Gulf of Maine Council on the Marine Environment
Celebrating 25 years of action for a healthy environment

Municipal Climate Change Adaptation around the Bay of Fundy: Status and Needs

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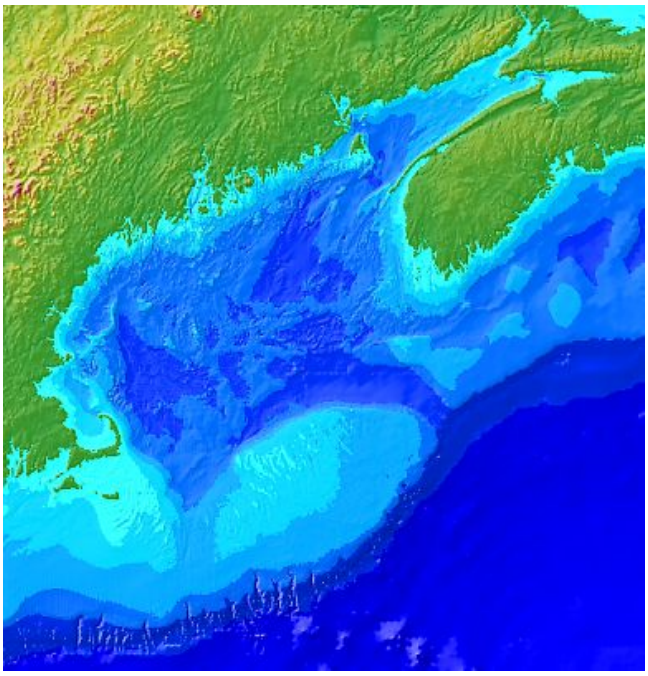
About the Gulf of Maine

The Gulf of Maine is a sea within a sea, bounded by the coastlines of Massachusetts, New Hampshire, Maine, New Brunswick, and Nova Scotia. The Gulf and its shoreline, which includes the Bay of Fundy, represent one of the world's most biologically productive environments, hosting 2,000 species of plants and animals. The Gulf's watershed encompasses a total land area of 179,008 square kilometers (69,115 square miles). Scientific research shows that the region is experiencing warmer average air and sea temperatures, more variable and volatile weather, and increased acidification of Gulf waters.



About the Gulf of Maine Council on the Marine Environment

The Gulf of Maine Council (GOMC), a US-Canadian partnership, has worked for 25 years to help ensure the environmental health and sustainability of the Gulf and its watershed. The GOMC Climate Network brings together planners and scientists from around the Gulf of Maine to raise awareness about climate impacts and inspire effective action in local communities — where residents experience first-hand the effects of changing conditions. The Network's approach is collaborative and regional, engaging participants across borders to address shared concerns—such as sea-level rise, extreme weather events, and ocean acidification.

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Executive Summary

Communities around the Gulf of Maine and Bay of Fundy are trying to prepare for a future where climatic and ecological conditions may be far less predictable than in recent generations. This study summarizes adaptation measures that municipalities have taken to date, actions they are planning, and resources they need to move forward.

Environment Canada's Health of the Oceans Program funded this research, and the Gulf of Maine Council on the Marine Environment (GOMC) Climate Network completed the study early in 2014. The Climate Network distributed a survey to 37 Bay of Fundy communities (33 of which completed it), and conducted phone interviews with 31 municipal and regional officials. Participants identified five interconnected factors as their primary climate concerns: extreme weather, hurricanes/high winds, inland/freshwater flooding, sea-level rise, and storm surge. The areas of municipal functioning deemed most vulnerable to these impacts were transportation infrastructure and accessibility, stormwater management, wastewater infrastructure, and emergency management.

The vast majority of municipalities are engaged in climate adaptation planning, but less than one-fifth characterize that effort as "active implementation"—with one-third having approved plans but minimal implementation, and another third still in preliminary discussions or plan development. Most of the communities surveyed have completed some assessments to guide planning, particularly in terms of flooding impacts/stormwater management (85 percent), and sea-level rise and storm surge (both roughly two-thirds). Nearly all of the communities reported having both flood mapping and zoning in place or planned that may help mitigate climate impacts. Two-thirds are actively working or planning to improve stormwater management as well.

To date, the municipalities surveyed have sought climate adaptation guidance primarily from provincial agencies and peer networks, with federal agencies and university researchers also a significant resource. In certain areas, regional entities such as planning agencies, nongovernmental organizations, and the Atlantic Climate Adaptation Solutions Association have played a pivotal role in supporting individual municipalities, generating valuable data and encouraging collaboration. Many communities cited the critical support lent by the Regional Adaptation Collaborative (a federal cost-sharing initiative that operated between 2008 and 2012) in jumpstarting climate adaptation planning and providing essential research. Those who had gotten LiDAR data through that program found it of great benefit, and nearly all the study participants voiced a need for further provincial support of LiDAR mapping.

A combination of factors—limited staff time and expertise, stretched budgets, and lack of jurisdictional authority—make it difficult for municipalities to address even well-documented vulnerabilities to climate change. There is strong interest in more ecosystem-based approaches to adaptation, particularly green/living shorelines and sustainable stormwater management techniques, and some municipalities are actively pursuing the latter. In terms of the coastal zone, which falls outside their jurisdiction, municipalities seek both education and active management support from provincial government.

Introduction

Communities in the Gulf of Maine watershed face many challenges in climate preparedness, and foremost among them are lack of staff time and lack of money. Among the 33 Bay of Fundy communities that participated in the GOMC Climate Network survey, 79 percent of respondents cited inadequate funds and 73 percent cited lack of staff time as constraints limiting progress in climate change adaptation.

That finding echoed the results of a 2010 study of New Brunswick municipalities conducted by Mount Allison University's Small and Rural Town Programme, entitled *Capacity for Climate Change Adaptation in New Brunswick Municipalities*. According to report authors Stephanie Merrill and Gwen Zwicker:

> *Almost half of municipalities felt that their municipalities could commit staff time to work on adaptation planning and staff time to implement adaptation plans, strategies and activities. Fewer were willing to commit funds for planning or implementation and some were unwilling to commit any resources at all. It is unclear, however, if municipalities are actually "unwilling" to commit, or perhaps more likely, "unable" to commit resources (p. 21).*

Recognizing that these constraints limit many municipalities, a 2013 study in the US sponsored by the National Oceanic and Atmospheric Administration (NOAA) and Sea Grant set out to find cost-effective climate adaptation measures that communities have successfully implemented—particularly ones focused on coastal hazard management. Two NOAA-funded graduate fellows, Michael Brady and Judd Schechtman, spent 15 months compiling and summarizing data from 35 communities (spanning from Maine to Virginia) based on personal interviews and review of relevant municipal policies and bylaws. The resulting 232-page report, *Cost-Efficient Climate Change Adaptation in the Northeast*, provides a compendium of climate adaptation measures already in use by municipalities (with cost identified in three categories: very low (≤1,000 USD), low (≤10,000 USD), or medium (≤100,000 USD). Examples from the states of Massachusetts, New Hampshire and Maine are summarized in Appendix B.

The GOMC Climate Network study sought to identify climate adaptation measures (particularly low-cost and ecosystem-based ones) in use or in development among municipalities bordering the Bay of Fundy in New Brunswick and Nova Scotia. (Some respondents have drawn planning lessons from the Northumberland Strait region where communities have extensive experience battling erosion, but a review of techniques employed there was beyond the scope of this study.)

Several municipalities—particularly larger ones—are taking innovative approaches to climate-related challenges in the areas of stormwater management and floodplain zoning. These tools are described in the municipal interviews and arranged by topic in Appendix A (and summarized in Figure C on page 11). Most Bay of Fundy communities are still trying to determine how best to approach climate-related challenges and muster the resources to address their priority concerns. The GOMC Climate Network research did identify common themes (outlined in the Results and Discussion section) that could help foster a more coordinated approach to adaptation planning across all levels of government.

Background

Past and current federal and provincial initiatives have helped shape the climate adaptation efforts underway in municipalities around the Bay of Fundy. Many communities began focusing on climate adaptation with support from Natural Resources Canada's Regional Adaptation Collaboratives (RACs), which sought to "move science into action" by developing new tools and networks. Many study participants reported that the RAC for Atlantic Canada was instrumental in providing data for decision-making, linking communities, and creating a valuable compilation of research studies that continue to be referenced by municipal officials. This three-year, cost-shared initiative ended in 2012 (although reports are still available on its website at www.atlanticadaptation.ca). New Brunswick also lost its Climate Change Public Education and Outreach Hub in 2012, which had provided resources and support for twelve years.

New Brunswick communities are undergoing a transition now from smaller regional planning districts to Regional Service Commissions (which encompass a much larger area—just three RSCs span New Brunswick's Bay of Fundy shoreline). They currently coordinate shared services like waste management and land use planning, but are awaiting directives from the Province about what will be included in regional plans.

With guidance provided by Service Nova Scotia, most municipalities in Nova Scotia have completed a Municipal Climate Change Action Plan (MCCAP) in order to remain eligible for federal gas tax funds. Each community received a guidebook to facilitate development of its plan. Some communities took this opportunity to engage in a careful review of risks and vulnerabilities (sometime relying on the services of consultants—given limited staff time and expertise), and some have begun to incorporate measures from the MCCAP into municipal plans and bylaws. Yet even those municipalities that have developed comprehensive MCCAPs indicate that budgetary constraints could thwart implementation.

While climate preparedness measures could help towns avoid significant future costs (one US study suggests that every dollar invested in preventive action can save four dollars in disaster response), most Bay of Fundy communities are still struggling to recover from a prolonged recession. According to an NGO staffer who works extensively with municipalities, "the Atlantic region is facing major challenges with economic development and job creation, youth outmigration, and costs associated with newly mandated secondary wastewater treatment systems." Many of the municipal representatives interviewed for this study understand the economic benefits of anticipatory planning and propose modest adaptation measures to their Councils. But frequently those requests are denied. In some cases, the Councillors recognize the value of the proposed measures, but cannot prioritize actions with longer-term returns when faced with many immediate needs.

Results and Discussion

The GOMC Climate Network distributed its survey to 37 Bay of Fundy communities, 33 of which completed it (an 89 percent response rate). Thirty-one follow-up phone interviews amplified findings from the survey. Those conversations are summarized in the following section, and responses to survey questions—collated by province—appear in Appendix C.

Survey respondents identified five leading climate-related concerns (all interconnected):

- extreme weather;
- hurricanes/high winds;
- inland/freshwater flooding;
- sea-level rise; and
- storm surge.

