. Croix estuary area. The Southwest New Brunswick Marine Planning Initiative[129], led by resource users and agencies, and with extensive public consultation, released a draft plan in 2009, "The Preferred Future of the Bay"[130], that provides a framework for decision making about marine space use and activities, based on a set of community values criteria, that all regulatory agencies might mutually recognize and implement.

The Southwest New Brunswick Marine Advisory Committee[131] (SWNBMAC) was established in 2010 to provide advice and recommendations to government agencies for delivery of this integrated management concept. It currently meets three times a year to do so and welcomes public input[132].

Compatible, Sustainable Economy Priorities for this Decade

The following are recommended priorities and actions, with prospective delivery entities noted in italics (see Appendix 1 for acronym identification).

#1: Continue to reduce the impacts of Atlantic salmon aquaculture on the natural marine ecosystem.

Recommended Actions:

- Continue to develop and apply best management practices to reduce nutrient and chemical discharges from fish aquaculture sites; monitor these and report their impacts on the marine environment and other species (*DFO, EC, DAAF, DMR, aquaculture operators, independent research interests*).
- Continue to develop and apply best management practices to reduce the spread of sea lice and Infectious Salmon Anemia (ISA) from aquaculture sites to wild species (*DFO, EC, CFIA, DMR, aquaculture operators, independent research interests*).
- Monitor and evaluate water temperature, flushing rates and other factors that may compromise the viability of salmon aquaculture sites in the St. Croix estuary area, and base their future permitting on both industry and government (or, lacking this, independent) assessments of potential ecosystem risks *vs.* industry gains (*aquaculture operators, DAAF, independent research interests, SWNBMAC*).

#2. Continue to assess, and adjust, commercial rockweed harvesting to support longterm ecological and economic sustainability.

- For the present, continue present rockweed harvesting industry best management practices and harvest controls, erring on the side of precaution for ecological sustainability (*ASL, DAAF*).

- Actively pursue research to meet the information gaps in rockweed harvesting effects on marine ecosystems and species. Report on, and apply, these findings to future industry permitting, as soon as possible (*ASL, independent research interests, DAAF, SWNBMAC*).

#3. Support active planning to develop a sustainable and locally-compatible marine industrial park and port at Bayside.

- Implement a design plan for Champlain Industrial Park lands that will assure an attractive, functional setting for new, marine-based businesses and minimize industrial visual impacts on the estuary's natural setting.

#4. Support maintained, and restored, traditional marine fisheries

- Encourage government agencies and user interests to implement a longterm sustainable softshell clam harvest management plan for Oak Bay (*user interests, ECW, DFO, EC, SCIWC, CFIA*)
- Encourage immediate *international* planning for future St. Croix alewife and eel stock management and harvest (SCIWC, SCEP, conservation interests, user interests, SCFSC)

#5. Support future decision-making on marine space and use allocations that reflect an agreed balance of economic, environmental and social goals.

- Encourage support for, and action by, the Southwest New Brunswick Marine Advisory Committee for government and user implementation of the 2009 "Preferred Future of the Bay" integrated marine resource management plan.

Environmental Priority 4: Informed Stewardship

Today's society seems to have little connection to the natural world: food comes from supermarkets, water from taps and personal contact from electronic devices, almost without thought. However, this natural dependency is inescapable and increasingly fragile.

In the past, when societies lived in immediate contact with the natural environment, they had to be in constant balance with it to survive. While this is still true in some places, the world's "developed" cultures have relied on technology to "overcome" this need for over two centuries[133].

Technology has improved our lives in many ways – we see this around us every day – but some of it has also had unexpected but very profound effects on the natural systems that support all life on the planet.

Some of these effects cannot be reversed by more technology. Climate change will happen, some waters will never again be pristine and some species that have been part of our landscape and economy for centuries will disappear. This plan acknowledges some of these inevitable changes and suggests ways to reduce their impacts on the region's people and ecosystems.

While the past cannot be changed, the future is yet to be written. With extensive knowledge of how some current economic and social practices directly affect the natural world, it is now possible to fix some of these – often in simple and cost-saving ways – to allow our society to "live more lightly on the land" so that we continue to have a viable place to live.

Awareness of nature's needs and values, and the choices that we have to make that affect all life forms, are the critical first step. This awareness can be direct and hands-on, if the opportunity exists, but today comes more often from publications, media and the web.

Knowing how to reduce our impacts – and be motivated to do so – is the second step. How-to information is available from many sources but, ultimately, the commitment to act is a hands-on personal and societal choice.

A range of programs were started by governments and non-profit organizations late in the last century to give people an active role in environmental conservation and protection at the community, school and individual level. The 2007 world-wide economic recession reduced government abilities to support many such programs and, when possible, non-profit and community interests have done their best to fill this gap with their own diminished resources.

This outlook is unlikely to change in the current decade. As in other parts of this plan, this section suggests some practical, largely low-cost, ways for federal, provincial and local partners to improve the St. Croix estuary's environment and interconnected economy, within current constraints. Some of the programs that now encourage St. Croix stewardship are noted below, along with suggestions on how these can be enhanced.

National and provincial environmental stewardship initiatives

Stewardship initiatives under federal and provincial climate change and clean water programs are noted in earlier sections (see these), but there are additional government avenues for public involvement.

Environment Canada's national Eco-Action Program[134] and Atlantic Ecosystem Initiatives Program[135] (also known as the Atlantic Coastal Action Program - ACAP) provide on-going support for community-based environmental stewardship projects in the Atlantic Region. Eco-Action grants are awarded annually and competitively to groups whose projects best address one of four themes: clean air, clean water, climate change and nature. ACAP funding, also annual and competitive, is available just to designated organizations in 18 priority Atlantic coastal locations for projects that involve knowledge generation and assessment, integrated planning and decision-making or collaborative science – all of which can include citizen participation and stewardship. Eco-Action has funded a number of St. Croix area projects over the last 18 years and ACAP has supported SCEP's environmental initiatives annually since 1991.

Environment Canada's *Take Action for the Environment* website[136] lists environmental stewardship options, information sources and volunteer opportunities, and merits exploring.

New Brunswick also has programs that support environmental stewardship. Its Environmental Trust Fund[137] – funded by bottle recycling deposits –makes annual community-based grants for resource protection, restoration, conservation, sustainable development, education and beautification. The province's Wildlife Trust Fund[138] – financed by supplemental hunting and fishing license fees and conservation license plates – awards annual grants for projects that benefit fisheries, wildlife, trapping, biodiversity and conservation education. Efficiency NB[139], established in 2005, offers technical assistance and financial incentives to homeowners, as well as to businesses and industries, to reduce their energy use.

For municipalities, New Brunswick provides a tool kit and technical resources to help communities develop sustainability plans[140] that engage their councils and residents in meeting long-term, linked goals for environmental, social and economic well-being. At the watershed level, it has supported the formation and activities of local watershed organizations and encouraged the formation of a provincial watershed association network

Two New Brunswick "eco-challenges" deserve attention.

