Examining Community Adaptive Capacity to Address Climate Change, Sea Level Rise, and Salt Marsh Restoration in Maritime Canada

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Executive Summary

The climate in Maritime Canada is changing and sea level is rising. Of great concern are the many stretches of dykes that provide protection to agricultural land, infrastructure, homes and communities. These dykes also inhibit salt marshes from naturally shifting with the level of the sea, and absorbing and dispersing the impacts of intense wave action. There are three adaptation strategies for society to consider: raising and reinforcing the dykes, realigning the dykes, or restoring dykelands to natural salt marsh. This report focuses on salt marsh restoration, which is a relatively new activity in the Maritimes, especially around the Bay of Fundy. Only a handful of sites have been restored to date. This report does not deal with unplanned restorations. We focus on community involvement and capacity building during planned restoration projects. To gain a better understanding of the challenges and opportunities for salt marsh restoration in Maritime Canada, a multidimensional study was undertaken by the Mount Allison Coastal Wetlands Institute and the Rural and Small Town Programme of Mount Allison University with funding from Canada's Climate Change Impacts and Adaptations Program and New Brunswick's Environmental Trust Fund.

Six separate but linked research activities were conducted including the monitoring of a restored marsh at Musquash, in southwestern New Brunswick; a literature review on community adaptive capacity and biophysical conditions; a two day workshop was held on salt marsh restoration as an adaptation method; various key informants were interviewed; policy and legislation related to salt marsh restoration were researched; and during a second workshop, with the use of a hypothetical dykeland flooding scenario, community adaptive capacity for decreasing the negative impacts associated with flooding events was measured using a framework we developed, with Sackville, New Brunswick as a case study.

This report provides a summary of our research findings and conclusions. It begins by providing some background information on climate change impacts and sea level rise, and the benefits of salt marshes in adapting to a rising sea level. Salt marshes are coastal ecosystems of invaluable significance because they fulfill such an important number of ecological functions, including filtering pollutants, flood protection, wildlife habitat, carbon sinks, self adaptation to sea level, as well as cost-effective human protection.

We then briefly introduce the reader to some of the main planned salt marsh restoration projects in the Maritimes, according to data collected during key informant interviews. Some projects are the result of compliance-enforcement issues where the landscape was altered illegally. Others are the result of simply wanting to restore the function of a wetland. Restorations of note include Musquash, NB, Cheverie Creek, NS, Red Head, NB, Ruisseau à Sivret, NB, Newfoundland Creek, NB, Walton's Creek, NS, Allain's Creek, NS, and Ten Mile House, PEI.

The ecological benefits of restoring salt marshes and the biophysical parameters for a successful restoration are then explained. Success in a salt marsh restoration is evaluated using the criteria set at the beginning of the project which is why, aiming for

realistic objectives is important, particularly when these are to be cited on legal documents, such as permits, agreements and contracts. This section also addresses some common concerns with salt marsh restoration such as salt water intrusion into nearby wells and property flooding.

Economic conditions are then discussed including the challenge of economic valuation of natural capital. The economic values of wetlands and salt marshes are diverse. They are used for eco-tourism, sport and commercial fishing, hunting, bird watching, as well as a variety of other activities. It can be very difficult to place an economic value on a natural resource such as a salt marsh, and the science of economic valuation is still developing. The report describes the pros and cons of three valuation models: willingness to pay, the alternative cost method, and total economic value.

An analysis of vulnerability and community adaptive capacity follows. Adaptive capacity is the ability of a community to make adjustments in order to decrease its vulnerabilities, moderate damages, take advantage of opportunities, and cope with changes. It is a measure of a community's resilience in the face of change. A community may be vulnerable to climate change for a variety of biophysical and socio-economic reasons. The same weather event can have different affects in different communities. Effects differ due to a multitude of socio-economic conditions within individual communities.

The report goes on to examine barriers and challenges for restoration. The key informants and Salt Marsh Restoration Workshop participants reported various challenges and barriers for restoration projects including lack of funding, lack of experience, lack of awareness and support among the public, lack of awareness and commitment from government, logistical problems, and stakeholder and land use conflicts. Key informants also commented on the unique opportunities that some of the local communities and residents presented.