Areas of municipal functioning deemed most vulnerable to climate impacts included

- transportation infrastructure and accessibility;
- stormwater management;
- wastewater infrastructure; and
- emergency management.

Less than one-fifth of survey respondents characterize local climate adaptation as being in an "active implementation" mode, with one-third having approved plans but minimal implementation, and another third in preliminary discussions or plan development. Most of the communities surveyed have completed some assessments to guide planning, particularly in terms of flooding impacts/stormwater management (85 percent), and sea-level rise and storm surge (both roughly two-thirds). Nearly all of the communities report having both flood mapping and zoning in place or planned that may help mitigate climate impacts. Two-thirds are actively working on or planning better stormwater management as well. Only a few municipalities have been able to undertake any cost-benefit analyses so most lack economic data on which to base decision-making.

To date, the municipalities surveyed have sought climate adaptation guidance primarily from provincial agencies and peer networks, with federal agencies and university researchers also a significant resource. In certain areas, regional entities such as planning agencies, nongovernmental organizations, and the Atlantic Climate Adaptation Solutions Association (ACASA) have played a pivotal role in supporting individual municipalities and fostering knowledge-sharing. These collaborative networks appear to act as a strong catalyst for adaptation planning—bringing in needed scientific expertise; funding valuable data (like LiDAR maps); facilitating community engagement; and offering municipal staff support in planning.

Both southwestern New Brunswick (with support from the St. Croix Estuary Project and Eastern Charlotte Waterways) and southeastern New Brunswick (with support from RSC7 and EOS Eco-Energy) benefit from extensive regional collaboration. Another regional collaborative, Kings 2050 in Nova Scotia, grew organically from the shared needs and concerns of four interlinked municipalities. Through a regional planning effort that included preparing a joint Municipal Climate Change Adaptation Plan, the four communities are considering shared land-use challenges such as floodplain management and inundation threats.

Strong collaboration is evident in the peer-to-peer network that operates among municipal staff, facilitated by organizations such as the Union of Nova Scotia Municipalities, Association of Municipal Administrators—Nova Scotia and the Association of Municipal Administrators of New Brunswick. Their gatherings and list-servs encourage sharing of questions and experiences as municipalities work on climate preparedness. Some communities (such as ones in the Tantramar region of New Brunswick) gain additional support by participating in the Federation of Canadian Municipalities' Partners for Climate Protection Program.

Among sources for guidance on climate change mitigation and adaptation, the peer network is topped only by provincial agency staff (noted by 94 percent of respondents). Numerous municipal officials acknowledged the valuable resources offered by provincial staff, while reiterating their ongoing need for further support at both provincial and federal levels.

Municipal respondents noted that their communities can integrate climate adaptation into local zoning and bylaws, undertake modest infrastructure upgrades, and conduct general educational outreach. However, they cited numerous examples of climate preparedness that fall beyond the scope of their jurisdiction, expertise and/or funding capacity. Examples included:

- lack of jurisdiction over the historic dykes (maintained by provincial departments of agriculture) that could be overtopped or breached with increased sea-level rise and storm surge, damaging residences, businesses and municipal infrastructure and endangering residents;
- lack of jurisdiction over a shoreland zone that increasingly needs erosion control measures (and where poorly engineered shoreline hardening measures can exacerbate both ecological and management problems);
- lack of jurisdiction or expertise to investigate options for restoring saltmarshes in historically dyked areas (or to assess their capacity relative to dykes for buffering inland areas from storm surge)
- lack of expertise or capacity to educate private shoreland owners about ecologically sound erosion control measures (such as those outlined on the Massachusetts' StormSmart Properties website);
- lack of financial capacity to undertake extensive infrastructure replacement needed to accommodate higher volumes of precipitation and increased sea levels;
- lack of financial capacity to assemble LiDAR data needed for mapping and modeling;
- lack of jurisdiction over roads that provide vital access to communities but are increasingly vulnerable to flooding and washouts;
- lack or jurisdiction over privately owned dams (in New Brunswick) that could exacerbate flooding downstream; and
- lack of time to compile detailed guidance on stormwater management tools and concrete design specifications for contractors.

Municipalities that face a combination of these challenges can find it difficult to address even the most readily apparent climate-related concerns. Adaptation measures may be postponed unless an extreme weather event moves them abruptly to the top of the municipal agenda. Many study participants noted that a major storm event helped instigate more concerted adaptation planning. As one municipal official noted, "that storm really brought things home."

Some communities have had success with a more pro-active approach by using inundation maps to raise awareness about the potential costs of inaction. An ACASA research study done in the Tantramar region confirmed that any visual depictions of impacts (they need not be animated computer models) can increase residents' awareness and change perspective (presumably increasing motivation to act). Many municipal officials recognize the value that detailed maps afford—both for planning and public outreach, and seek greater provincial support for LiDAR mapping within their communities.

Among those interviewed for this study, awareness of climate threats and motivation to act is strong. Many feel stymied, though—by lack of resources and, in about one-third of the communities, by lack of broader concern and political will among local residents. Several survey respondents voiced a strong desire that their local efforts to be mirrored by stronger leadership at provincial, federal and international levels—reducing greenhouse gas emissions, promoting renewable energy, and helping industries prepare for the challenges ahead. They would like to see awareness and action at every level, and stronger collaboration among those levels to help accelerate the pace of climate adaptation.

Figure A

Municipal Constraints to Active Climate Adaptation:

- Budgetary constraints due to eroding tax base (aging housing stock, youth outmigration and limited development)
- Pressing short-term budgetary demands preclude long-term investments
- High-cost competing requirements (*e.g.,* wastewater treatment or infrastructure upgrades)
- Lack of jurisdictional authority (*e.g.,* over roadways subject to flooding, eroding shorelines, or dykelands that affect the flow of both tidal waters and freshwater runoff)
- Lack of expertise (*e.g.,* modelling, engineering, hydrology, behavioral change)
- Lack of staffing capacity (in smaller communities) to implement even those planning measures already enacted
- Existing staff oversubscribed with multiple demanding roles (*e.g.,* one person serving as development officer, fire chief, EMO coordinator and building inspector)
- High property values of waterfront real estate make rezoning challenging
- Lack of adequate LiDAR mapping and "downscaled" data depicting impacts under different sea-level rise/flooding/storm surge scenarios
- Lack of widespread public concern (in some communities), generating the political will to implement adaptation measures

Figure B

Forms of Provincial Support that Municipalities Need

- Improved coordination and communication with municipalities concerning resources under provincial jurisdiction that profoundly affect municipal functioning (*e.g.,* roadways, dykelands and the coastal zone)
- Risk assessments for existing roads, dykelands and other public infrastructure jeopardized by climate change impacts
- Further research on the impacts of sea-level rise and ocean acidification on marine ecosystems and fisheries
- Data on potential economic impacts and cost-benefit analyses to guide decision-making
- Scientific and planning expertise and support applied at the community level (such as ACASA provided)
- Links to larger networks of those engaged in climate preparedness and shared training experiences
- Further education on ecosystem-based approaches to adaptation (particularly approaches to stormwater management and coastal erosion)
- More active, regional management of eroding coastlines (and approaches to dyke management that consider the economic and social vulnerability of nearby communities)
- Financial support (*e.g.,* through a matching grant program) of expanded LiDAR mapping
- Loan funds to support building efficiency improvements
- Grants to support major infrastructure upgrades needed to cope with climate impacts
- Educational materials that municipalities could customize and use with residents providing guidance in areas such as stormwater design techniques and shoreline erosion control (as well as educational workshops for the public)
- Support of regional collaboration and information-sharing, and potentially more formalized agreements to address shared concerns (*e.g.,* compensation to towns that provide emergency services to outlying populations)
- Coordination with private dam owners to minimize downstream flooding in extreme weather events
- Compilation of examples (*e.g.,* bylaw changes) illustrating low-cost adaptation measures available to small, rural communities
- Sharing of information across borders (municipal, provincial and national)
- Engagement of more stakeholders across sectors (*e.g.,* real estate, insurance, natural resource industries, transportation) in regional climate adaptation planning

Figure C

Summary Table of Municipal Adaptation Tools Currently In Use

This chart summarizes some of the tools (identified through interviews) that municipalities around the Bay of Fundy are currently using that can help mitigate climate impacts. Appendix A provides further explanations of these tools, and the hyperlinks connect to municipal documents that offer details.

Stormwater Practice	Examples
"Zero net runoff" requirement	St. John, NB and Dieppe, NB
Conservation buffer by waterways	Moncton, NB
Limiting impervious cover in construction zones	Truro, NS
Increasing municipal pipe diameters 20 percent	Dieppe, NB
Bylaw specifying lot grading and drainage	East Hants, NS
Use municipal land to test low-impact techniques	Colchester, NS

Flood Protection	
Minimum floor elevation requirements	Dieppe, NB
Zoning the precludes openings below a certain elevation or prohibits mechanical/elec. in basements	Sackville, NB
Offer backwater valves in municipal sewerage areas	Moncton, NB
Educate residents through online maps and guides	Moncton, NB and Kings County, NS

Municipal Interviews

The summaries that follow—representing nearly all of the communities surveyed—appear in geographic order moving eastward around the Bay of Fundy from the St. Croix region in southwestern New Brunswick to the Cape Sable region off southernmost Nova Scotia. The semi-structured phone interviews included questions asked of every community and questions specific to its survey. Climate adaptation measures cited in these interviews are summarized—for ready reference—in Figure C (page 11) and Appendix A (page 34). While the vast majority of interviews were with municipal staff (including chief administrative officers, mayors, planning directors, development officers and one councillor), two interviews in New Brunswick were conducted with regional planners and one with an NGO representative who has done adaptation planning with multiple communities.

Southwest New Brunswick Service Commission

The Southwest New Brunswick Service Commission (SNBSC), formed in January 2013, is one of 12 Regional Service Commissions (RSCs) the Province created as part of a new plan for local governance. The province's southernmost Commission has eight municipalities with roughly half the region's population in small towns and half in outlying areas (known as local service districts). (Some of these municipalities overlap with those involved in another regional initiative—described in the subsequent summary on page 13.) Outlying areas traditionally have had limited access to planning support, and the RSCs are designed to help provide that. Participating SNBSC communities have little previous experience with regional cooperation, having collaborated only on waste management. The RSCs have no mandates concerning climate adaptation but some are considering actions in the coming year on wetlands mitigation and flood risks.

SNBSC Director of Planning, Dan Harrington, notes that municipal responses to climate impacts have—to date—largely been reactions to extreme events. The initial focus has been on emergency management, but he anticipates that more preventive measures may be incorporated in coming years as communities update municipal plans and emergency response plans. "All the current infrastructure—from transportation to wastewater treatment—was based on certain assumptions," he says, "and with climate variability and volatility, many of those no longer apply."