In early 2009, at the province's urging, the mayors of six New Brunswick cities joined in a challenge to see which could <u>most</u> reduce its environmental footprint during a three month period[141]. Later in the year, a second six -week challenge engaged nine communities of various sizes, including local St. Andrews, in a similar competition[142]. Much rivalry, effort and entertaining media coverage resulted from both of these. Not important was who won but rather that the people in these communities, together, cut the province's greenhouse gas emissions by 285 tonnes in a very short time and had a hands-on role in environmental stewardship. This eco-challenge concept could easily become an annual or semi-annual event, expanded into a friendly province-wide rivalry for all municipalities and even rural districts, perhaps starting in the St. Croix region.

In 2012, DELG piloted a Family Eco-Challenge that offered simple means and measures to cut personal environmental impacts in five key areas: water, waste, energy, transportation and climate change[143]. The results of this pilot project are being evaluated and, pending the findings, this could become a province-wide initiative.

Local environmental stewardship initiatives

The St. Croix estuary area is fortunate to have a number of organizations that encourage active connections between its residents and the coastal environment.

The Huntsman Marine Science Centre (HMSC)[144] is a world renowned, non-profit marine consortium, located on the St. Croix estuary in St. Andrews. Established in 1969 by universities, government agencies and private sector partners, its mission is to inspire marine stewardship through education and research. While its activities have a national and international reach, they also benefit local residents. In 2011, HMSC opened a new 20,000 square foot Fundy Discovery Aquarium that brings the public into direct contact with the region's marine species and industries. Its expert staff, laboratories and research vessel, and the local shorelines, are the basis for a wide range of hands-on teaching programs for students (K-university) and others. Some of its programs are currently free, due to sponsorships, notably a 2-day Ocean Discovery course for area Grade 6 classes and a monthly marine lecture series for adults. Many other activities and courses are available at a modest cost.

The St. Croix Estuary Project Inc. (SCEP) is a community-based organization, described earlier, that provides many of its projects from its 350-acre Ganong Nature Park[145]. Since 1992, it has annually sponsored school and community projects that have engage residents in activities including water monitoring, fisheries restoration, shorefront protection, native plant restoration, water conservation and pollution reduction. One of its current projects gives high school students a series of 12 hands-on stewardship training sessions – on land, on the water and in the classroom – followed by the completion of sustainability projects and participation in a provincial "Envirothon" competition. Another annual program offers sustainability demonstrations and advice (composting, native plants, energy reduction, etc.) to over a thousand people at a SCEP-sponsored county fair.

Other local organizations also provide marine education and stewardship-building programs. Among these are the Coastal Livelihoods Trust[146] in St. Andrews, whose "Our Bay, Our Future" elementary school program brings students in contact with the resources and people who drive the local marine economy, and the Sunbury Shores Arts & Nature Centre[147], which leads educational public beach walks in the summer.

All of these, together, have established a strong educational base for local stewardship but, notably, are all non-profit organizations that must rely on grant sources (shifting from year to year) and the success of annual grant applications (often last-minute) to maintain their present involvement. Until funding opportunities improve, it is more likely that any specific coastal stewardship programs will be delivered through municipal sustainability plans or volunteer groups with a specific focus.

Beach cleanups are one exception and are a regular activity in the St. Croix estuary area. The Nature Trust of New Brunswick[148] holds an annual cleanup on its nearby island reserves. Paddlefest[149], a three-day recreation and music event sponsored by the St. Andrews business community each May, equips visitors and residents alike with garbage bags to clean up beaches and

streets, with great success. Other groups hold beach cleanups to analyze the types of waste, involve youth or build teamwork. All of these achieve two important objectives: engaging people in hands-on coastal stewardship and reducing a portion of the manmade waste on coastal shores. Subtly if not directly, they also contribute to public awareness that very simple societal changes could prevent nearly all of this from occurring. This simple means of stewardship engagement could easily be expanded to include others, including the marine industry.

Coastal land conservation is another ongoing stewardship avenue. The Nature Trust of New Brunswick (NTNB), with generous landowner and donor support, has created four nature preserves[150] in the St. Croix estuary area that provide permanent public access and resource conservation on 675 acres (273 hectares) of coastal land. The St. Croix Estuary Project offers public access and community programs at its 350-acre Ganong Nature Park on the estuary. Federal, provincial and municipal governments, and private landowners, maintain a number of other access and viewing sites[151].

There are other stewardship opportunities.

While the area is fortunate to have organizations that offer hands-on marine education – and local ecotourism operators also excel in this regard – as yet there are no direct web-based or other sources for information on St. Croix coastal resources, issues, management and public involvement. Developing an appropriate website, or adding this information to existing websites, would be extremely useful.

Equally useful would be for local libraries and museums to offer periodic 'theme' displays on their primary St. Croix estuary holdings, and for historical and other community groups to expand their promotion of the area's marine heritage through projects, presentations, newspaper articles and interpretive plaques. Each of these can help to maintain a local connection and on-going commitment to the St. Croix's marine heritage and resources.

SCEP continues to explore opportunities to develop a community-based environmental sustainability training centre and estuary information node at its 350-acre Ganong Nature Park, on the estuary waterfront. If achieved, this would complement and enhance the St. Croix marine education focus at HMSC and expand the province's network of sustainability resource centres from two[152] to three.

Informed Stewardship Priorities for this Decade

The following are recommended priorities and actions. Potential delivery organizations are noted in italics (see Appendix 1 for acronym identification).

#1. Improve public access to information on St. Croix coastal resources, issues, management and public involvement opportunities

Recommended Actions:

- Expand website access to information on the above St. Croix themes (*SCEP, HMSC, SCIWC, SWNBMAC, RSC10, StAndrews, StStephen)*
- Encourage local organizations, tourism businesses and public media to regularly feature St. Croix marine heritage and stewardship in their activities and coverage (*SACT, CCHS, PC,*

HMSC, SCEP, SCIWC, eco-tourism operators, StStephen, StAndrews, CHCO-TV, St. Croix Courier).

- Encourage area libraries and museums to offer periodic displays of their St. Croix estuary holdings (*StStephen, StAndrews, HMSC, SABS, CCHS, CCA*)

#2. Expand the involvement of residents, students and local governments in environmental stewardship.

Recommended Actions:

- Continue, and expand, voluntary coastal cleanups as a primary stewardship venue and let the results, through government planning and policy development, reduce coastal pollution (*CCNB, HMSC, SCEP, Paddlefest, aquaculture industry, schools, StAndrews, StStephen, DAAF, DELG*).
- Continue to conserve and provide traditional public access to marine shorelands, accesses and viewpoints; pursue opportunities to increase this (*NTNB, StAndrews, StStephen, SCEP, DTHC, BNB, landowners*)
- Establish provincial eco-challenge programs for families/individuals and municipalities that provide the tools and incentives to be better environmental stewards (*DELG*)
- Encourage local municipalities to develop active, long-term community sustainability plans that include coastal stewardship objectives (*DELG*)
- Continue current elementary school marine stewardship programs. Explore the development of a half-day or one-day coastal resource and stewardship learning unit for local middle or high schools, to carry this awareness into the upper grades.

#3: Explore options to continue to establish a public centre for community-based environmental sustainability and St. Croix coastal resources at the Ganong Nature Park.