Determinants of adaptive capacity are measured and compared. Suggestions for building capacity, knowledge and engagement are discussed. Some authors offer suggestions to combat risks from climate change and sea level rise by measuring adaptive capacity. A new tool called the Measuring Adaptive Capacity Tool was developed and tested and is presented here. The table includes five capacity areas: knowledge resources, institutional resources, economic resources, human resources, and social resources. The table can be used by any community wanting to measure its adaptive capacity to take action and adopt strategies that deal with sea level rise and reduce negative impacts and risks associated with a flooding event, such as adaptation through salt marsh restoration.

When a community group decides to restore a salt marsh because of its ecosystem services, economic, and/or social values, it is very important to educate the local community and stakeholders. Thus, during our workshop on salt marsh restoration we collected ideas for public education including: workshops with stakeholders, incorporating wetland education as part of school curriculum, creation of databases, environmental messages on every day items, educational bill boards, climate change video games, field trips, community events, 'Heritage Moments' television commercials, increased funding for ecotourism that offers interpretive services, and ‘Adopt-a-Marsh’ campaigns.

Once a community has decided it wants to undertake salt marsh restoration, it is important to identify local priority areas for restoration. However, we currently lack well tested methods to assess dyked and drained salt marshes for their restoration potential. What does a community need to know about the dyke, the adjacent lands and uses, etc.? Some potential criteria, according to Salt Marsh Restoration Workshop participants, are risk assessment, stakeholder opinions, physical characteristics of the dyke, physical characteristics of the dykeland, the costs and benefits of adaptation, and policy considerations.

The report goes on to discuss the importance of community consultation in any restoration project. It is vital that the public be consulted, that their concerns and questions are addressed, and that they are engaged in the process. Some consultation methods include publishing articles in local papers, posting signs, mailing letters and updates, holding community meetings, offering a hotline for questions and concerns, publishing newsletters, having an information kiosk at a prominent community spot, sending plans and updates to local landowners, presentations to students and teachers, marsh walks, and kitchen table meetings.

A brief discussion of the policy environment for salt marsh restoration in both New Brunswick and Nova Scotia is presented. The political framework that a community would find itself in while undertaking a salt marsh restoration around the Bay of Fundy includes both federal and provincial legislation and regulations. Some of the important policies and legislation include: The *Federal Policy on Wetland Conservation*, *Canadian Environmental Assessment Act, New Brunswick Wetlands Conservation Policy*, *New Brunswick Watercourse and Wetland Alteration*, *New Brunswick Coastal Areas Protection Policy*, *Nova Scotia Policy Respecting Alteration of Wetlands*, and the *Nova Scotia Agricultural Marshland Conservation Act*.

While some permits and approvals may be long and costly to obtain, the main barrier to restoration is not found in policies and legislation, but is the lack of knowledge and study about salt marsh restoration. There have been few discussion papers on Canadian wetland policy, especially salt marsh policy. Furthermore, while there are some foggy jurisdictional issues in the coastal zone, there are no policies that truly prohibit salt marsh restoration. However, salt marsh restoration remains a new idea and is not yet on the minds of the general public. Climate change is a confusing topic for many, and the general public lacks understanding of the issues, including sea level rise. Communities and non-governmental organizations also need to work in partnership with the federal and provincial governments to develop more effective policies where, perhaps, restorations can be expedited through the environmental impact assessment processes, common goals can be reached, and methods of evaluation can be created. In summary, the general policy environment is more positive than negative toward salt marsh restoration, but remains in its infancy.

The report continues with a list of recommendations for successful community-based salt marsh restoration projects. Key informants, workshop participants, and the literature reviewed stressed the importance of public education and stewardship, the need for leadership, communication with local people as well as gaining their support for the project, taking a holistic approach, and what to do before, during and after a restoration.