It's hard for municipal leaders to focus on these considerations, though, unless concerns are imminent. "When you know you're at risk," Harrington observes, "that changes your attitude." The electric grid is receiving attention now because of widespread outages this winter that left residents without power for up to two weeks. But "it's amazing how quickly people forget," he notes, "if they weren't directly affected."

Smaller communities may model actions after larger municipalities—like Moncton and St. Andrews—that are at the forefront of flood risk assessment and planning, but they face added challenges with restricted budgets and limited staffing. Some smaller communities do not have up-to-date municipal plans and lack the capacity to implement existing planning measures. With old housing stock, little new development, and eroding tax bases, their resources are stretched thin. And new measures—such as updated wastewater regulations—demand additional funds.

"They're expected to do so much more with so much less," Harrington notes. "To make headway with adaptation planning, they will need more funding and professional support."

Harrington would like to see more examples and case studies of low-cost adaptation measures taken by small, rural communities. In his region, some of those receive "hands-on help" from NGOs (see profile of St. Croix Estuary Project Regional Collaboration), but many lack access to basic tools such as LiDAR maps (due to the prohibitive cost).

St. Croix Estuary Regional Collaboration (involving the NGO St. Croix Estuary Project and St. Andrews, St. Stephen, St. George, Blacks Harbour and Grand Manan), New Brunswick

Following the 2010 storms that caused extensive flooding in southwestern New Brunswick, the St. Croix Estuary Project (SCEP)—a community-based nongovernmental organization—recognized the need to take a more pro-active approach to climate adaptation. "Beyond disaster assistance, someone had to take the lead on planning," says SCEP Director Kim Reeder, "and that's hard for small and underfunded municipalities with staff already stretched beyond their limits." After discussions with two other regional entities (the St. Croix International Waterway Commission and Eastern Charlotte Waterways), SCEP began facilitating a process helping five towns discuss climate preparedness.

The participating communities had markedly different concerns and approaches, Reeder notes, depending on how dramatically they had already felt climate change impacts. Two communities that had not experienced major flooding or erosion were primarily concerned with trends like warming ocean water temperatures and the spread of invasive species. If they pursue any next steps, they may explore economic diversification—working to reduce their dependence on particular species and industries.

St. Stephen, having coped with major flooding, focused primarily on disaster risk reduction and response to future crises. St. Andrews is working to engage more citizens in understanding and discussing future climate impacts (see previous summary). None of the participating communities are making changes to bylaws yet, Reeder says, but SCEP is looking at models from towns like Beaubassin East, New Brunswick (which has now mandated that any new construction be located 1.4 meters above the projected 2100 sea level). SCEP is also gathering examples of building code changes that could facilitate climate preparedness (such as not situating mechanical/electrical systems in basements).

Until SCEP hired consultants to help model water flows in the region, it was limited by a lack of region-specific information. "Information needs to be downscaled," Reeder notes. SCEP is working with institutes, organizations, industry and others to encourage the sharing of relevant data and the setting of uniform standards as New Brunswick's new Regional Service Commissions will need a breadth of data for effective adaptation planning.

Reeder would welcome improved information-sharing and coordination of adaptation planning efforts, particularly across borders. Communities in Washington County, Maine, for example—just to the south of SCEP's region, undertook similar mapping work and vulnerability assessments, but SCEP has not yet benefitted from their experience. She'd also like to see more communication with a broader base of stakeholders—like real estate, insurance, forestry and other industries that need to be at the forefront of climate adaptation.

Based on SCEP's experience to date, Reeder says, there's a critical need for more economic analyses to help guide municipal adaptation planning—helping communities determine which measures offer the best return on investment. Those numbers are vital to shifting the focus from disaster response to pro-active planning that could reduce both the economic and social costs of climate change. SCEP also hopes to facilitate more study of ecosystem services in the region and how those may be affected by climate change.

Town of St. Andrews, New Brunswick

Two storms with intense precipitation and storm surge late in 2010 helped persuade residents of St. Andrews, a peninsula town, of the need to plan responses to sea-level rise and more frequent extreme storms. When trying to assess its future capacity for stormwater management, town officials quickly realized the need to better understand what they had and how it was functioning. They soon discovered, says Mayor Stan Choptiany, "220 years of mistakes in infrastructure design," with cross-connections between sewer and stormwater, supersaturated soils forcing water into building basements, and many sewer lines and culverts in critical need of replacement. An abandoned municipal dump near the shore will erode more with sea-level rise, possibly exposing hazardous waste requiring remediation.

St. Andrews, New Brunswick in a November 2010 storm that brought up to 13 cm. (5 in.) in a 24-hour period.

The community began by looking at regional sea-level rise projections, relying primarily on two ACASA reports prepared for New Brunswick: Sea-level Rise and Coastal Flooding Estimates for New Brunswick Coastal Sections; and Local Government, Sustainability and Climate Change: A Resource for Elected Municipal Officials in New Brunswick. Having factual, dispassionate sources of scientific information helped people visualize the extent of flooding impacts in coming decades.

Recognizing the high costs of inaction, the Town of St. Andrews budgeted $185,000 for an extensive stormwater management plan (to be completed in Spring 2014) that relies on LiDAR

mapping to establish flow patterns, and proposes measures for mitigation. Dedicating this sum to adaptation planning was challenging, Choptiany concedes, given competing municipal needs. But funding will become a far larger issue with outdated and failing infrastructure. The price tag for replacing just three below-capacity sewer lines (each less than 1.5 miles) in St. Andrews will run more than $800,000. Many new culverts are needed, too, given storms that can now dump up to 13 cm. (5 in.) in a 24-hour period. The tab for all the needed work, Choptiany estimates, could rise to $10-15 million.

For St. Andrews, lack of funding is the primary constraint to advancing climate preparedness. The community has many assets that are helping to propel the Town's process: engaged and concerned citizens willing to work on problem-solving (with a strong representation of scientists on town committees, given two marine research stations in town); collaborative sharing of knowledge and resources within the community and the larger Regional Service Commission; and beneficial partnerships with NGOs like the St. Croix Estuary Project (SCEP). Implementing its new Stormwater Management Plan, though, will take significant support from provincial and federal sources.

St. Andrews plans to begin looking at by-law/zoning changes as well, particularly in parts of its historic district already vulnerable to flooding. SCEP is helping the Town in this process, drawing on municipal examples from Northumberland Strait. It will be a sensitive process, with much expensive and historic real estate along the shorefronts likely to experience the most extensive flooding. Choptiany hopes that further public education and engagement will help facilitate progress.

Town residents are encouraged to see growing regional and province-wide attention to the potential impacts sea-level rise could have on estuarine habitats in the Bay of Fundy. "These marine habitats are key to our fisheries and economy," Choptiany says.

Town of St. George, New Brunswick

St. George is updating its Emergency Response Plan, identifying where it's most vulnerable to climate impacts such as floods. The St. Croix Estuary Project (see previous summary) helped provide St. George with LiDAR data covering part of the community. Sean Morton, who serves as the town's EMO Coordinator, Assistant Development Officer and Fire Chief, would like LiDAR data covering a broader area, including a dammed lake that strongly influences local flooding. He'd welcome more provincial support with mapping, given its high cost.

Morton participated in a recent provincial workshop on flood risk reduction, which provided useful information and contacts. But his efforts to minimize an evident local flood risk have been thwarted by jurisdictional complications. St. George has a road at risk of washing out that would leave 3,000 people and an industrial park without services, but neither the Department of Environment nor the Department of Transportation are taking action. The affected road is beyond town jurisdiction, but a washout would prove costly to the municipality.

St. George has similar jurisdictional challenges with large landowners in the area because New Brunswick does not regulate dam management on private lands. "There are no provisions for lake levels or opening of dam gates in emergency situations," Morton notes, "so it's hard to

operate in a coordinated manner." He would like to see the forest industry landowner work with scientific researchers to install adequate water-level gauges and plan for what will happen under given circumstances.

There's a need for greater regional coordination in terms of emergency response since towns equipped with generators, food and supplies may serve community members from outlying areas. St. George provided those services during an extended power outage in December 2013, but there's no system in place for it to receive compensation for those services.

With municipal budget constraints, it can be hard to persuade Councillors to invest in measures that could help the community respond to climate-related challenges. Morton made previous requests to fund generators and a warming shelter that were denied. Only after the recent power outage did the Town reconsider those purchases.

Town of Grand Bay-Westfield, New Brunswick

Two storms in 2005 and 2007 helped alert the Town of Grand Bay-Westfield to its flooding risks and stormwater management challenges. The Town's subsequent participation in a RAC project with three other communities along the southern St. John River, says Development Officer David Taylor, helped the community visualize the need for strict zoning setbacks and subdivision planning. Grand Bay-Westfield currently requires a 30-meter setback from water courses for new construction

The best outcome of that process, Taylor says, was the LiDAR mapping which has been valuable for both planning and education:"The LiDAR maps depict scenarios where river water levels rise 1-4 meters higher than normal, which can happen in freshet floods, so the visualization tool is helpful even in normal spring conditions—let alone anticipated sea-level rise predictions. The maps make it pretty obvious for people why they should be building back from water courses."

The Town has found adequate guidance to date on adaptation planning and stormwater control, Taylor notes, but "it's an evolving science" that requires staying current on new practices.

City of St. John, New Brunswick

When St. John began revising its municipal plan in 2010, it took a new approach to land use. Rather than reacting to intense precipitation events, the City wanted to integrate stormwater guidelines and infrastructure approaches that would mitigate problems in future events. The City formed a Community Advisory Committee that helped foster public participation and generate widespread support for the final plan (online at http://www.saintjohn.ca/en/home/cityhall/developmentgrowth/communityplanning/plansj/municipalplan.aspx). "St. John is fortunate," notes Senior Planner Mark Reade, "to have an engaged and educated community that understands the links between planning and environmental well-being."

St. John now has a "zero net change in stormwater runoff" requirement in its design criteria manual, specifying that the quantity of runoff (in a 1-in-100 year storm) cannot be greater following development than it was prior to development. In looking at flooding risks, the City

has drawn on many existing resources—from the both the Shediac region of New Brunswick (where studies have been done on sea-level rise and storm surge) and from research compiled by Atlantic Climate Adaptation Solutions Association (www.atlanticadaptation.ca). The City is currently revising its zoning maps and bylaws.

Further climate-related planning is underway, and more stormwater management work is needed within certain districts. The biggest obstacle, Reade says, is funding.