Recommended Actions:

- Deliver on-going public presentations, workshops and demonstration projects on environmental sustainability practices for local communities, residents and students at the Ganong Nature Park. (*SCEP, ASSD, DELG, DAAF, organizations with nature, horticulture and agriculture focus)*
- Sponsor school and community-based interpretive activities and field sessions on the local coastal and intertidal environment at the Ganong Nature Park (*SCEP, HMSC, ASSD, individual schools, community sponsors*)
- Host regional conferences, conference sessions and workshops on environmental sustainability and coastal planning at the Ganong Nature Park that offer local residents and students the opportunity to learn from others (*SCEP, DELG, SCIWC, IJC, SWNBMAC, ACASA*)
- Explore funding models and opportunities to establish a long-term regional sustainability resource centre at the Ganong Nature Park *(SCEP)*

Getting Started

This plan reflects three months of research and discussion about how environmental priorities for the St. Croix estuary area have evolved over the last 15 years and what the most urgent needs are now. It seeks to focus on actions that can't wait – that if not taken in this decade will lead to largely irreversible changes in the quality of the St. Croix estuary area's environment and the wellbeing of those who live and work along it.

Four themes rose to the top:

Clean water is essential to the region's environmental and economic future. Four priorities are recognized: 1) Monitor fresh & estuarine water quality and use the findings for long-term planning; 2) Monitor and reduce land-based point source pollution; 3) Monitor and reduce major land-based nonpoint pollution sources; and 4) Support government commitments to longterm water quality protection. The 15 recommended actions seek to continue current efforts, better use monitoring information for longterm planning, and encourage strategic water policy-making.

Climate change imperatives call for quick action. Five priorities were identified: 1) Take action to reduce greenhouse gas emissions; 2) Implement policies and programs to conserve water use, especially in the summer months; 3) Initiate longterm adaptation plans to address sea level and stormwater increases; 4) Track changes to ocean conditions and species that signal longterm ecological trends, and initiate proactive conservation and management plans to adapt to these changes; and 5) Monitor climate change impacts on land and freshwater based species that have significant implications to the local ecology or economy, and initiate proactive conservation and management plans to adapt to these changes. The 14 recommended actions focus on combining long-term thinking and now-available tools to reduce the effects of climate change on our society, and our effects on the climate.

A **compatible, sustainable economy** will support current and future generations, in the maritime tradition of the St. Croix region. The five priorities noted were: 1) Continue to reduce the impacts of Atlantic salmon aquaculture on natural marine ecosystems; 2) Continue to assess, and adjust, commercial rockweed harvesting to support longterm ecological and economic sustainability; 3) Support active planning to develop a sustainable and locally-compatible marine industrial park and port at Bayside; 4) Support maintained, and restored, traditional marine fisheries; and 5) Support future decision-making on marine space and use allocations that reflect an agreed balance of economic, environmental and social goals. The nine recommended actions focus strongly on better-informed and better-integrated decision making to ensure that economic choices made in the short term do not compromise the economic opportunities of the future – or the environment that makes them possible.

Informed stewardship lays the foundation for the other themes. Society is the cause and only potential cure of the environmental problems that it faces, and we are all part of society. This plan selected three priorities: 1) Improve public access to information on St. Croix coastal resources, issues, management and public involvement opportunities; 2) Expand the involvement of residents, students and local governments in environmental stewardship; and 3) Explore options to establish a public centre for community-based environmental sustainability and St. Croix coastal resources at the

Ganong Nature Park. The 12 recommended actions encourage the greater use of information and activities to promote awareness of our ultimate, and inescapable, dependence on ecosystem health and on providing new ways to be less a part of the problem and more a part of the solution.

The St Croix Estuary Project (SCEP) hopes that the many parties that have a stake in the future of the St. Croix area estuary will consider, and hopefully pursue, this plan's recommendations. SCEP will encourage them to do so. It will also work directly on actions for which it is identified as a potential partner, to the extent that its resources allow.

A sustainable, vibrant and culturally-connected future is possible for the St. Croix coastal region. It is possible to maintain a healthy longterm marine ecosystem and support an active economy that ultimately depends on this, if all work together.

We hope that everyone will.

Appendix 1: Acronyms and Abbreviations

The following acronyms or abbreviations are used in this plan.

ACAP	Atlantic Coastal Action Plan – Environment Canada
ACASA	Atlantic Climate Adaptation Solutions Association
ASL	Acadian Seaplants Ltd.
ASSD	N.B. Anglophone South School District
BoFEP	Bay of Fundy Ecosystem Partnership
CCA	Charlotte County Archives
CCHS	Charlotte County Historical Society Inc.
CCP	Charlotte County Ports Ltd. (Bayside rock quarry and aggregate processing plant)
CEMP	Community Environmental Management Plan – St. Croix Estuary Project
CFIA	Canadian Food Inspection Agency
CSO	Combined sewer overflow
DAAF	N.B. Department of Agriculture, Aquaculture & Fisheries
DED	N.B. Department of Economic Development
DELG	N.B. Department of Environment & Local Government
DFO	Fisheries & Oceans Canada
DH	N.B. Department of Health
DMR	Maine Department of Marine Resources
DOT	N.B. Department of Transportation & Infrastructure
DTHC	N.B. Department of Tourism, Heritage & Culture
EC	Environment Canada
ENB	Efficiency New Brunswick
ESIP	EcoSystem Indicator Partnership, Gulf of Maine Council on the Marine Environment
ETF	N.B. Environmental Trust Fund
FCM	Federation of Canadian Municipalities
GOMC	Gulf of Maine Council on the Marine Environment
GTF	Gas Tax Fund – Government of Canada
HMSC	Huntsman Marine Science Centre
IBC	Insurance Board of Canada
IJC	International Joint Commission

IPCC	Intergovernmental Panel on Climate Change – United Nations
NBWTF	New Brunswick Wildlife Trust Fund
NRCan	Natural Resources Canada
NSERC	Natural Sciences & Engineering Research Council of Canada
NTNB	Nature Trust of New Brunswick
PC	Parks Canada
RAC	Regional Adaptation Collaborative program – Government of Canada
RSC10	N.B. Regional Service Commission 10 (Southwest N.B.)
SABS	St. Andrews Biological Station – Fisheries & Oceans Canada
SACT	St. Andrews Civic Trust
SCEP	St. Croix Estuary Project Inc.
SCFSC	St. Croix Fisheries Steering Committee
SCIWC	St. Croix International Waterway Commission
SWNBMAC	Southwest New Brunswick Marine Advisory Committee
StAndrews	Town of Saint Andrews
StStephen	Town of St. Stephen
USGS	U.S. Geological Survey
WPL	Woodland Pulp LLC
WTP	Wastewater treatment plant

Appendix 2: Atlantic Ecosystem Initiatives Priorities

At 2012, the following are Atlantic Ecosystem Initiatives priorities that align closely with the current work of Environment Canada in the Atlantic Region and are eligible for support under the AEI program. .