In conclusion, we provide a list of gaps in knowledge as well as important areas requiring further research in the future. Climate change adaptation and salt marsh restoration remain relatively new research domains. Thus, there are areas that are in need of research attention including: human responses to climate change; vulnerability and adaptive capacity studies; the collection of local information about climate change processes, sea level data, and zones of vulnerability; criteria for assessing dyke infrastructure; appropriate policy development; best practices; and the role of community consultations in salt marsh restorations. Work to develop methods to evaluate the economic and social values of salt marshes should continue. Furthermore, communities and regions need to begin measuring their adaptive capacity. Perhaps most importantly, awareness about climate change, sea level rise and the potential of salt marshes in adapting to these changes needs to be at the forefront of the public mind.

It is our hope that communities, groups and governments wishing to undertake salt marsh restoration will take the lessons learned from this report, along with the Measuring Adaptive Capacity Tool in Appendix B, to measure their own capacity levels, look at their own situations, and design successful restoration projects that are suited to the local environment, ecology, community and stakeholders.

Acknowledgements

This multi-year project has been extensive and wide reaching and we wish to offer our gratitude to the many people who contributed to the success of our work. First, we want to thank Canada’s Climate Change Impacts and Adaptations Program and New Brunswick’s Environmental Trust Fund for funding. Gwen Zwicker was the project manager and took care of logistical details for the workshops. Students Rosie Smith and Allison Walker assisted with various research and field activities and data entry. Ellen Wall, Colin McKinnon, and Nancy Chiasson presented at the Salt Marsh Restoration Workshop. Craig Brett also presented at the workshop and edited sections of this report on economic valuation. Réal Daigle and George Woodburn presented at the Measuring Adaptive Capacity Workshop. Brian Herteis provided GIS mapping support. Finally, we wish to thank all of the key informants and workshop participants for their time and their valuable insight and ideas.

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List of Abbreviations

CCIAP	=	Climate Change Impacts and Adaptations Program
CV	=	Contingent valuation
CWS	=	Canadian Wildlife Service (Environment Canada)
DFO	=	Department of Fisheries and Oceans
DNR	=	Department of Natural Resources
DOT	=	Department of Transport
DUC	=	Ducks Unlimited Canada
EA	=	Environmental assessment
EAC	=	Ecology Action Centre
EC	=	Environment Canada
EHJV	=	Eastern Habitat Joint Venture
EIA	=	Environmental impact assessment
GIS	=	Geographic information system
HADD	=	Harmful alteration, disruption or destruction
NGO	=	Non-governmental organization
HHWLT	=	Higher high water large tide
MACWI	=	Mount Allison Coastal Wetlands Institute
MHW	=	Mean high water
MLA	=	Member of the Legislative Assembly
MOU	=	Memorandum of Understanding
MP	=	Member of Parliament
MPA	=	Marine protected area
NB	=	New Brunswick
NS	=	Nova Scotia
RDA	=	Regional Development Authority
RSTP	=	Rural and Small Town Programme
TEV	=	Total economic valuation
WTA	=	Willingness to accept
WTP	=	Willingness to pay

1. Introduction: Community-Based Salt Marsh Restoration

The climate in Maritime Canada is changing. Sea level is rising at 30 to 40 cm per century in the Bay of Fundy and this rate may double by the end of the 21st century. Of great concern in the Maritimes are some of the many stretches of dykes protecting agricultural land, roads, rails, power lines, houses, stores, and industries. These dykes are centuries old and their creation, meant to drain the fertile soil for agriculture, also meant the loss of an estimated 85% of the 365 km^2 of pre-colonial area of salt marsh in the Bay of Fundy (Gordon and Cranford, 1994). Salt marshes offer one way of adapting to sea level rise because they are natural buffers, shift with the level of the sea, and absorb and disperse the impacts of intense wave action.

As the climate changes and sea level rises, there will be three options for society to consider: raising and reinforcing the dykes, realigning the dykes, or restoring dykelands to natural salt marsh. Although dyke reinforcement will be necessary in some regions to protect vital infrastructure, salt marsh restoration can be a viable alternative in other regions. Furthermore, raising and reinforcing dykes will become progressively more expensive as time goes on and dykes cannot self-adapt to ongoing changes in climate and sea level as salt marshes do (Crooks et al., 2002). Therefore, communities may wish to consider salt marsh restoration as an adaptation to climate change. However, using salt marsh restoration as an adaptation will require special capacities and tradeoffs against other land uses.