Village of Alma, New Brunswick

Despite its small population (under 250 people), Alma has a large expanse of land (nearly 50 square km.) and an expansive vision for its future. The Village has spent three years formulating Vision Alma, a plan to revitalize the community and expand its capacity to accommodate the tourists who come to enjoy Fundy Trail corridor and Fundy National Park, which lies on Alma's southern border.

Elements of this planning process, while not initiated by climate concerns, may help the community adapt to future changes. Plans are underway to create a secondary water source (with adequate well field protection), and the Village has placed a moratorium on fracking within its boundaries to protect drinking water supplies. Working with Atlantic Canada Opportunities Agency (ACOA) and the Province, Alma plans to embark in 2014 on a major project to stabilize the shoreline in its wharf area. With support from Regional Service Commission 7, the Village will soon update its rural plan, incorporating zoning measures to protect sensitive ecosystems while allowing for new growth.

City of Moncton, New Brunswick

The RAC, a federal initiative that operated between 2008 and 2012, helped Moncton jumpstart its climate adaptation process by providing support for a consultant to compile technical data on flooding risks (associated with more frequent and intense precipitation events and with sea-level rise). After reviewing those data, the Moncton City Council asked staff to prepare a Corporate Climate Adaptation Plan that was completed in July 2013—a process that involved strong interdepartmental collaboration. City staff members found valuable guidance on New Brunswick climate futures from ACASA. Moncton's plan focuses on flooding as the greatest perceived risk, but incorporates consideration of other potential climate impacts such as drought, heat waves, ice storms and more severe winter weather. More details on the City's planning process appear in the initial sections of Moncton's Climate Adaptation Plan.

Elaine Aucoin, Director of Environmental Planning and Management, says the City's new municipal plan incorporated many measures from its Climate Adaptation Plan—such as conservation buffers for water bodies and a "zero net" policy for stormwater (requiring new development to generate no more stormwater than the site did prior to development). Moncton is launching a two-year study to develop more naturalized and site-specific stormwater management strategies for the entire city. Strategies may include installation of wetlands, rain gardens and tree plantings, as well as dictating the percentage of impervious surface allowed in different zones. "We have examples from elsewhere," Aucoin observes, "but we need to know what is applicable here."

An important next step for the City, Aucoin adds, will be engaging more of the community and promoting what is in the Climate Adaptation Plan. The City already provides residents with a $500 rebate toward installation of a City-approved backwater valve (to prevent sewer line backflush from entering basements during periods of heavy rainfall).

City of Dieppe, New Brunswick

Participation in a RAC helped Dieppe lay the groundwork for climate adaptation planning. The RAC study, undertaken in collaboration with neighboring Moncton and Riverview (and funded through federal and provincial grants), generated data to help guide future decisions. "We're fortunate to have had that specific work done for our area," observes Dieppe's Director of Planning Jacques LeBlanc: "Now that we know better, we need to act on this information."

A City committee has begun meeting to set priority actions and longer-term measures (such as policies and capital investments). More research is needed still—particularly cost-benefit analyses associated with infrastructure improvements (such as augmenting existing dykes). LeBlanc anticipates that new adaptation measures will result in both regulations and new construction. Even before those are in place, he says, "we need to advise landowners in floodprone areas and help them evaluate risks."

The City is already in the process of updating its municipal plan. As city officials decide on next steps, they may rely on the experience of neighboring Moncton (see previous summary) which shares similar climate influences and has already completed a climate action plan. Dieppe will also rely on pioneering examples from communities along the Northumberland Strait.

Dieppe already has some measures in place (which were enacted to minimize evident erosion) that will be helpful in managing more intense precipitation events. A zoning provision requires a minimum floor elevation for occupied buildings. Another bylaw requires that new development meets a "zero net impact" standard for stormwater runoff: both residential and commercial development proposals need to calculate and compensate for runoff from precipitation up to a 1:100-year storm.

The City has updated design guidelines to increase municipal pipe sizing 20 percent (for stormwater piping and culverts) in both new development and retrofits. The City is also working to create more detention areas upstream of culverts.

Southeast New Brunswick Regional Service Commission (7)

The former Tantramar Planning District recently expanded to become Regional Service Commission 7, which contains the province's highest population density—supporting 12 municipalities and 24 Local Service Districts on issues primarily concerning land-use planning and solid waste.

Prior to 2013, regional climate-related planning benefited from ACASA funding for LiDAR mapping and flood mapping research (undertaken by consultants and Mt. Allison University researchers). Findings helped clarify areas of greatest flooding vulnerability in Sackville, which is in a low-lying area at the head of the Bay of Fundy bordered by extensive marshlands and historic dykes.

The region is bisected by a highway and rail corridor, both of which are overtopped by a 1-in-10-year storm, so there are complex management and jurisdictional issues. "The ACASA research brought these issues forward in a very real and graphic manner," says Commission Planner Tracey Wade, "and helped solidify the issues." The ACASA process gathered those with a stake in the region's infrastructure: CN Rail, the provincial Departments of Transportation and Agriculture (the latter is charged with dyke maintenance), and planners from nearby areas of Nova Scotia. "It's a challenge getting everyone at the table," Wade concedes, and reconciling their perspectives. "A little flooding may be fine from an agricultural perspective but not from the vantage point of a building owner."

Initial planning efforts benefited from a collaborative approach that engaged the planning board, Mt. Allison faculty and students, and NGOs. The nonprofit EOS Eco-Energy helped launch an annual community Climate Awareness Week with flooding maps distributed through town, science cafés discussing sea-level rise impacts, and a targeted media strategy.

Researchers studied the difference in mapping presentations to see if 3-D presentations had more impact than hard-copy maps. As it turned out, "people need to *see* the impact but it doesn't have to be high-tech," Wade says. "The visual element did help change people's perspective and understanding."

When the Town of Sackville subsequently created a new flood map with minimum flood depth a meter higher than it had been, it was readily adopted. The Council unanimously approved a flood-risk map in the zoning bylaw. The map has a flood-risk area with regulations that prevent door or window openings below a certain level in that zone. "People can still build there," Wade says, "but all openings need to be above the flood level—so potentially they can't have a basement with windows."

The process of changing regulations within the region is slow and ongoing. Emergency management plans get updated more frequently, and tend to be more responsive to new climate data. There's a risk with crisis response, Wade notes, "if a community simply plans to 'declare a state of emergency' rather than take pro-active measures." One of the next regulatory challenges for the region, Wade adds, is being pro-active about new development in the most vulnerable areas.

Town of Sackville, New Brunswick

Despite the extensive work Sackville has done to map potential flooding risks and revise municipal flood maps (see previous summary), funding protective measures remains a challenge. Sackville's Chief Administrative Officer Phil Handrahan says that in the absence of recent floods or imminent threats, climate preparedness measures don't get budgeted. Handrahan credits a small corps of local citizens dedicated to sustainability with keeping these issues before the Town's Council, and he believes that the research and educational work done to date (see previous summary) is "the greatest accomplishment in this area." Handrahan cites a recent observation made by a Sackville Town Councillor Margaret Tusz-King that "we may not have concrete plans yet, but at least we have a lot of people talking about it. Information is our strongest tool."

Recent economic research by a Mt. Allison faculty member may advance public discussion further—by creating a vulnerability valuation tool that allows the Town to assess the potential costs of flooding (in terms of personal/property damage, not municipal infrastructure) within affected areas. Having those cost estimates can help the Town weigh the potential economic costs of flooding against the cost of building up existing dykes. Public presentations of those findings, Handrahan says, may influence upcoming revisions to Sackville's municipal plan and land-use bylaws. He anticipates a greater focus on sustainability than ever before, and changes as to what kinds of development occur in the Town's most floodprone sections (identified by a newly approved floodplain zone).

Sackville has a strong and coordinated Emergency Measures Organization, and Handrahan feels the community is well-prepared in terms of a crises. Ironically, it's only in times of crises that management lines are clear—with decision-making made by the Town's Emergency Management Coordinator. Ordinarily, the private and public property owners and agencies involved in managing infrastructure (such as the highway, rail line and dykes) all have competing interests so coordinated planning and the funding and implementation of initiatives are much more murky."

Village of Dorchester, New Brunswick

The small village of Dorchester joined forces with three other communities (Memramcook, Port Elgin and Sackville) to complete its federally mandated Integrated Community Sustainability Plan (ICSP). Extensive help in that process came from staff at the regional planning district (now RSC 7) and the regional NGO EOS-Eco Energy. The latter supports public outreach and offers guidance on sustainability measures such as municipal energy audits and building retrofits.

Much of Dorchester's efforts to dates have focused on mitigation efforts, given limited staffing. The community experiences bi-annual flooding (at unusually high tides) that can leave it an island. The surrounding roads provide critical access to the village, says Councilor Kim MacLeod, but are maintained by the province (and affected by the CN rail line) so they fall outside Dorchester's jurisdiction.

Town of Amherst, Nova Scotia

For Amherst, which lies by marshlands at the Bay of Fundy's upper reaches, climate adaptation planning is complicated by the Town's dependence on a dyke system over which it has no formal jurisdiction. "There's a mélange of players, agencies and mandates," explains Andrew Fisher, the Town's Senior Planner, "with no comprehensive management system yet in place." Dykes are under the jurisdiction of the provincial Department of Agriculture, but protect buildings, roadways and a rail line in two provinces. As part of a Tantramar region climate working group (organized by the NGO EOS Eco-Energy), local communities on both sides of the border join in an annual workshop with agency staff.

Fisher notes that current calculations of dyke height are dictated by the highest high-tide levels. With a greater risk of more powerful storms and storm surge, Fisher feels that approach may no longer be adequate. He would like to explore a Dutch system that calculates height of dykes relative to the value of assets they protect. The provincial government of Nova Scotia is working

to secure funding to complete a cost-benefit analysis of the Tantramar dyke system. It already has helped cover LiDAR data sets for the marsh area, and its Municipal Climate Change Adaptation Plan (MCCAP) staff has provided planning guidance.

Amherst's recent MCCAP identifies dyke management as a priority concern, along with stormwater management (primarily in a brook that bisects the town), and updates to its existing emergency management plan (including more cross-border cooperation in the case of a dyke failure). Implementing the plan's measures may prove challenging because some town residents see no imminent threat from sea-level rise or increased precipitation. Open water lies 5 km. out past extensive marshes, Fisher says, "and they assume the Bay will stay out there."