Nearshore Water Quality	Habitat and Biodiversity Loss	Impacts of Climate Change
Nutrients Impacts of nutrient loadings in fresh and marine water. Identifying and managing sources of nutrient loadings (e.g.: from agricultural or other land uses). Fecal coliform source identification.	**Wetlands and Saltmarshes** Eelgrass. Seawater intrusion into wetlands. Conservation.	**Sea Level Rise** Impacts on waterfowl and other species and their vulnerability to sea level rise. Increased flooding and related watershed/ coastal zone impacts. Impacts of coastal erosion related to sea level rise.
Sediments Agricultural activities and impacts on sediment loadings. Impacts of erosion and sedimentation on freshwater. Prevention of erosion and sedimentation.	**Conservation of Flora** Partnering with provincially protected areas - focus on areas adjacent or complimentary to protected areas. Unique and threatened habitat. Biodiversity: maintaining current levels of biodiversity and habitat (conservation). Management and/or mitigation of invasive species (e.g.: purple loosestrife).	**Other** Sea/air temperature changes and effects on species. Seawater intrusion into wetlands. Changes in sediment input into coastal ecosystems. Resilience and vulnerability of coastal ecosystems to climate change.
Toxics Cumulative effects of multiple stressors on the aquatic ecosystem (freshwater). Effects of pesticides on fresh water quality. Addressing point and non-point source pollution. Microbial source tracking Shellfish management options (multi-stakeholder approaches). Land use impacts on water quality and shellfish contamination.	**Conservation of Fauna** Migratory Birds and Shorebirds. Aerial insectivores. Assessing habitat needs of other important species (e.g.: wood turtle). Management and/or mitigation of invasive species (e.g.: green crab).	

Citations and Endnotes

Below are sources for, and further details on, information presented in this plan. The web citations were accurate and available at late March 2013 but may change with time.

Introduction

1. Current Atlantic Ecosystem Initiative partners are: ACAP Cape Breton , ACAP Humber Arm Environmental Association Inc. , ACAP Saint John , Bedeque Bay Environmental Management Association , Bluenose Coastal Action Foundation, Central Labrador Environmental Action Network, Clean Annapolis River Project, Eastern Charlotte Waterways Inc., La Société d'aménagement de la rivière Madawaska et du lac Témiscouata, Labrador Southeast Coastal Action Program Inc., Miramichi River Environmental Assessment Committee, Northeast Avalon ACAP, St. Croix Estuary Project Inc., Pictou Harbour Environmental Protection Project, Southeast Environmental Association, Atlantic Coastal Zone Information Steering Committee, Southern Gulf of St. Lawrence Coalition on Sustainability, and the Bay of Fundy Ecosystem Partnership. Further information is available at http://www.ec.gc.ca/iea-aei/default.asp?lang=En&n=AE53A7A0-1
2. Gardner Pinfold Consulting Economists Limited. 2002. An Evaluation of the Atlantic Coastal Action Program (ACAP): Economic Impact and Return on Investment. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=FA7646AC-8B3B-4F04-BEE8-7DC8D823A2D5
3. St. Croix International Waterway Commission. 1993. St. Croix International Waterway – A Heritage, A Future: Plan for Long-Term Cooperative Management of the St. Croix International Waterway. St. Stephen, New Brunswick and Calais, Maine. http://www.stcroix.org/what-we-do/management-plan
4. Gulf of Maine Council on the Marine Environment. Gulf of Maine Council on the Marine Environment Action Plan 2012–2017. http://www.gulfofmaine.org/documents/ap-2012-2017/2012-2017-Action-Plan.pdf

Clean Water

5. A recent Statistics Canada report confirms that the southern part of Canada, where 98% of the population lives, has access to only 38% of Canada's water supply; the remainder flows north to the Arctic. Statistics Canada. 2010. Human Activity and the Environment: Freshwater supply and demand in Canada. Catalogue No. 16-201-X. Ottawa, Ontario. http://publications.gc.ca/collections/collection_2010/statcan/16-201-X/16-201-x2010000-eng.pdf
6. Each year since 2008, the Royal Bank of Canada has polled Canadians about their attitudes on freshwater issues. These polls consistently record that Canadians rank clean water as the nation's most valuable natural resource but have surprising lapses in how to deal with it. The news releases from these polls are insightful and interesting reading; view them at http://www.rbc.com/newsroom/2009/0317-waterstudy.html
7. See note 5.
8. The Federal Water Policy was tabled in Parliament in 1987. This policy outlined five strategies: water pricing, science leadership, integrated planning, legislation and public awareness). Environment Canada. 1987. Federal Water Policy. Ottawa Ontario. Web and pdf versions are currently available at http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=D11549FA-1
9. Organizations such as the Canadian Chamber of Commerce and Canadian Water Resources Association have called on the federal government to update its 1987 water policy by adopting a National Water Strategy that addresses current and future needs. Read more at http://www.chamber.ca/images/uploads/Resolutions/2010-en-fr/Water%20for%20Sustainability%20-%20A%20Canada-Wide%20National%20Water%20Strategy.pdf, and http://www.cwra.org/News_Events/Articles/Press_Release_Final_2008_06_18_2.pdf
10. Canada's Action Plan for Clean Water is available on Environment Canada's website at http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=B1128A3D-1
11. The federal press release on the sewage treatment standards, with a link to the full regulation, is at http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=601AD687-480E-4EB9-8FDD-6027B021634A

12. Follow the Dept. of Environment & Local Government's Water link to a wide range of programs: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/water.html

13. See this link for general information and legislation on surface drinking water supply: http://www2.gnb.ca/content/gnb/en/services/services_renderer.201091.html

14. See this link for general information and legislation on New Brunswick water classification: http://www2.gnb.ca/content/gnb/en/services/services_renderer.201090.html

15. See this link for general information and legislation on Maine's water classification program: http://www.maine.gov/dep/water/monitoring/classification/

16. The 1907 Boundary Waters Treaty between the United States and Canada contains a number of important agreements about boundary water use. See the full text on the International Joint Commission website at http://www.ijc.org/en/BWT

17. The Environment Canada gauge at the Milltown dam makes an instantaneous record of surface water temperature, specific conductance, pH, turbidity and dissolved oxygen. These data are not yet available through the St. Croix hydrologic network website but may be at some future time.

18. This water quality gauge beside the Milltown border crossing is operated cooperatively by the U.S. Geological Survey and Woodland Pulp LLC. Initiated in 1972, budget constraints have limited is operation to June-September since 1996. Its longterm record of water temperature, dissolve oxygen, specific conductance and pH are available on the St. Croix hydrologic network website http://me.water.usgs.gov/stcroix.html

19. Find the IJC's St. Croix Board's annual reports at http://ijc.org/boards/iscrwb/publications/

20. This report assesses the current state of the St. Croix watershed based on eight criteria that cover the gamut of economic, resource and social uses. Find this on the IJC's St. Croix Board webpage at http://ijc.org/boards/iscrwb/publications/

21. For information on these water monitoring reports, contact the St. Croix Estuary Project, 350 Todds Point Road, Dufferin, NB, E3L 3R8.