The planned conversion of dyked land back to natural salt marsh is a relatively new activity in the Maritimes, especially around the Bay of Fundy. Only a handful of sites have been restored to date. Thus, to gain a better understanding of the challenges and opportunities for salt marsh restoration in the region, a multidimensional study was undertaken by the Mount Allison Coastal Wetlands Institute and the Rural and Small Town Programme of Mount Allison University with funding from Canada’s Climate Change Impacts and Adaptations Program (CCIAP).

This final project report focuses on the ecologic, economic, social, and policy conditions under which a community might employ dyke removal and salt marsh restoration in the Bay of Fundy region as an adaptive response to future climate change and sea level rise. This report does not deal with unplanned restorations. We focus on community involvement and capacity building during planned restoration projects. We also identify deficiencies in adaptive capacity which might prevent a community from undertaking such action in Maritime locations, and provide ideas for building adaptive capacity. We begin by summarizing our research activities.

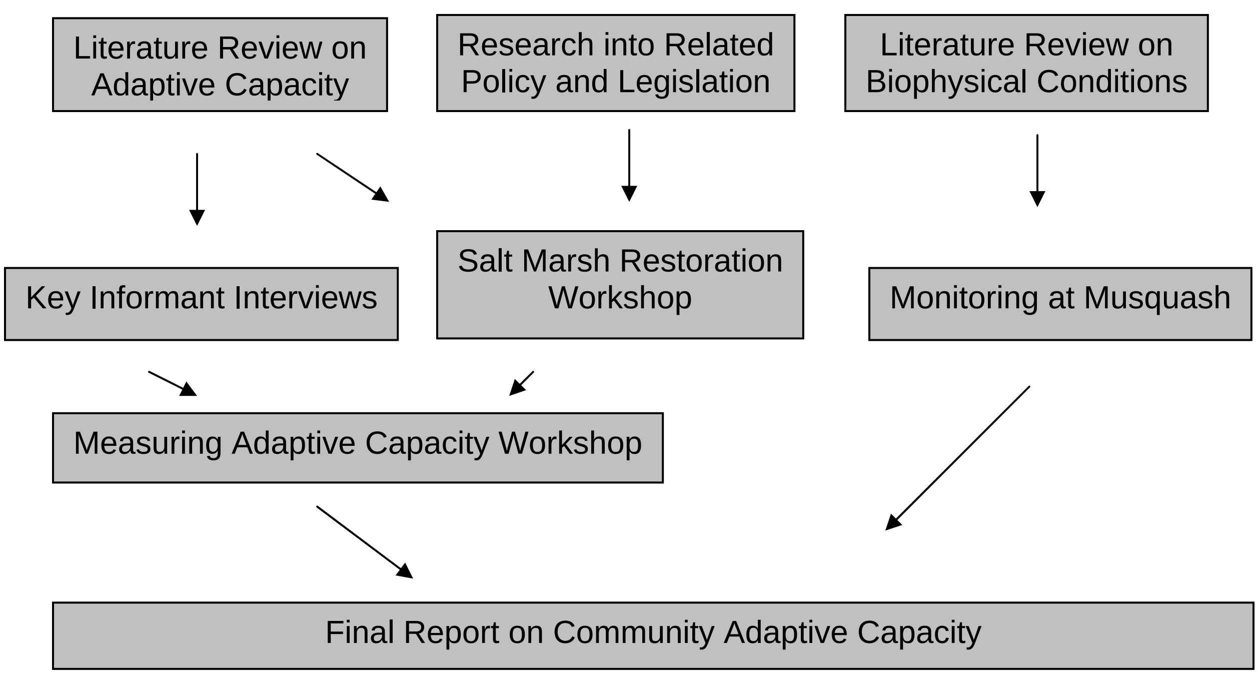
1.1. Methodology

Six separate but linked research activities were employed for this project:

- Monitoring of a restored marsh at Musquash, in southwestern New Brunswick, began in 2004.
- Literature reviews were conducted on community adaptive capacity and biophysical conditions.
- A two day workshop on salt marsh restoration as an adaptation method was held on campus at Mount Allison University in June 2006.
- Twelve key informants, experts in salt marsh restoration in the Maritimes, were interviewed.
- Policy and legislation that might apply during a community-based restoration project were researched.
- Finally, a hypothetical dykeland flooding scenario was presented at a one day workshop in November 2006 to assess the level of adaptive capacity and preparedness in the Tantramar, New Brunswick region to deal with sea level rise and increased severity of storms in the Bay of Fundy. During this workshop, a Measuring Adaptive Capacity Tool (see Appendix B) was developed and tested.

The research for this report was based on an evolving, multi-step process as shown in Figure 1.

Figure 1 - Diagram of Research Activities



Post-restoration monitoring work was conducted at Musquash. The team developed models of the marsh using a geographic information system (GIS). Components of the marsh monitoring program included studying changes in vegetation, sediments, etc. The team mapped the marsh with GIS in order to study changes over time.

Literature on sea level rise and community adaptive capacity for salt marsh restoration around the world was reviewed, with a focus on Maritime Canada. Roughly 250 internet sources, journals, government documents and non-governmental organization (NGO) reports were reviewed. The many definitions of adaptive capacity, and the various elements needed for successful adaptation including strong social, economic and environmental systems, equitable resource allocation, high skill levels, and the ability to disseminate useful information were examined. The challenges of economic and social valuation of salt marshes were also reviewed. Salt marsh restoration projects and the community consultation tools that were employed were compared. In addition, literature on biophysical conditions for salt marsh restoration was explored. Topics researched include scientific processes that are responsible for marsh restoration, impacts of climate change as well as restoration activities on salt marshes, vegetation distribution, primary and secondary productivity, gas cycling, along with other biological and physical processes involved in restoration. The literature review helped to inform our background work for the workshops, key informant interviews and to provide background for this final report.

On June 15th and 16th, 2006 the project team hosted a workshop entitled *Salt Marsh Restoration as a Community Adaptation to Climate Change and Sea Level Rise in Maritime Canada* (see Singh (2006) for the workshop report). Funded by the New Brunswick Environmental Trust Fund, it was designed as a tool to obtain preliminary community feedback on the option of using salt marsh restoration as a community adaptation strategy to sea level rise. Forty-seven stakeholders from all levels of government, First Nation groups, agricultural producers and associations, non-governmental organizations (NGOs), and community groups were invited. The workshop focused on three main questions:

- What are the barriers and challenges to using salt marsh restoration as a community adaptation?
- What are the criteria upon which such an adaptation strategy should be based?
- What educational concerns and strategies need to be considered to help move forward on this issue?

Twelve key informant interviews (with representatives of provincial and federal government departments, non-governmental organizations, local communities, and consultants from New Brunswick and Nova Scotia) were conducted to learn more about specific salt marsh restoration projects in terms of policy decisions, community consultations, stakeholder involvement, barriers, challenges, conflicts and how they were dealt with, as well as to obtain advice for communities considering salt marsh restoration (see Appendix A). The key informants reported on some of the salt marsh restoration projects in the Maritimes including Musquash, NB, Cheverie, NS, Red Head, NB, Ruisseau à Sivret, NB, Newfoundland Creek, NB, Walton's Creek, NS, Allain's Creek, NS, and Ten Mile House, PEI.

Research was conducted on the policy environment of salt marsh restoration in New Brunswick and Nova Scotia. We examined and compared policy, legislation and regulations that relate to salt marshes and their restoration around the Bay of Fundy. We paid careful attention to any policies which may create challenges or barriers against restoration and we highlighted gaps in policy and provided recommendations.