Municipality of Cumberland, Nova Scotia

Participation in two ACASA projects between 2010 and 2012 helped the Municipality of Cumberland begin to grapple with how rising sea-levels, storm surge and coastal flooding may affect the region. The Bay of Fundy ACASA project generated LiDAR and data that helped municipal staff understand how far water might go if it overtopped or breached dykes. In places, water extended nearly across the isthmus," says the Municipality's Director of Policy and Research Steve Ferguson: "that really turned the lights on."

Another hard but valuable lesson came from the ACASA research, Ferguson adds: "how much we don't know." Researchers and provincial staff brought extensive expertise of benefit to the municipality, but many questions—about how much water might come over or through the dykes in different scenarios—met with the same answer: "it's hard to say."

In addition to raising awareness, generating valuable data and identifying data gaps, participation in ACASA helped the community connect with others engaged in climate change work—through broader planning sessions and a wrap-up conference. Ferguson suspects that the long-term benefits of ACASA will be evident as the Province reviews the Municipal Climate Change Adaptation Plans (MCCAPs). One lesson his community drew from ACASA, he says, is that "it certainly doesn't make sense to leave climate adaptation totally at the municipal level."

Cumberland does participate in a cross-border Tantramar region climate working group organized by the NGO EOS Eco-Energy that draws together planners, EMOs, transportation professionals and others for dialogue. They meet annually for a one-day workshop and hold conference calls to discuss shared concerns. Cumberland and four other municipalities have also begun operating a Regional Emergency Measures Organization (REMO).

One of their next steps, outlined in Cumberland's MCCAP, is to examine various flooding scenarios (caused by dyke overtopping or breaching) in the Bay of Fundy community of Advocate Harbor, which has a connected seawall and dyke. A newly purchased LiDAR map will help the community work through different scenarios. That process, Ferguson hopes, will be valuable both for REMO planning and for land-use and zoning decisions.

Colchester County, Nova Scotia

A rainstorm in September 2012 that produced localized flooding helped spark discussions in Colchester about planning for climate impacts. That storm broke through berms maintained by

the Province, leading to discussions with provincial staff about developing a more comprehensive approach to flood management. Colchester has detailed flood maps that date back to the 1980s, showing impacts from 1-in-20 year and 1-in-100 year flood events. Since 1988, Colchester has used maps generated by the Canada-Nova Scotia Flood Damage Reduction program to develop planning by-laws and land use controls on its central floodplain. Help from the Province in 2013 allowed the County to get LiDAR flown for areas bordering Cobequid Bay, allowing for better projections both of sea-level rise and the combined impacts of unusually high tides and freshwater runoff.

Colchester now has a study underway to identify further measures to reduce flooding. Crawford MacPherson, the County's Director of Community Development, anticipates some of those recommendations may involve dykes that need to be shifted to accommodate freshwater runoff. "Not much money has been spent to date," he says, "on engineering solutions."

Saltmarsh restoration could be part of the solution, but it's not clear who has jurisdiction for natural salt marsh areas or would advocate for their expansion. The provincial Department of Agriculture manages the dykes—but only for agricultural purposes. Colchester would like greater consideration given to how the dykes affect freshwater runoff—given predictions that climate change may bring more intense precipitation events.

Colchester would also welcome provincial help in educating shoreland owners about coastal mechanics, the risks of traditional shoreline hardening approaches, and lower-impact approaches to reducing erosion. Landowners along Cobequid Bay's north shore, MacPherson says, have taken a "do-it-yourself" approach to shoreline hardening that is ineffectual and potentially damaging. "Our Council has asked the Province to conduct workshops for property owners and contractors explaining the functions of these coastal geological processes and proper ways to minimize erosion." When the flood study is completed later this year, it may lead to new standards set in Colchester's development bylaws—particularly in floodprone zones.

Colchester is pioneering innovative approaches to stormwater retention at an eco-industrial park that the County owns and is redeveloping at the site of a former military base. Funded in part by the Royal Bank of Canada and Gulf of Maine Council on the Marine Environment, Colchester is testing a porous (permeable) pavement parking lot; building demonstration rain gardens (in cooperation with Dalhousie's Agricultural Campus) that test different plants and media; and gauging the effectiveness of a gravel-bed saltmarsh for stormwater management. "The Debert Industrial Park relies on groundwater and sits within the watershed of a wildlife refuge so it's a place that requires special treatment," MacPherson says. "If we test these techniques ourselves, we know what works and what it costs when we ask contractors to use similar measures."

Colchester is piloting use of several "green" stormwater management techniques on municipal property, including installation of porous pavement.

Sustainability advances at Debert are strengthened through a close collaboration with a former US military base, Devens Enterprise Commission situated in a National Wildlife Refuge west of Boston, Massachusetts. Colchester has learned valuable information from visiting both Devens and the University of New Hampshire's Stormwater Center in Durham, New Hampshire.

Town of Truro, Nova Scotia

Truro's new Municipal Climate Change Adaptation Plan (MCCAP) summarizes risks—such as coastal and inland flooding—that have long affected the community but could be exacerbated by climate change. A portion of the Town occupies former tidal marshes, reclaimed from the sea and protected by a series of dykes. Director of Planning Jason Fox notes that the Town has not forgotten the 1869 Saxby Gale, a hurricane with a 2-meter storm surge that caused extensive damage throughout the upper Bay of Fundy. The MCCAP process helped focus Councillors' attention on future climate impacts, building interest in taking action.

There is consensus on moving forward with LiDAR mapping and implementing a new floodplain plan, but notably less on how to manage land use in upland areas. Budgetary limits can still hinder progress, given the high costs of LiDAR and consulting help (for a study of floodplain management). It would be great, Fox says, to have a provincial program that provided financial assistance for LiDAR surveys.

Localized flooding events have raised public awareness about stormwater management, and Truro is reducing stormwater through innovative amendments to its land-use bylaws.

The Town limits the amount of impervious surface in different zones of residential and commercial construction projects. Permit applicants who wish to exceed those limits must implement improvements (such as infiltration trenches, rain gardens, French drains each of which provides certain credits). Detailed provisions appear in section 4.5 of the Truro land-use bylaws (pages 4-27). An unexpected benefit of the bylaw has been its educational value, Fox notes. Every permit applicant now learns about stormwater management techniques through the application process.

Past workshops on topics like stormwater management have been helpful for Town staff, inspiring interest in new approaches. Fox would like to see a template provided that towns could use to customize their own stormwater design manuals. It could include guidance on stormwater management tools and concrete design specifications for contractors to use.

Municipality of the District of East Hants, Nova Scotia

The primary climate planning concerns in East Hants center on stormwater (primarily from localized flooding), overflowing river banks, and coastal erosion. An updated floodplain study, part of the Municipal Climate Change Action Plan (MCCAP) process, will help guide a review of the East Hants municipal plan now underway. Zoning changes will follow. Planner Sean Gillis says there's likely to be a high-risk zone that permits no future construction and a medium-risk zone that allows minimal development and requires floodproofing measures.

East Hants already has a bylaw specifying lot grading and drainage requirements to minimize stormwater runoff. The community is waiting to learn more about the results of work underway by Nova Scotia Environment's Hydrology Lab on watershed mapping and where stormwater is threatening water quality. The community could take more mitigation measures, Gillis says, if there was funding support for projects. Clean Nova Scotia, for example, recently approached East Hants about running a pilot project in the community that would provide rain barrels and education on ecological landscaping. "That's exactly what we want to do with stormwater education and they would have provided the expertise and project management, but we didn't have the budget this year," Gillis says. "We could match a provincial grant and provide staff time, but we can't cover 100 percent."

East Hants is also looking to the Province for help with coastal erosion challenges. With many competing budgetary demands, the Municipal Council has not approved funds for a study that would quantify erosion rates in the most vulnerable areas. "We lack the expertise or funding to address coastal zone erosion," Gillis notes, "and problems need to be approached from a regional perspective."

Municipality of the District of West Hants, Nova Scotia

Support from ACASA helped West Hants begin its climate adaptation planning. That work was advanced by its recent Municipal Climate Change Adaptation Plan (MCCAP), which a consultant helped the municipality complete. Concerned with both adaptation and mitigation, this plan identified eight natural hazards (drought, wildfire, inland flooding, coastal flooding from storm surge, winter ice events, tropical storms, hurricanes and coastal erosion). The next step, says Director of Planning Karen Dempsey, will be to determine what West Hants can implement in coming years and how much of that work can be done in-house.

Elements such as LiDAR mapping and a risk assessment of municipal, provincial and private infrastructure (such as breaches of dykes and dams) require outside expertise, she says, which can translate into significant costs. Right now LiDAR is available for only a small portion of the community. Last year, mapping was written into their municipal budget but got eliminated in a subsequent round of budget cuts. It would be helpful, she adds, if the Province could provide leadership support for mapping with a match from municipalities.

West Hants, like many Bay of Fundy communities, faces erosion issues and would like more engineering and soil science expertise to help with erosion control. Shoreline hardening measures have limitations, Dempsey acknowledges, so they'd like to learn more about alternative measures like green (living) shorelines. It's not clear which agency could provide that guidance, though.

The MCCAP process helped identify new areas of focus for the Regional Emergency Measures Organization. The REMO will begin addressing possible climate-related impacts such as coastal and inland flooding and wildfires (since a large portion of the area is forested and could be vulnerable in a drought).

Town of Hantsport, Nova Scotia

The primary climate adaptation concerns for Hantsport are stormwater management (particularly in extreme weather events), and erosion management in the face of sea-level rise and storm surge. Past events with extensive flooding have raised awareness about the need for better approaches. "We're looking at how to mitigate and capture stormwater runoff," notes Chief Administrative Officer Rob Frost. The community could use further guidance and resources on how best to implement different measures. To date, some support has come from nearby Acadia University (studying salt marsh dynamics in a river with an aqueduct), and the Town is looking to NGOs like the Ecology Action Centre for additional guidance.

Kings County, Nova Scotia

For Kings County, climate adaptation planning is bound into a larger regional planning initiative called Kings 2050 that links the County with the three municipalities it surrounds: Wolfville, Kentville and Berwick. Unlike the previous Integrated Community Sustainability Plan process—which each municipality did independently, the Municipal Climate Change Adaptation Plan (MCCAP) took a more regional approach to concerns like coastal erosion and floodplain management. The communities joined forces in the MCCAP, says Kings 2050 Research Coordinator David Poole, "because we wanted something with meat on it, something we could base budgets on."

Kings 2050 emerged several years ago when participating communities realized their interlinkages and the need for a longer-term vision to guide land-use decisions. "It's never been done like this in Nova Scotia," says Poole. "Several big proposals involving potential conflicts between agriculture and non-agricultural uses galvanized the community and sparked a series of public meetings. Now we're trying to analyze the costs and benefits of development to help people see the value of infill development." The location of new development greatly influences stormwater runoff one of the region's climate-related concerns.