22. The Gulf of Maine Council on the Marine Environment is a unique collaboration of two provinces, three states and various U.S. and Canadian agencies who are working together to protect and manage the region's shared ocean resources. Read more about the Council and its 2012-2017 action plan at http://www.gulfofmaine.org

23. Find an overview the Gulfwatch marine contaminants program at http://www.gulfofmaine.org/gulfwatch/

24. Gulfwatch annual data reports are available at http://www.gulfofmaine.org/gulfwatch/data/files.php. There has been limited synthesis and interpretation of Gulfwatch findings to date; conducting these is one of the recommendations of this plan.

25. Learn more about the Gulf of Maine Council's Ecosystem Indicator Partnership and its results at http://www.gulfofmaine.org/2/committees-and-programs/ecosystem-indicator-partnership/

26. Among the references confirming this is: St. Croix International Waterway Commission St. Croix International Waterway Commission. 1993. St. Croix International Waterway – A Heritage, A Future: Plan for Long-Term Cooperative Management of the St. Croix International Waterway. St. Stephen, New Brunswick and Calais, Maine. Page 12. http://www.stcroix.org/what-we-do/management-plan

27. Current licensed and operational wastewater discharges to the lower St. Croix are, on the Canadian side: Town of St. Stephen, East Coast Village Mobile Home Park, Oak Bay Hatchery, Oak Bay Campground, Champlain Industrial Park, Town of Saint Andrews and Atlantic Salmon Federation. On the Maine side these are: Woodland Pulp LLC, Town of Baileyville, Irving Oil (Route 9 Big Stop), City of Calais and Washington County Community College.

28. The Town of St. Stephen and the N.B. Department of Environment & Local Government, with the St. Croix Estuary Project's ongoing assistance, continue to study and work to eliminate the town's few remaining historic combined sewage and stormwater lines.

29. Dioxins and furans are highly toxic compounds that are by-products of pulp and paper bleaching, home and commercial waste incineration and leaded fuel use, among the sources that might affect the St. Croix.

30. To reduce your own effect on water quality, search *water pollution reduction* on the web. Start here: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/water/content/water_conservation.html, http://water.epa.gov/polwaste/nps/dosdont.cfm or contact the N.B. Dept. of Environment & Local Government.

31. St. Croix Corridor Zoning Regulation – Community Planning Act, Regulation 95-STC-012-00. This is available from the N.B. Dept. of Environment & Local Government and Regional Service Commission 10.

32. See http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/CoastalAreasProtectionPolicy.pdf

33. This Health Canada webpage offers basic information on cyanobacteria and its effects: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/cyanobacter-eng.php

34. Sea otters off British Columbia were the first marine mammals documented to be killed by cyanobacteria , in 2007 (http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0012576). Cyanobacteria have long been known to have toxic effects on saltwater fish in the wild and in aquariums.

Climate Change

35. See http://en.wikipedia.org/wiki/Paleocene%E2%80%93Eocene_Thermal_Maximum for a historic overview.

36. There are many statements about the human cause of current climate change. One of these is from the Government of Canada, see http://www.climatechange.gc.ca/default.asp?lang=En&n=F2DB1FBE-1

37. The full details of the Kyoto Protocol and United Nations Framework on Climate Change process are available at http://unfccc.int/kyoto_protocol/items/2830.php

38. Canada was a signatory to the 1997 Kyoto Protocol, under which it committed to reduce national greenhouse gasses from 1990 levels by 6% by 2012. However, faced with the reality of a 17% national increase in GHG emissions between 1990 and 2009, and an anticipated $14 billion cost in compliance, Canada withdrew from the Kyoto Protocol in 2012, see a summary at http://www.theglobeandmail.com/news/politics/canada-formally-abandons-kyoto-protocol-on-climate-change/article4180809/. Canada has instead adopted a national goal of a 17% GHG reduction between 2005 and 2020, see http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=AD1B22FD-1 under the 2009 Copenhagen Accord. A general explanation of this Accord is at http://en.wikipedia.org/wiki/Copenhagen_Accord

39. See information on this amendment on the United Nations Framework Convention on Climate Change website at http://unfccc.int/kyoto_protocol/doha_amendment/items/7362.php

40. See full information on this international climate change panel at http://www.ipcc.ch/

41. Natural Resources Canada. 2008. From Impacts to Adaptation: Canada in a Changing Climate 2007. Cat. No. M174-2/1-2007. Ottawa, Ontario. This report gives a solid Canadian perspective on climate change, by region. A downloadable version is at http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/assessments/132.

42. Health Canada offers a good overview of the future effects of climate change on Canadian's health at http://www.hc-sc.gc.ca/ewh-semt/climat/impact/index-eng.php

43. The U.S. Environmental Protection Agency (EPA) provides a wealth of easy-to-read information on climate change – what it is and what to do about it – on its website. Start here: http://www.epa.gov/climatechange/

44. Canadian climate change initiatives are included in its Federal Sustainable Development Strategy. A summary of 2010-2013 action can be found at http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=23E4714E-1 At the time of this plan's writing, the federal government is consulting with Canadians on its proposed 2013-2016 climate change actions, (through Environment Canada's Sustainable Development Office). The consultation paper is currently available at http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=A22718BA-1; Chapter 2 Theme I and Annex 1 refer to climate change.

45. New Brunswick climate change initiatives are described on the Dept. of Environment and Local Government website at http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change.html

46. Details on RAC Agreement activities can be found on the Natural Resources Canada website at http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/regional-collaborative/48

47. The Atlantic Climate Adaptation Solutions website offers climate change information, adaptation tools, case studies and technical guides for Atlantic Canadians at http://atlanticadaptation.ca/. It also offers an excellent, short video that explains climate change in Atlantic Canada (see http://atlanticadaptation.ca/climate-change)/

48. Key forecasts on sea level rise, transportation infrastructure risks and other topics are on the ACASA website at http://atlanticadaptation.ca/impacts-climate-change. A general summary on the provincial website at http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_affectingnb.html. Also see Note 41.

49. See http://atlanticadaptation.ca/links-communities-examples and http://atlanticadaptation.ca/vulnerability-assessment

50. See http://atlanticadaptation.ca/sites/discoveryspace.upei.ca.acasa/files/Municiple_Guidebook_English_Sept_2012.pdf and http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/mun/pdf/mun_e.pdf

51. The best summary of Canada's action plan for climate change is found on pages 6-7 of this publication: Environment Canada. 2012. A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act. Cat. No. En11-11/2012E-PDF. This is available on-line at:http://www.ec.gc.ca/Publications/98673EA5-AD03-4D6A-93B4-1CDF2088BF43/KPIA-Plan-2012---April-25-_E_02.pdf. Additional information is available on Canada's Climate Change website: http://www.climatechange.gc.ca

52. New Brunswick climate change annual progress reports are listed at: www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/action_plan.html

53. New Brunswick tracks changes in 12 climate indicators, including the likelihood of a White Christmas: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_indicators.html

54. Canada's 10 Canadian Environmental Sustainability Indicators include ones related to climate change. See http://ec.gc.ca/indicateurs-indicators/default.asp?lang=En

55. Track provincial GHG emissions at http://logixml.ghgregistries.ca/New%20Brunswick%20Dashboard%20Solo/

56. Follow national GHG emissions at http://ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=FBF8455E-1

57. See http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_full_report_final.pdf

58. See http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/climatechange/index.htm

59. See Note 38.

60. Announced by Environment Minister Peter Kent, in August 2012: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=D59B6AF5-5533-49F7-9CEA-52DE5F3766C5