The final research activity was a workshop on measuring adaptive capacity for climate change and sea level rise using a dykeland flooding scenario in the Tantramar, NB region. We met with 13 stakeholders including representatives from the Town of Sackville, Dorchester Emergency Measures Organization (EMO), New Brunswick Power, CN Rail, New Brunswick Department of Transportation, New Brunswick Department of Agriculture, Environment Canada, Mount Allison Department of Geography, and the Tantramar District Planning Commission. The objectives of the workshop were to discuss ways of decreasing potential negative effects of a flooding event and to measure existing capacity to deal with sea level rise. Measurement was done with a Measuring Adaptive Capacity Tool which we developed (see Appendix B).

1.2. Outline of the Report

This final report provides a summary of our research activities, findings and conclusions with respect to salt marsh restoration as a viable adaptation method to sea level rise in the Bay of Fundy. The report begins by providing some background information on climate change impacts and sea level rise, and the benefits of salt marshes in adapting to rising sea level. We then briefly introduce the reader to some of the existing salt marsh restoration projects in the Maritimes. The ecological benefits of restoring salt marshes and the biophysical parameters for a successful restoration are then explained. Economic conditions are discussed including the socio-economic values of both dykelands and salt marshes, and the challenge of economic valuation of natural capital. Social conditions and an analysis of vulnerability and community adaptive capacity follow. Challenges and barriers to salt marsh restoration as collected from the Salt Marsh Restoration Workshop are provided. Determinants of adaptive capacity and measures are compared. Our Measuring Adaptive Capacity Tool is introduced and explained. Suggestions for building capacity, knowledge and engagement are included. Suggestions from key informants and salt marsh restoration experts are offered to communities considering salt marsh restoration. Finally, a brief discussion of the policy environment for salt marsh restoration in both New Brunswick and Nova Scotia is presented including current policies and legislation, political barriers, and we propose policy recommendations. The report concludes with a summary of the issues, challenges and opportunities, gaps in knowledge, and an examination of the next steps in salt marsh restoration around the Bay of Fundy.

2. Background and Context

The following section outlines some important background information on climate change and sea level rise in Canada and in the Maritimes. In particular, it explains the benefits of natural salt marshes for adapting to sea level rise.

2.1. Climate Change and Sea Level Rise

According to the IPCC (2001), climate change "refers to any change in climate over time, whether due to natural variability or as a result of human activity." The nature of climate change in Canada will be diverse because the country is so ecologically, climatically and socio-economically diverse. Canada has seven different climatic regions. Climate change will have a variety of impacts across the country – some positive and some negative. Warmer temperatures and longer growing seasons may contribute to economic development. Chiotti (1998) argues that agriculture and forestry exports could improve due to climate changes, transportation costs may decrease due to shorter winters, but impacts are less certain for energy and fishery industries.

General impacts that may be felt all across the country include a reduction in the quality and quantity of water; increased conflicts over water supply; buildings and construction integrity; and increased ice on power lines. While energy demands may decrease during the winter, they may increase during the summer due to air conditioning. Urban areas may be plagued by more intense and frequent heat waves and human health concerns.

Impacts in the rest of the world may be felt within Canada as well. The United States may need our water, and 'environmental refugees' from around the world may look to live in Canada (Chiotti, 1998). Yohe and Schlesinger (2002) argue that developing countries will be more vulnerable to the negative effects of climate change. The authors suggest that climate change could intensify income inequalities between and even within countries. Differences in socio-economic situations will impact on how different regions are able to respond to change.

> *According to the Intergovernmental Panel on Climate Change (2001), climate change "refers to any change in climate over time, whether due to natural variability or as a result of human activity."*

Chiotti (1998) claims it is more challenging to predict the costs associated with extreme weather events (storms, hurricanes, storm surges, flooding, droughts, etc.) than with general, gradual climate change. It is impossible to predict the intensity, frequency, length, and location of such events. These extreme events may prove to have a greater impact on the natural and social environments than gradual, general climate change.