The MCCAP outlines some of the region's key climate-related vulnerabilities: three sewage treatment plants and multiple lift stations situated in the floodplain; an aging dyke system that could be at risk; coastal erosion; and flooding risks due to both storm surge and heavy precipitation events. Saltwater intrusion and drought pose major risks to a region that generates a third of the province's agricultural value and where nearly all residents rely on groundwater for drinking.

The County and participating municipalities have been gathering more data on which to base adaptation actions. LiDAR has been flown, and consultants have mapped aquifer vulnerability and potential flooding impacts in extreme rainfall events (complete with animation videos simulating storm surge and sea-level rise impacts—posted on the Kings 2050 website).

The County is also updating stormwater management and floodplain regulations, and working to develop better guidance on floodproof construction. The communities plan to establish a monitoring program for coastal erosion, but are uncertain how planned tidal energy projects may affect tidal amplitude. Looking at issues regionally is a slow process," Poole concedes, but "we're making progress."

Town of Wolfville, Nova Scotia

Bordering the Minas Basin, Wolfville anticipates its greatest climate impacts coming from sea-level rise and storm surge. Recent animation work done as part of the Kings 2050 Planning Initiative (see previous summary) depicts potential inundation impacts. "Visual modeling is great," says Director of Planning Chrystal Fuller. "It's useful for people to see what could happen in the next Saxby Gale" [an 1869 hurricane that decimated the region]. Whether or not they're convinced about potential other climate impacts, Fuller says, "nearly everyone gets that there's going to be more water."

As the community takes steps toward land use and stormwater management choices reflecting that recognition, Wolfville will likely seek guidance from professional associations for public works directors and planners. The community has already integrated many environmental sustainability measures to date (based on the Natural Step framework). "We tend to be forward thinking, and have some floodproofing measures already in place," Fuller says. "But there's only so much that municipalities can do—focusing on land use, stormwater management and public education—especially when there's been construction for a century within the floodplain. It's easy to get discouraged at the local level given the critical need for more concerted efforts at provincial, national and international levels on big issues like energy production, transportation, and cap-and-trade. Lack of bigger commitments at those levels leads to disempowerment at the community level."

Town of Kentville, Nova Scotia

Kentville's Municipal Climate Change Adaptation Plan (MCCAP) is tied into the regional Kings 2050 planning initiative (see Kings County summary). Through that process, says Kentville's Director of Planning Beverly Gentleman, "it's been helpful to look at the risks and vulnerabilities within a shared floodplain. Kentville has its sewage treatment plant in a river floodplain, along with much of its residential and commercial center. The work that consultants

did modeling storm surge and depicting it through computer animation has been helpful, Gentleman adds. “We could never have done that ourselves.”

The community has already taken measures to institute floodproofing of buildings and strengthen infrastructure. Next steps may involve doing a cost-benefit analysis to assess the socio-economics of buyouts or relocation for the most floodprone areas. The municipality is currently updating its plan and will incorporate new data from the MCCAP process in defining the floodplain and guiding what further development will occur there.

Town of Berwick, Nova Scotia

Berwick worked collaboratively as part of Kings 2050 to prepare a regional Municipal Climate Change Adaptation Plan (MCCAP). The communities in Kings County (with a shared population of about 60,000) have worked together previously on regional issues such as transit and solid waste. Berwick’s Chief Administrative Officer Don Regan calls the shared MCCAP “the biggest win yet in the Kings 2050 process,” and he anticipates more in the future. Berwick already benefited from collaborative work that it could not have carried out on its own. Berwick paid itself for an additional inundation study of the hydro system that was the Town’s direct responsibility.

Berwick’s primary problem, Regan says, “is that water won’t get away from the town fast enough.” The plan identified the need to find better ways to treat and retard stormwater, and reduce risks around storage dams. Berwick has a drainage bylaw and is investigating expanded use of permeable (porous) pavement.

Regan would like to see more innovations happening with energy efficiency, with provincial support for loan funds that allow taxpayers to strengthen building efficiency (*e.g.*, installing heat pumps that would reduce greenhouse gas emissions). The US PACE Program offers one model, he says, as does HRM’s Solar City Program.

Berwick is drafting bylaw language that is modeled after the Solar City Program. “These are good systems,” Regan says, “because towns can help residents increase their property value but not their assessment, and save money on energy that they then can spend elsewhere in town.” Berwick is also finalizing plans to build a wind farm with four community electrical cooperatives.

Town of Middleton, Nova Scotia

Middleton has completed a Municipal Climate Change Adaptation Plan (MCCAP), and plans to integrate needs it identified into routine infrastructure repair and replacement. Needs confirmed by the plan—such as work on a water-pumping station—are likely to be moved up the Town’s priority list. “The MCCAP will become part of our planning strategy,” notes Acting Chief Administrative Officer, Brian Smith.

GIS support helped generate valuable data and perspectives for Middleton’s plan. Middleton benefits from its proximity to Nova Scotia Community College’s Centre of Geographic Sciences (COGS). The MCCAP process helped identify stakeholders with data valuable for planning—

like Nova Scotia Power which has done planning to gauge impacts from a potential failure of its dams along area rivers.

Town of Bridgetown, Nova Scotia

Unlike most communities in Nova Scotia, Bridgetown has not yet undertaken the process of creating a Municipal Climate Change Adaptation Plan (MCCAP) – due to recent upheaval in town government that resulted from employee fraud. Its new Chief Administrative Officer, Rachel Turner, expects to engage in climate adaptation planning during 2014. The Town will gather more data about known concerns such as flooding of the Annapolis River and sewage treatment plants situated in the floodplain. Stormwater runoff already produces some impacts and could become more problematic with heavier rainfall events. Given the importance of agriculture to the region, the Town will assess how climate change might affect the viability of local food chains.

Bridgetown has no dedicated planning staff, Turner notes, but there are good consultants in the region and the province has provided tools to help guide the process.

Municipality of the District of Digby, Nova Scotia

Through its Integrated Community Sustainability Plan (which preceded its Municipal Climate Change Action Plan or MCCAP), the Municipality of the District of Digby realized that its future lay with renewable energy—tidal, wind, biomass and solar. The Province selected the Port of Digby as the preferred choice in support of tidal development, says Terry Thibodeau, Renewable Energy and Climate Change Program Coordinator for the municipality, "but it's a slow process understanding and determining the future needs of tidal developers." The Municipality is exploring other options that could advance tidal work, such as establishment of a test facility for small-scale turbines and other marine science devices. Thibodeau hopes eventually to see growth of an industry and job creation that could help entice young people back to the region.

Through the MCCAP process, the Municipality of Digby determined that little of its infrastructure is vulnerable to climate change. The Municipality does plan to work with the larger community to communicate potential risks to private landowners—some of whom have properties like wharves that hold significant value for the community at large.
Local citizens could help, Thibodeau says, if there was a program encouraging them to record video footage of storm surge activity—creating evidence that could act as baseline documentation to guide planning. Thibodeau would welcome provincial support for a consultant to provide a detailed assessment of sea-level rise and storm surge impacts.

The Municipality of Digby will investigate the socio-economic impacts of climate change in an effort to identify potential costs to the region of both storm surge and sea-level rise. Right now, few residents view climate planning as a priority, Thibodeau says, making it harder to take action.

Municipality of the District of Clare, Nova Scotia

Clare's Municipal Climate Change Adaptation Plan (MCCAP), prepared largely by a planning firm in Halifax supported with gas tax funds, includes maps depicting areas that would be most vulnerable to sea-level rise, storm surge and erosion. The long shoreline of Clare is considered at moderate-to-high risk due to a combination of winds, currents and tides along its coast and the geologic substrate there. Within months of submitting its MCCAP, the community experienced a winter storm that demonstrated just what the modeling had predicted—storm surge flooding in low-lying areas and evident erosion. "Sometimes the planning work can feel theoretical, but we know now it can happen," says Clare's Administrative Assistant to the CAO Colette Deveau King. "That storm really brought things home."

Late in 2013, Clare experienced a winter storm in which storm surge caused flooding and coastal erosion just where newly completed inundation maps had predicted it would occur.

This was not the community's first instance of serious flooding. Several years earlier, following spring melt and a heavy rainstorm, an inland dam washed out—damaging a bridge and necessitating the evacuation of families.

The MCCAP process helped Clare's volunteer planning advisory committee identify priority actions, but the community's budgetary constraints will limit the pace of implementation. Staff members have many competing demands on them and the Council has more budgetary needs than it can meet.

Clare's Development Officer, Arnold Comeau, plans to use the MCCAP to educate property owners, helping raise awareness about erosion and flooding on their lands. People who have lived in the community for decades, Deveau King says, "see the erosion" but newcomers buying property can be unaware of hazards. Management of the shoreline falls under provincial jurisdiction so the municipality can do little more than educate and request help with erosion control measures.

Clare receives valuable guidance from a planning firm in Halifax, and from the Union of Nova Scotia Municipalities and the Association of Municipal Administrators, Nova Scotia. They offer

list-servs that allow town officials to post questions and benefit from advice shared by other communities.

Another great asset, Deveau King says, is "that we work together as a community, despite being spread out over a large area [852 km²]. There are a lot of volunteers willing to give time and resources." In response to community concerns, Clare is now working to zone its watershed. "We will hold public meetings and get input as we want people to be well educated about why good water quality will be critical for residents and businesses in the decades ahead."

Municipality of the District of Yarmouth, Nova Scotia

The District of Yarmouth hired a consultant to complete its Municipal Climate Change Adaptation Plan , and is still considering what actions to implement. This region has been hard hit by the loss of the ferry that ran formerly between Yarmouth and Portland, Maine (and is slated to resume service in 2014). The small, rural communities are aware of climate risks, says Brad Fulton, Senior Planner for the Districts of Yarmouth and Argyle, "but there are such demands for every single nickel."

The area has not been hard hit by storms in recent memory so in the face of constrained budgets, there is little political will to engage in climate adaptation. Some research was done in the District through the previous Atlantic Climate Adaptation Solutions Association, and that could help guide future actions. Fulton anticipates that the District may use gas tax funding to support an upgrade of its sewage treatment plant, increasing its capacity to handle stormwater.