61. Take personal steps to reduce GHGs. See some ways at http://nbhub.org/site/take-action/, http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/reduce.html and http://www.climatechange.gc.ca/default.asp?lang=En&n=D27052CE-1

62. Federation of Canadian Municipalities, 2012. Reaching Milestone 3:How to Create a Local Action Plan to Manage Energy and Emissions. Ottawa, Ontario. http://www.fcm.ca/Documents/tools/PCP/Reaching_Milestone_3_How_to_Create_a_Local_Action_Plan_to_Manage_Energy_and_Emissions_EN.pdf

63. The Pembina Institute's challenge is accessed at http://www.onelesstonne.ca/

64. The Seeds Foundation challenge is available at http://www.seedsfoundation.ca/otc/

65. See note 45.

66. One Canadian example is the City of Guelph, which has used a range of water conservation programs – including grants for low flow toilets and water reduction planning for businesses, as well as an outside water use bylaw – to avoid major capital expenditures for expanded water infrastructure. See more at http://guelph.ca/living/environment/water/water-conservation/water-smart-business/

67. Climate Change Secretariat, N.B. Dept. of Environment & Local Government. 2012. Sea Level Rise and Flooding: What They Mean for New Brunswick's Coastal Communities. Presented at *Climate 2100: Tools and Strategies for NB Communities*, Fredericton, NB, November 2012. Posted at http://atlanticadaptation.ca/node/328

68. Mahoney, Matthew. 2001. Coastal Flooding Potential in Western Passamaquoddy Bay & the St. Croix Estuary. St. Croix Estuary Project. St. Stephen, New Brunswick.

69. See Note 67.

70. Insurance Board of Canada. 2011. Municipal Storm and Sanitary Infrastructure Risk Assessment Tool Project. Toronto, Ontario.

71. This pilot project is described in the publication cited in Note 70.

72. View the results of a number of community risk assessment projects at http://atlanticadaptation.ca/vulnerability-assessment

73. See http://www.gov.ns.ca/snsmr/municipal/planning/integrated-community-sustainability-plans.asp and http://www.gov.ns.ca/snsmr/pdf/mun-icsp-guide.pdf

74. See http://www.gov.ns.ca/snsmr/pdf/mun-climate-change-action-plan.pdf

75. See http://www.nsinfrastructure.ca/documents/1/Gas%20Tax%20Municipal%20Funding%20Agreement%20-Final%20Version%202010.pdf for Nova Scotia's municipal funding agreement and find Gas Tax Fund details at http://actionplan.gc.ca/en/initiative/making-gas-tax-funding-municipalities-permanent

76. See information New Brunswick's Sustainable Communities initiative at http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/community_sustainability_plans.html

77. Pages 2-5 of this report summarize the major impacts of climate change on the North Atlantic Ocean: Gulf of Maine Council on the Marine Environment. 2010. Climate Change and its Effects on Ecosystems, Habitats and Biota. http://www.gulfofmaine.org/state-of-the-gulf/docs/climate-change-and-its-effects-on-ecosystems-habitats-and-biota.pdf

78. A number of recent articles cite scientific authorities on climate change and lobsters. Here are a few: http://bangordailynews.com/slideshow/alarmingly-warm-water-in-gulf-of-maine-bringing-changes/ , http://mlcalliance.org/2013/01/16/global-climate-change-and-you/, http://bangordailynews.com/2012/11/29/business/climate-changes-effects-on-lobster-fishery-among-topics-addressed-in-portland-symposium

78. In his December 17, 2012 article, *Alarmingly warm water in the Gulf of Maine*, Bangor Daily News reporter Bill Trotter reports on a study by University of Maine researcher Dr. Jeffrey Runge that projects the disappearance of *Calanus* from local waters by 2050. http://bangordailynews.com/slideshow/alarmingly-warm-water-in-gulf-of-maine-bringing-changes/

80. See http://www.geog.mcgill.ca/climatechange/ReportsMap/Calanus%20finmarchicus.pdf

81. Schuman, Carrie. 2009. It takes two to tango – a watery dance of life and death between two species *in* Gulf of Maine Times December 2009. http://www.gulfofmaine.org/gomt/?p=32

82. See http://en.wikipedia.org/wiki/Copepods#Ecology

83. A short but thorough background on 'red tide', the tiny organism that causes it, and paralytic shellfish poisoning: Ely, Eleanor and Neil W. Ross. Undated. Red Tide in the Northeast. Rhode Island Sea Grant Fact Sheet P1099. Narragansett, Rhode Island. http://seagrant.gso.uri.edu/factsheets/redtide.html

84. Infectious Salmon Anemia is discussed in the next section of this plan.

85. Sea urchins are one species that are being studied for a potential role in counteracting the effects of climate change, reports The Daily Telegraph (U.K.) in a February 5, 2013 article, *Can Sea Urchins Save Us from Global Warming?* Posted on line at http://www.wunderground.com/news/sea-urchins-climate-change-20130205

86. See Note 41.

87. The Southwest New Brunswick Marine Advisory Committee is discussed in the next section of this plan. Background information on this committee is available at its website: http://bofmrp.ca/home/

88. Learn more about the Bay of Fundy Ecosystem Partnership at its website: http://www.bofep.org/

Compatible, Sustainable Economy

89. See plans identified in Note 3 and Note 130.

90. See this Dept. of Agriculture, Aquaculture & Fisheries webpage for a brief overview of the Atlantic salmon aquaculture industry: http://www.gnb.ca/0027/Aqu/finfish-e.asp

91. Fisheries & Oceans Canada's National Aquaculture Strategic Action Plan Initiative 2011-2015 is currently available on line at: http://www.dfo-mpo.gc.ca/aquaculture/lib-bib/nasapi-inpasa/Report-eng.pdf. Under this initiative, it's regional East Coast Marine Finfish Sector Strategic Action Plan for 2011-2015 in on line at: http://www.dfo-mpo.gc.ca/aquaculture/lib-bib/nasapi-inpasa/finfish-east-marin-est-eng.pdf

92. Fisheries & Oceans Canada. 2012. Aquaculture in Canada 2012: A Report on Aquaculture Sustainability. Ottawa, ON. http://www.dfo-mpo.gc.ca/aquaculture/lib-bib/asri-irda/pdf/DFO_2012_SRI_AQUACULTURE_ENG.pdf

93. The most thorough of these studies is: Harvey, Janice and Inka Milewski. 2007. Salmon Aquaculture in the Bay of Fundy: An Unsustainable Industry. Conservation Council of New Brunswick. Fredericton, New Brunswick. It may be available at http://www.conservationcouncil.ca/publications

94. The Atlantic Salmon Federation reports on escaped aquaculture salmon, sea lice chemicals, ISA disease risks and the high cost of compensation for fish losses. See postings at http://www.asf.ca/cleanupsalmonfarming.html and http://www.asf.ca/aquaculture-in-need-of-change.html

95. Morris, R.J. *et al*. 2008. Prevalence and recurrence of escaped Atlantic salmon (*Salmo salar*) in eastern North American Rivers. Can. J. Fish. Aquat. Sci (2008) **65**:2807-2826. http://0101.nccdn.net/1_5/165/1c4/1be/morrisetal2008.pdf

96. Bourret, V. et al. 2011. Temporal change in genetic integrity suggests loss of local adaptation in a wild Atlantic salmon (*Salmo salar*) population following introgression by farmed escapees. Heredity (2011) **106**:500-610. http://0101.nccdn.net/1_5/2ca/308/365/2011-carr-temporalchange.pdf

97. The Magaguadavic River in New Brunswick and Dennys River in Maine, both within 30km of the St. Croix area, have remnant wild salmon populations according to the Atlantic Salmon Federation (NB) and Maine Department of Marine Resources (ME).