According to many authors (Chiotti, 1998; De Maio and Thomassin, 2002; Chisholm et al., 2004; Ecology Action Centre (EAC), 2006; Environment Canada, 2006), climate change is expected to have a significant impact in Maritime Canada, especially with sea level rise. An increase in sea level along with a possible increase in the frequency and intensity of storms could lead to increased coastal erosion, flooding, storm damage, and property loss. Storm surges and floods are predicted to overtop or break through dykes around the Bay of Fundy. It will put increasing pressure on coastal defenses such as dykes, dams, and other barriers. This will increase the risk of flooding in coastal regions.

Many of the salt marshes around the Bay of Fundy have been dyked and converted for agricultural and other uses. These dykes will become more and more costly to maintain as sea level rises. One method of adapting to the inevitable sea level rise is to restore these lands back to their original state as salt marshes. This requires that communities have a certain adaptive capacity or the ability to adapt to change.

Rising sea level will also impact colonies of breeding and migratory birds (Maxwell et al., 1997 in Chiotti, 1998). Fish harvests may also decrease due to decreases in fresh-water discharge and ecosystem productivity (Shuter et al., 1998 in Chiotti, 1998). However, longer growing seasons may have a positive effect on the local economy.

There is much uncertainty in predicting the above impacts that climate change may have. As Yohe and Schlesinger (2002) state, “Demographic patterns, socio-economic development, future land-use and forestry practices, political evolution, and technological change will all drive emissions of greenhouse gases and sulphur dioxide over the requisite century-long time horizon; each driver is a source of enormous uncertainty.” However, according to Yohe and Schlesinger (2002), many impact predictions have ignored the potential for humans to adapt and use technology to overcome economic damage, and we would argue, environmental and social damage as well.

2.2. The Importance of Salt Marshes in Adapting to Climate Change

Salt marshes are an important and characteristic component of the Bay of Fundy coastal ecosystem. Indeed, the area covered by salt marsh in pre-colonial times is estimated to have reached 365 km^2 (Gordon and Cranford, 1994), leading Griffiths (1992 in Desplanque and Mossman, 2004) to refer to them as “[…] the largest salt marsh lands in the world.”

Salt marshes are coastal ecosystems (see Plate 1) of invaluable significance because they fulfill such an important number of ecological functions, of which humans also greatly benefit, including filtering pollutants, wildlife habitat, and carbon sinks. They are also sources of biodiversity.

Wetlands act as filters that improve water quality by absorbing excess sediment and nutrients (nitrogen and phosphorus among others) from land-based pollutants such as farm runoff, pesticides, sewage, urban and industrial wastes. Salt marshes thus play a role in preventing the eutrophication of estuaries and bays (Deegan and Buchsbaum, 2005). Indeed, some salt marsh restoration projects were undertaken in Sweden and the United States to reverse eutrophication in polluted estuaries (Fleischer et al., 1994; HRTC, 2006).

Plate 1 - Salt Marsh at Cape Jourimain, NB (Photo: Léa Olsen)

Salt marshes provide habitats and a source of food to a diverse array of plants and wildlife such as invertebrates, fish, birds, and mammals which in turn help sustain trophic linkages of associated ecosystems, such as mudflats, estuaries and bays. The most obvious characteristic of salt marshes may lie in their important contribution to primary productivity (Walters, 1990), which is the amount of solar energy that is turned into plant material by photosynthesis. In the Cumberland Basin, salt marshes make up 53.3% of the total primary productivity (Gordon and Cranford, 1994). This organic production is exported from the marsh as detritus and dissolved organic matter and makes its way into the diets of a number of fishes and invertebrates, thus contributing to secondary production - in other words, the growth and feeding of wildlife (Adam, 1990; Weinstein and Kreeger, 2002; Duque, 2004).

The role of marshes in sustaining secondary production also lies in the fact that fish use them as spawning areas and juvenile fish use them as feeding grounds (Olewiler, 2004; Duque, 2004; Weinstein and Kreeger, 2002). In fact, the positive correlation between the primary production of salt marshes and the secondary production of nekton formed the premise for one of the world's largest restoration projects which took place in Delaware. In order to offset massive destruction of fish larvae and juveniles that occurred annually downstream of its power plant, the Public Service Electric and Gas Company voluntarily restored 5,040 ha of salt marshes around Delaware Bay (Weinstein et al., 2001). Finally, this contribution to secondary production, most of which benefits fringing ecosystems, may especially be of interest when considering that, in the United States for instance, approximately two thirds of commercially and recreationally valuable fish species use estuaries at some point of their lives, either as habitats, feeding grounds or life-staging areas (Weinstein and Kreeger, 2002).