Town of Yarmouth, Nova Scotia

The Town of Yarmouth collaborated with Atlantic Climate Adaption Solutions Association and Dalhousie University to generate scientific data and model inundation flooding in different sea-level rise and storm surge scenarios. Findings from this collaboration helped guide setbacks and elevation standards that the Town has implemented through its land-use bylaws. The Town chose to base its regulations on flood levels that occurred in the infamous 1976 Groundhog Day storm, since Yarmouth has already experienced those, rather than on the worst-case scenario (based on a 100-year storm).

Models demonstrated the potential local impact of storm surge and sea-level rise impacts on roads and other infrastructure. "They helped identify areas that would be completely cut off by a major storm surge event," says Arthur MacDonald, Yarmouth's Director of Planning. Researchers from Dalhousie University also completed a social vulnerability study that assessed impacts on people throughout the study area. Other studies gauged impacts on social assets, physical infrastructure and the economy, as well as the capacities of emergency planning and of the Town to handle climate change impacts.

This sort of research has been a valuable asset for Yarmouth, and MacDonald hopes that future studies will gather information on intense rainfall events and their potential impacts on surface drainage and stormwater infrastructure. Funding research out of limited town resources can be difficult, given competing demands. Even though the area has experienced intense storm events, Yarmouth has not yet funded a study to determine stormwater impacts and mitigation actions based on storms that could occur in climate change scenarios. In June 2013, the Town held a

grand opening celebrating a new park and within a few days, MacDonald reports, the park was under water.

Yarmouth celebrated the opening of a new park in June 2013, but the park path was submerged within a week.

Municipality of the District of Argyle, Nova Scotia

For Argyle, the Municipal Climate Change Action Plan (MCCAP) process offered a chance to determine where its vulnerabilities are. The planning, completed by municipal staff, Councillors and citizens, included GIS mapping of storm surge impacts. The mapping made clear that the Municipality is highly vulnerable economically—in the event of a major storm surge event—due to the shorefront setting of its fishing industry (the community's primary economic driver), and to the low-lying roads that connect community centers. "A 4-meter storm surge in this area," says Brad Fulton, Senior Planner for the Municipality of the District of Argyle, "creates a number of islands and a lot of problems."

Argyle experienced significant inland flooding in November 2010, which washed out a one-lane bridge and isolated a portion of the community from emergency services. That event helped spark greater awareness of climate threats, which the MCCAP process further strengthened. The community is likely now to account for climate change in local planning decisions (like siting a new municipal building). The greater difficulty lies in the fact that they can do little about the miles of low-lying roads that are under provincial jurisdiction, and the businesses that must be situated near the water. "It's all well and good to know what the dangers are," Fulton says, "but hard if you can't do much about them."

Town of Clark's Harbour, Nova Scotia

Clark's Harbour, a small community on Cape Sable Island, is just beginning to identify potential climate impacts—working with an engineer and geologists to map potential sea-level rise. With a long shoreline, roadways that follow the shore, and seven harbour authority facilities, the impacts could be profound. Under higher sea-level rise scenarios, says Town Clerk Brian Crowell, "Cape Sable Island becomes three islands with the connecting roadways submerged. In low-lying areas, solutions are going to be costly." Where that funding will come from is not apparent, he says.

While the community does have an Emergency Measures Organization, there is little regional planning support to address potential climate impacts on transportation and waterfront infrastructure. The Town is beginning to alert landowners in floodprone areas about risks, and does plan to incorporate provisions regarding new construction in those areas into its updated municipal plan.

Municipality of the District of Barrington, Nova Scotia

While completing its Municipal Climate Change Adaptation Plan (MCCAP), the Municipality of Barrington reviewed its land-use and subdivision bylaws. Using an average from other municipalities, it extended its setback from all water courses from 25 to 40 feet. Development Officer David Andrews said the Municipality balanced potential climate impacts with a concern about placing too many restrictions on property owners: "The ocean draws a lot of people to this area so we wanted to be reasonable." To minimize coastal erosion, the Municipality created a "green zone" along the shoreline where landowners are required to maintain natural vegetation and are not permitted to clearcut.

Emergency preparedness is more of a concern now, Andrews says, than preventing long-term impacts. Municipal staff attended Bay of Fundy Estuary Partnership (www.bofep.org) workshops that demonstrated how sea-level rise could affect the region. Those were informative and interesting, Andrews observes, "but until there's a storm that cuts off access it will be hard to build the political will for climate adaptation."

Appendix A: Low-cost, Ecological Sound Adaptation Tools cited in This Study (by topic)
Municipalities around the Bay of Fundy are already employing the following adaptation tools to help cope with climate impacts. The hyperlinks connect to municipal documents that provide further details on each technique. This list, while not comprehensive (being drawn only from the study interviews), offers a menu of low-cost options to consider in adaptation planning.

Stormwater Management

- In design criteria and manuals, create a "zero net change" requirement so that runoff (e.g., in a 1-in-100 year storm) does not exceed runoff from the site prior to development. For examples, see the communities of St. John, NB and Dieppe, NB
- Require conservation buffers around water bodies (being developed currently by Moncton, NB) and used in US States (see *Appendix C*)
- Limit amount of impervious cover in different zones of residential and commercial construction projects. Require permit applicants who exceed limits to implement improvements). Details appear in section 4.5 of the land-use bylaws of Truro, NS.
- Increase by 20 percent the diameter of municipal pipes used in new development and retrofits to accommodate increased precipitation (Dieppe, NB)
- Incorporate a bylaw on lot grading and drainage to minimize runoff (see the example of East Hants, NS)
- Use municipal land to test and demonstrate low-impact development techniques like porous pavement and rain gardens, making it easier for contractors to see how they work (Colchester, NS)
- Additional measures are summarized in Stormwater and Wastewater Management Workshop proceedings (Nova Scotia's Ecology Action Centre, April 2012)

Flood Protection

- Consider adding a minimum floor elevation requirement in zoning provisions for occupied buildings in floodprone areas (see example from Dieppe, NB)
- Add zoning provisions that preclude openings below a certain elevation (Sackville, NB) or prohibit installation of mechanical/electrical systems in the basement
- Within municipal sewerage areas, offer incentives for residential installation of one-way valves (see Moncton, NB's program
- Educate residents about flooding risks and floodproofing measures they can take (showing them inundation maps/models and providing them with web-based resources when possible to minimize printing costs). See Moncton's *The Homeowner's Guide to Flood Protection*:

Appendix B: Coastal Hazard Mitigation Measures from Gulf of Maine States
Abridged from *Cost-Efficient Climate Change Adaptation in the Northeast*
by Michael Brady and Judd Schechtman for the National Oceanic Atmospheric Administration and Sea Grant (2013)

Ogunquit, Maine

1) Redefined mean high water to increase margin by 4 feet over current observations (no cost).The town is using a unique legal method to increase its shoreline setback without changing the setback itself, but rather by amending the definition of normal high water upon which the setback is based. The highest annual tide predicted for the region is generally about 7 feet above mean high water. By amending its definition of "normal high water" to 11 feet above mean sea level, the town includes a margin of about 4 feet for sea level rise, which is also 2 feet higher than the FEMA 100-year designated floodplain. The adopted language reads as follows: In the case of land adjacent to tidal waters, the normal high water line shall be considered to be the contour line at an elevation of 11.0 feet above mean sea level as determined by a land surveyor based on the nearest USGS benchmark. (Town of Ogunquit, ME, Town Code, Art. 2, Definitions, p. 24)

Scarborough, Maine

1) Cluster Zoning. The town has a cluster subdivision design ordinance that is required to be used in the coastal zone. The purpose of the law is to "conserve and protect the town's freshwater wetlands, watercourses, farmlands, open space and natural features, while enabling more flexibility for residential developments to design around these natural features and resources." (Scarborough, ME. Comprehensive Plan, Sec. VII (A))

   In three zoning districts, (RFM, RF and R-2), conservation subdivision design is required when:
   a. The land to be subdivided contains one acre or more of wetlands.
   b. Twenty percent (20%) or more of the land to be subdivided is wetlands.
   c. Twenty percent (20%) or more of the land to be subdivided is within the Shoreland Zone under the Town of Scarborough Shoreland Zoning Ordinance.
   d. A subdivision will alter (through lot configurations and road, driveway, and utility crossings) 4,300 square feet or more of wetland if designed and developed in a conventional layout.
   e. A subdivision proposes to include two-family and/or multi-family dwellings.
2) Unique Flood Ordinance Provision. Growth Management Ordinance The town maintains a unique enforcement mechanism in its flood ordinance. It provides that its code enforcement officer shall, upon determination of a violation of the ordinance, submit a declaration to the Federal Insurance Administration, requesting a denial of flood insurance. (Scarborough, ME. Town Code, Art. XI.) In addition, the code requires special notification to applicants who obtain a variance for construction in the floodplain. The Chairman of the Board of Appeals must notify in writing that: The issuance of a variance to construct a structure below the base flood level will result in greatly increased premium rates for flood insurance up to amounts as high as $25 per $100 of insurance coverage; that such construction below the base flood level increases risks to life and property; and, requires the applicant to agree in writing that he or she is "fully aware of all the risks inherent in the use of land subject to flooding, assumes those risks

and agrees to indemnify and defend the municipality against any claims filed against it that are related to the applicant's decision to use land located in a floodplain and that the applicant individually releases the municipality from any claims the applicant may have against the municipality that are related to the use of land located in a floodplain." (Scarborough, ME Town Code, Art. XI, F.1.)

3) Guiding Growth away from Coast. The most recent update to the Comprehensive Plan, finalized in 2006, continues to attempt to influence the development patterns of the town in the direction of smart growth, "recommending higher density development in some parts of the designated Growth Area and limiting the rate of residential development that will be allowed in the designated Limited Growth Area" (which includes the three historic summer colonies along the immediate coast). The comprehensive plan supports the goal of integrating land conservation objectives with coastal resilience. Action C.1.e. calls for the town to "Target floodplains, riparian corridors, and buffer zones along water bodies in land protection efforts, whether through the Town of Scarborough Parks and Conservation Land Advisory Board or other local conservation organizations, in order to maintain or restore vegetated buffers along water bodies." (p. 5-7)

Saco, Maine

1) Three-foot Freeboard Requirement. Saco is the first municipality in the region to adopt a more stringent freeboard requirement than required by FEMA. The ordinance requires elevation of the structure if work involves greater than 50 percent of the value. The change was approved smoothly, with unanimous consent of council members and only one resident speaking in dissent. Town planner Bob Hamblen was quoted as saying, "Coastal homeowners have been receptive of the policy...some really appreciate the city partnering with them in this" (Clean Air Cool Planet, n.d.).