98. Sowles, John W. 2003. Water Quality and Benthic Impacts of Marine Aquaculture in Maine. Maine Dept. of Marine Resources. Augusta, Maine. http://www.maine.gov/dmr/aquaculture/reports/wqbenthic.pdf

99. Information on research into multi-species rearing at aquaculture sites is available on the NSERC Integrated Multi-Trophic Aquaculture Network website: http://www.cimtan.ca/. An overview on improved other salmon aquaculture management practices is given in the report cited in Note 92.

100. Basic information on the red tide and paralytic shellfish poisoning caused by *Alexandrium* species is given at https://www.whoi.edu/redtide/human-health/paralytic-shellfish-poisoning and http://en.wikipedia.org/wiki/Paralytic_shellfish_poisoning

101. Sochasky, L. 2003. Preliminary findings on the potential mortality of wild Atlantic salmon (*Salmo salar*) as a result of exposure to phytoplankton blooms in the Bay of Fundy, August-September 2003. St. Croix International Waterway Commission. St Stephen, New Brunswick and Calais, Maine.

102. Select papers on cypermethrin toxicity to other crustaceans. Shrimp and lobster: Haya, K., L.E. Burridge and B.D.Chang. 2001. Environmental Impact of chemical wastes produced by the salmon aquaculture industry. ICES Journ. Mar. Sci. (2001) 58:492-496. http://icesjms.oxfordjournals.org/content/58/2/492.full.pdf. Sea urchins: Gartnestein, Simon, Rosanne G. Quinnell and Anthony W.D. Larkum. 2006. Toxicity effects of diflubenzuron, cypermethrin and diazinon on the development of *Artemia salina* and *Heliocidaris tuberculata*. Aust. Journ. Ecotoxicity (2006) 12:83-90. http://www.ecotox.org.au/aje/archives/vol12p83.pdf. Marine plankton: Medina, Matais, et al. 2004. Effects of cypermethrin on marine plankton communities: a simulated field study using mesocosms. Ecotoxicol. Environ. Saf. (2004) 58(2):236-245. http://www.ncbi.nlm.nih.gov/pubmed/15157578

103. Saint John Times Globe. 1996. Salmon farmers' deadly chemical 'cookbook': lawyer says memo tells growers how to kill pests with banned compound - and get away with it. From NB Telegraph Journal Archives, *http://archives.nben.ca/environews/media/mediaarchives/96/kill.htm*

104. CBC News – New Brunswick. February 17, 2010. Fundy lobster deaths blamed on pesticide. http://www.cbc.ca/news/canada/new-brunswick/story/2010/02/17/nb-lobster-fund-pesticide-1209.html

105. One recent report. BBC News (UK), Highlands and Islands Edition. November 7, 2012. Sea lice killing 'large numbers' of salmon. http://www.bbc.co.uk/news/uk-scotland-highlands-islands-20236291

106. A general backgrounder on ISA and other impacts on wild salmon: http://0101.nccdn.net/1_5/1ba/228/251/aquaculture-backgrounder2012-2.pdf. Herring and cod can be carriers of ISA, although not lethally affected: http://www.cfsph.iastate.edu/Factsheets/pdfs/infectious_salmon_anemia.pdf

107. This backgrounder by the Atlantic Salmon Federation chronicles $100 million in disease compensation paid to the region's salmon aquaculture industry http://0101.nccdn.net/1_5/2a6/300/167/compensation3.pdf

108. CBC –New Brunswick. January 28, 2013. CFIA switches gears to preventing deadly salmon virus: Infectious salmon anemia is deadly to fish, but is not a risk to human health. http://www.cbc.ca/news/canada/new-brunswick/story/2013/01/28/nb-infectious-salmon-anemia-prevention-730.html. Also CFIA Fact Sheet on ISA http://www.inspection.gc.ca/animals/aquatic-animals/diseases/reportable/isa/fact-sheet/eng/1327198930863/132719921951

109. A useful and insightful study. Wiber, Melanie Gay, Sheena Young and Lisette Wilson. 2012. Impact of Aquaculture on Commercial Fisheries: Fishermen's Local Ecological Knowledge. Hum. Ecol. 40:29-40. http://link.springer.com/content/pdf/10.1007/s10745-011-9450-7#page-1

110. The Southwest New Brunswick Marine Resource Planning Initiative, discussed later in this section, is pursuing means to better integrate ecological, social and economic needs for the local marine area.

111. Bay of Fundy Ecosystem Partnership. 1996. The Rockweed Forest. Fundy Issues #4. Autumn. 1996. http://www.bofep.org/rockweed.htm

112. Campbell, Patrick. 1792. Travels in the Interior Inhabited Parts of North America in the Years 1791 and 1792. Edinburgh, Scotland. Excerpts from his writings about the local rockweed (kelp) potential, on p. 363-365: "The whole of this extensive shore is covered with kelp ware, and yet never an ounce of kelp was made here, or in any part of this country. It often occurred in going along these bays, that it would be a good speculation to bring a parcel of kelpmakers from Scotland". "…if kelp were to sell anything near to what we have seen it in Britain, I am perfectly satisfied that whoever should try this experiment would find it answer probably beyond his expectations." http://ia600404.us.archive.org/11/items/travelsininterio00camp/travelsininterio00camp.pdf

113. Ugarte, Raúl A., and Glyn Sharpe. 2001. A new approach to seaweed management in Eastern Canada: the case of *Ascophyllum nodosum*. Cah. Biol. Mar (2001) **42**:63-70. http://www.acadianseaplants.com/_mm_files/ckfiles/images/files/Full%20Report%20A%20new%20approach%20to%20seaweed%20management.pdf

114. Acadian Seaplants Ltd. webpage: Acadian Seaplants' Best Practices. http://www.acadianseaplants.com/marine-plant-seaweed-manufacturers/resource-management

115. Ugarte, Raúl A. 2011. An evaluation of the mortality of the brown seaweed *Ascophyllum nodosum* (L.) Le Jol. Produced by cutter rake harvests in southern New Brunswick, Canada. J. App. Phycol. (2011) **23**:401-407. http://link.springer.com/article/10.1007%2Fs10811-010-9574-y#page-2

116. Sutherland, Beau C. 2005. An Independent Study and Review of the New Brunswick Rockweed Harvest: Phase 2. Eastern Charlotte Waterways Inc.. Blacks Harbour, New Brunswick. http://www.ecwinc.org/Publications/Entries/2011/6/8_Marine_files/Rockweed2005.pdf

117 Find additional information on the Port of Bayside on its website: http://portofbayside.com/

118. Eastern Charlotte Waterways Inc. 2002. Community Emergency Response Resource Guidebook: A Directory of Information for the Protection of Coastal Waters Affecting the St. Croix Estuary, Passamaquoddy Bay and South-Western New Brunswick. St. George, New Brunswick. http://www.uscg.mil/d1/response/jrt/documents/community%20resource%20guides/Western%20Charlotte.pdf

119. Information on the Canada-United States Joint Marine Pollution Contingency Plan (CANUSLANT) and reports on its past biennial oil spill exercises are available at http://www.uscg.mil/d1/response/jrt/plans.asp

120. In 2005, the Atlantic Pilotage Authority contracted a Pilotage Risk Management Methodology (PRMM) study to determine whether there was a need to set a federal requirement that pilots be compulsory for large vessels transiting to and from the Bayside Port. Extensive local assessments, and some recommendations, are included in the PRMM final report on file with the Atlantic Pilotage Authority. For further information, contact the Authority via www.atlanticpilotage.com

121. Seeking to capitalize on U.S. energy markets in the early 2000s, three liquefied natural gas (LNG) projects were proposed for the Maine side of the St. Croix estuary/Passamaquoddy Bay area in 2005-2006: Quoddy Bay LNG (10km southwest of the St. Croix estuary), Downeast LNG (directly opposite St. Andrews) and Calais LNG Project (directly opposite Bayside). All of these initiated U.S. federal and state licensing processes, the federal component of which requires a positive U.S. Coast Guard waterway suitability (i.e. vessel passage) assessment. The projects received positive waterway assessments, dependent on compliance – to be approved by the USGS – with a long list of conditions and requirements, which include Canada's agreement to allow LNG vessel transit through Canadian sovereign waters to reach the proposed Maine terminal sites. Canada has clearly stated that this will not be forthcoming. Two of the three projects (Quoddy and Calais) have now been abandoned. At 2013, Downeast LNG is still proceeding through the U.S. Federal Energy Regulatory Commission licensing process. The most recent FERC report on this application (March 2013) indicates that, if approved, construction will not be authorized without all necessary U.S. and Canadian approvals in place.

122. For Transport Canada ballast water exchange information see these sites for first a summary and then the details: http://www.tc.gc.ca/eng/marinesafety/oep-environment-ballastwater-management-1963.htm and http://www.tc.gc.ca/eng/marinesafety/tp-tp13617-preface-2086.htm

123. This site provides details on Canada's ban on the marine use of TBTs: http://www.ec.gc.ca/toxiques-toxics/Default.asp?lang=En&n=98E80CC6-1&xml=C608DAAE-83F2-4C73-B669-365619C3474D

124. See pages 40-42 of the plan cited in Note 3.

125. Dejardins, Pierre-Marcel. 2007. Economic Impact of Lobster Sector – Province of New Brunswick and Its Counties. Prepared for and posted by the Province of New Brunswick at: http://www.gnb.ca/9999/Publications/lobster.pdf

126. Sochasky, L. 2009. St. Croix Anadromous Fisheries Program: 2008 Report. St. Croix International Waterway Commission. St. Stephen, New Brunswick and Calais, Maine.

127. Oak Bay was classified as Conditionally Approved for clam harvesting, beginning in 2000. This allowed for public and commercial clam digging at times when testing showed that federal shellfish sanitation criteria were being met. (See more details at) In 2002, due to reduced testing, the area was restricted to harvesting under depuration licence only (clams taken under these licenses are held in disinfected seawater to filter out pollutants and bacteria in their system, and then tested, before marketing). Testing at Oak Bay was expanded in 2012, to allow a return to open digging when sanitation criteria are met. More information on the Canadian Shellfish Sanitation Program (CSSP) is at: http://www.inspection.gc.ca/food/fish-and-seafood/shellfish-sanitation/eng/1299826806807/1299826912745

128. St. Croix International Waterway Commission. 1997. 1997 Oak Bay Project. St. Croix International Waterway Commission. St. Stephen, New Brunswick and Calais, Maine.

129. See the Background section of the Initiative's website: http://www.bofmrp.ca/home/

130. Download the "Preferred Future of the Bay" report at http://www.bofmrp.ca/home/index.php/phase2/reports/

131. See information on this Committee's mandate, membership, operating procedures and guiding community values at: http://www.bofmrp.ca/home/index.php/Marine_Advisory_Committee/

132. Click the community input icon at the bottom of each page of the SWNBMAC website (enter at http://www.bofmrp.ca/home/index.php) to send comments and suggestions for committee action.

Informed Stewardship

133. See http://en.wikipedia.org/wiki/Industrial_Revolution for an overview of the history and impacts of the Industrial Revolution

134. See the EcoAction website: http://www.ec.gc.ca/ecoaction/

135. Visit the ACAP/AEI website at: http://www.ec.gc.ca/iea-aei/default.asp?lang=En&n=AE53A7A0-1

136. *Take Action for the Environment* website: http://www.ec.gc.ca/education/Default.asp?lang=En&n=E413CCE7-1

137. The N.B. Environmental Trust Fund is posted at: http://app.infoaa.7700.gnb.ca/gnb/Pub/EServices/ListServiceDetails.asp?ServiceID1=13136&ReportType1=ALL

138. The N.B. Wildlife Trust Fund website: http://www.nbwtf.ca/eindex.asp

139. The Efficiency NB website: http://www.efficiencynb.ca/home.html

140. See Note 76.

141. Results of first 2009 N.B. Mayor's Eco-Challenge (cities): http://www2.gnb.ca/content/gnb/en/news/news_release.2009.06.0807.html

142. The second 2009 NB Mayor's Eco-Challenge (towns): http://www.gnb.ca/cnb/news/env/2009e2004ev.htm

143. Background on New Brunswick's Family Eco-Challenge pilot project: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/take_the_family_eco-challenge.html

144. See http://www.huntsmanmarine.ca/

145. See www.ganongnaturepark.org/

146. See information on the Coastal Livelihoods Trust at: http://www.gulfofmaine.org/gomt/?p=436

147. See http://www.sunburyshores.org/

148. See http://www.naturetrust.nb.ca/wp/

149. See http://www.paddlefestnb.ca/wp/

150. NTNB has four Nature Preserves in the St. Croix estuary area: Navy Island, Pagan Point, Caughey-Taylor and Dick's Island. At http://www.naturetrust.nb.ca/wp/, click on the St. Croix area icons on the Preserve map to see details on these

151. These include municipal parks and shore accesses in St. Andrews and St. Stephen; Parks Canada's Saint Croix Island International Historic Site and New Brunswick's St. Croix River Provincial Park (undeveloped) at Bayside; and traditionally-accessible but non-public scenic outlooks at Chamcook Mountain and Simpson's Hill.

152. The Falls Brooke Centre in Knowlesville (http://www.fallsbrookcentre.ca/) and Cape Jourimain Nature Centre in Bayfield (http://www.capejourimain.ca/) are the province's two present sustainability demonstration centres