York, Maine

1) Transfer of Development Rights. The town recently instituted a Transfer of Development Rights (TDR) program to discourage development in coastal wetlands in York Beach. The program was instituted after homeowners brought regulatory takings cases against the town, and the courts accepted the use of TDR as just compensation. Owners of wetland property can now transfer the development rights to an area outside the wetlands. There is no credit bank, so the program only works if a seller can find a willing buyer. Unfortunately, the town has not yet seen any TDR transactions. The program does not allow building in a wetland, but it allows landowners to recoup some of the loss of value from the development prohibitions.

Portsmouth, New Hampshire

1) Tidal Wetlands Buffer Law. Portsmouth requires a wetland buffer for any wetland or water body of 100 feet. (Portsmouth, N.H. Town Code, Sec. 10.1014.22). The buffer requirements apply to the tidal wetlands of Sagamore Creek, Little Harbour, North Mill Pond, and South Mill Pond; all vernal pools; and inland wetlands of great than 10,000 sq ft. (Sec. 10.1013) The ordinance prohibits construction of buildings or any impervious surfaces as well as filling or dredging in the wetland or wetland buffer. Examples of permitted uses include forestry and tree farming, wildlife refuges, parks and recreational uses, conservation and nature trails, and open spaces. (Sec. 10.1016.10) The use of motor vehicle is also expressly prohibited. There is an exception for the construction of an addition or extension to a house that existed prior to the effective date of the

ordinance or was constructed subject to a conditional use permit, with specific limitations on the size of such addition.

Barnstable, Massachusetts

1) Land Reclamation in Open Space Plan. The Town's Open Space Plan includes an unusual element that provides support for retreat strategies, in which the Town has adopted "property reclamation" or "undevelopment," as a strategy for creating open spaces adjoining coastal resource areas. A former motel was acquired and demolished, to preempt more intensive development in the vulnerable coastal location.

Brewster, Massachusetts

1) Wetland Buffer. The conservation commission of the town regulates coastal and inland wetlands. The commission raised standards recently to include a limitation on site disturbance and an undisturbed buffer zone of natural vegetation between wetlands resources. Sea level rise is explicitly discussed as rationale for these stricter regulations. The regulations require a 35-foot setback from wetlands and 50 feet from coastal areas. When the slope of an undisturbed setback exceeds 18%, or in any instance where the scope of the project is likely to require a greater spatial offset to wetland areas, the commission reserves the right to increase the setbacks. The zoning code minimum required lot dimensions includes the following restriction: "No building, except a boathouse or building used for agricultural purposes, shall be within 50 feet of any water body, watercourse or wetland area or, if subject to flooding, within 50 feet beyond its flood line to the higher elevation." (Brewster, Mass. Town Code, Ch, 179)

Appendix C: Summary of Survey Form Responses (New Brunswick and Nova Scotia)

Summary of Survey Form Responses from New Brunswick Communities
(12 Surveys Completed)

1) Which climate impacts concern your community? (underlined items were those most often underscored as in the top three concerns)
11 Extreme weather events
11 Freshwater/inland flooding
9 Hurricanes/high winds
9 Sea-level rise
7 Storm surge
8 Erosion
4 Drought/ Adequate water supplies
4 Water quality impacts (*e.g.*, sewage runoff, saltwater intrusion)
2 Ocean acidification (and potential fisheries impacts)
2 Changes in plants/wildlife (*e.g.*, loss of species or introduction of invasives)
2 Agricultural impacts/food security
1 Other (erosion of dykes)

2) How would you characterize the status of your community's current climate change adaptation planning?
0 Negligible (minimal to no attention to climate preparedness)
4 Reactive (primarily a focus on emergency response to crises)
8 Anticipatory (taking steps to plan for potential future climate impacts)
- **2** Preliminary research and discussion
- **3** Developing plans
- **1** Approved plans but minimal implementation
- **2** Active implementation

3) Which aspects of municipal functioning would most likely be affected by climate-related impacts? (underlined items were those most often underscored as in the top three concerns)
4 Building infrastructure
8 Transportation infrastructure and accessibility
6 Dykeland erosion/overtopping
4 Drinking water supply and/or distribution infrastructure
10 Wastewater infrastructure/treatment
11 Stormwater management
4 Electricity/power supply
4 Public health/safety/well-being
8 Emergency management
1 Disruptions to farming/forestry/fisheries
7 Economic impacts
4 Recreation/Tourism

4) Has your community completed any of the following assessments related to climate change?
11 Flooding impacts and stormwater management
3 Drinking water supplies

4 Wastewater treatment systems and facilities
7 Emergency evacuation
5 Sea-level rise
5 Coastal storm surge
5 At-risk infrastructure
5 Land use plans/zones
1 Socio-economic implications
2 Cost-benefit studies
1 Other (flood risk areas)

5) Which of the following tools/techniques does your community currently employ or are you actively planning to employ specifically to address potential climate change impacts?
7 Building/design standards
11 Zoning/subdivision regulations (e.g., development/construction setbacks)
12 Flood mapping
7 Permitting/enforcement
3 Comprehensive plan
6 Emergency/hazard mitigation plan
1 Repetitive loss buyout/structural relocation
0 Transfer of development rights
4 Shoreline hardening (dykes, jetties, armouring)
3 Green/living shoreline protection (dune revegetation, saltmarsh restoration)
1 Conservation easements/rolling easements
7 Outreach/education
4 Partnerships
0 Taxation policies
0 Utility rates/fees
2 Public safety rules/regulations
2 Dykeland management
1 Water conservation
0 Porous pavement
10 Stormwater management

6) Are there particular climate adaptation best practices that you would like to know more about? Please elaborate.
Best practices for roadways at risk of flooding; relocation strategies and incentives; zoning/development bylaws for floodprone areas; and "no adverse impact" floodplain management.

7) Where do you turn for guidance in terms of climate change mitigation/adaptation?
11 Provincial agencies

7 Federal agencies
4 Regional entity (please specify)
8 College/university researchers
4 Nongovernmental organizations (please specify)
1 Businesses
8 Peer network (*i.e.,* other municipal officials)
0 Newspapers
0 Television/radio
2 Websites
1 Other (PEI erosion program/resources)

8) What are the key constraints for your community preventing action in terms of climate change adaptation?
9 Lack of staff time
3 Lack of expertise/data to guide decision-making
3 Lack of concern/political will
2 Lack of community consensus on need for adaptation planning
2 Lack of community consensus on best actions to take
10 Inadequate funds for planning and implementation
1 Other (ability to act given conflicts with federal and provincial jurisdictions)

9) What resources would be most useful to help decision-makers in your community take adaptive actions?
5 Information
12 Funding
8 Best management guides/adaptation manuals for municipalities
2 Training videos
0 Other Resources

Summary of Responses from Nova Scotia Communities
(21 surveys completed)

1) Which climate impacts concern your community? (underlined items were those most often underscored as in the top three concerns)

18 Extreme weather events
16 Freshwater/inland flooding
16 Hurricanes/high winds
19 Sea-level rise
19 Storm surge
11 Erosion
6 Drought/ Adequate water supplies
10 Water quality impacts (*e.g.,* sewage runoff, saltwater intrusion)
6 Ocean acidification (and potential fisheries impacts)
6 Changes in plants/wildlife (*e.g.,* loss of species or introduction of invasives)
9 Agricultural impacts/food security
1 Other (wildfires)

2) How would you characterize the status of your community's current climate change adaptation planning?

0 Negligible (minimal to no attention to climate preparedness)
1 Reactive (primarily a focus on emergency response to crises)
20 Anticipatory (taking steps to plan for potential future climate impacts)
- **0** Preliminary research and discussion
- **6** Developing plans
- **11** Approved plans but minimal implementation
- **4** Active implementation

3) Which aspects of municipal functioning would most likely be affected by climate-related impacts? (underlined items were those most often underscored as in the top three concerns)

9 Building infrastructure
21 Transportation infrastructure and accessibility
10 Dykeland erosion/overtopping
10 Drinking water supply and/or distribution infrastructure
13 Wastewater infrastructure/treatment
17 Stormwater management
3 Electricity/power supply
9 Public health/safety/well-being
16 Emergency management
10 Disruptions to farming/forestry/fisheries
12 Economic impacts
9 Recreation/Tourism

4) Has your community completed any of the following assessments related to climate change?

17 Flooding impacts and stormwater management
6 Drinking water supplies
10 Wastewater treatment systems and facilities
10 Emergency evacuation
16 Sea-level rise
17 Coastal storm surge
12 At-risk infrastructure
132 Land use plans/zones
6 Socio-economic implications
0 Cost-benefit studies
0 Other (flood risk areas)

5) Which of the following tools/techniques does your community currently employ or are you actively planning to employ specifically to address potential climate change impacts?
3 Building/design standards
16 Zoning/subdivision regulations (e.g., development/construction setbacks)
19 Flood mapping
6 Permitting/enforcement
12 Comprehensive plan
12 Emergency/hazard mitigation plan
2 Repetitive loss buyout/structural relocation
0 Transfer of development rights
10 Shoreline hardening (dykes, jetties, armouring)
2 Green/living shoreline protection (dune revegetation, saltmarsh restoration)
1 Conservation easements/rolling easements
5 Outreach/education
10 Partnerships
0 Taxation policies
0 Utility rates/fees
3 Public safety rules/regulations
8 Dykeland management
1 Water conservation
2 Porous pavement
12 Stormwater management

6) Are there particular climate adaptation best practices that you would like to know more about? Please elaborate.

- Best practices for stormwater management; ecologically sound shoreline protection measures and erosion control; and storm surge protection.
- Further information on green/living shorelines; conservation easements; rolling easements; Dutch cost-benefit calculations for dyke height determination; and cost-benefit analyses for the purchase and relocation of buildings in vulnerable environments.

7) Where do you turn for guidance in terms of climate change mitigation/adaptation?
20 Provincial agencies
11 Federal agencies
4 Regional entity (please specify)
8 College/university researchers
1 Nongovernmental organizations (please specify)
1 Businesses
13 Peer network (*i.e.,* other municipal officials)
1 Newspapers
1 Television/radio
7 Websites
1 Other (consultants/engineers)

8) What are the key constraints for your community preventing action in terms of climate change adaptation?
14 Lack of staff time
10 Lack of expertise/data to guide decision-making
8 Lack of concern/political will
5 Lack of community consensus on need for adaptation planning
4 Lack of community consensus on best actions to take
16 Inadequate funds for planning and implementation
0 Other

9) What resources would be most useful to help decision-makers in your community take adaptive actions?
15 Information
19 Funding
18 Best management guides/adaptation manuals for municipalities
5 Training videos
1 Other Resources (expert news releases)