Salt marshes also release little greenhouse gases and are effective carbon sinks, taking in excess carbon dioxide (Conner et al., 2001; Chmura et al., 2003). This is done by photosynthesis and sediment accretion on the marsh surface. As an example of the usefulness of this function, it is estimated that if all of Canada's dykelands were reverted to salt marsh they would sequester four to six percent of Canada's necessary reduction in emissions under the goals of the Kyoto Protocol (Conner et al., 2001). This could be worth considering as "greenhouse gas emissions in Atlantic Canada are forecasted to increase by approximately 23% between 1990 and 2010", which amounts to an annual rate of increase of 1.1% (NRCan, 1999 in AMEC, 2005).

However, in the challenge to adapt to climate change and rising sea levels, they offer even more vital services: self adaptation to sea level, flood control, and cost effective human protection (Crooks et al., 2002). Salt marshes have the ability to rise with sea level by accruing sediment from the water column. As tidal waters inundate coastal salt marshes the marsh vegetation slows the speed of the water and causes sediment to fall out of suspension and be left on the marsh surface. Over time this process can raise the surface of the marsh. This process is relevant to maritime dykelands because the large amount of suspended sediment present in the Bay of Fundy suggests that there would be no shortage of sediment supply to the marsh (Amos and Tea, 1989 in Davidson-Arnott et al., 2002; New Brunswick Department of Agriculture, Fisheries and Aquaculture, 2003). Furthermore, Davidson-Arnott et al. (2006) refer to numerous authors (Stevenson et al., 1986; Bricker-Urso et al., 1989; Oenema and DeLaune, 1988; Patrick and DeLaune, 1990; Cahoon et al., 1996; Callaway et al., 1996ab), and claim abundance in sediment supply means that marshes could potentially, given the right circumstances, accrete at rates comparable, or even higher than sea level rise rates.

Salt marshes act as a buffer between the land and the sea. They mitigate a significant portion of the destructive energy, or erosion, associated with floods and storm surge events (Desplanque and Mossman, 2004). Salt marshes act as barriers between land and sea and provide space for increased amounts of sea water. According to Olewiler (2004), four-tenths of a hectare of wetlands can store over 6,000 m^3 of floodwater.

Without these buffers, the wave energy acts directly on dykes and, in the event of a breach, will act directly on occupied land or infrastructure potentially causing catastrophic damage. Additionally, salt marshes remove large portions of suspended sediment from the water column before the water reaches further inland, sediment that may otherwise find its way into towns, highways and other vital infrastructure (Davidson-Arnott et al., 2002). Desplanque and Mossman (2004) cite the case of the Salmon River near Truro (NS) which, in 1837, was used as a waterway by as many as 150 ships a day. By 1867, extensive dyking on Cobequid Bay had caused the river to fill up with so much sediment that it was closed to shipping.

> *In the challenge to adapt to climate change and rising sea levels, salt marshes offer even more vital services – self adaptation to sea level, flood control, and cost effective human protection.*

Relative to hard coastal defences like sea walls and dykes, salt marshes offer a cheap and cost effective tool for human protection (Crooks et al., 2002). Aside from the initial cost of dyke realignment or removal, salt marshes have the potential for self-maintenance and even expansion in perpetuity with little to no monetary input.

Salt marsh restoration is beneficial to both humans and the environment in the form of flood protection and many ecological services outlined above. The next section outlines selected salt marsh restoration projects in the Maritimes. We examine the reasons behind the restorations as well as the levels of public support.

3. A Brief Summary of Maritime Salt Marsh Restoration Projects

The following section provides an overview of the main salt marsh restoration projects in the Maritimes. The data was collected during key informant interviews.

3.1. Reasons for Restoration

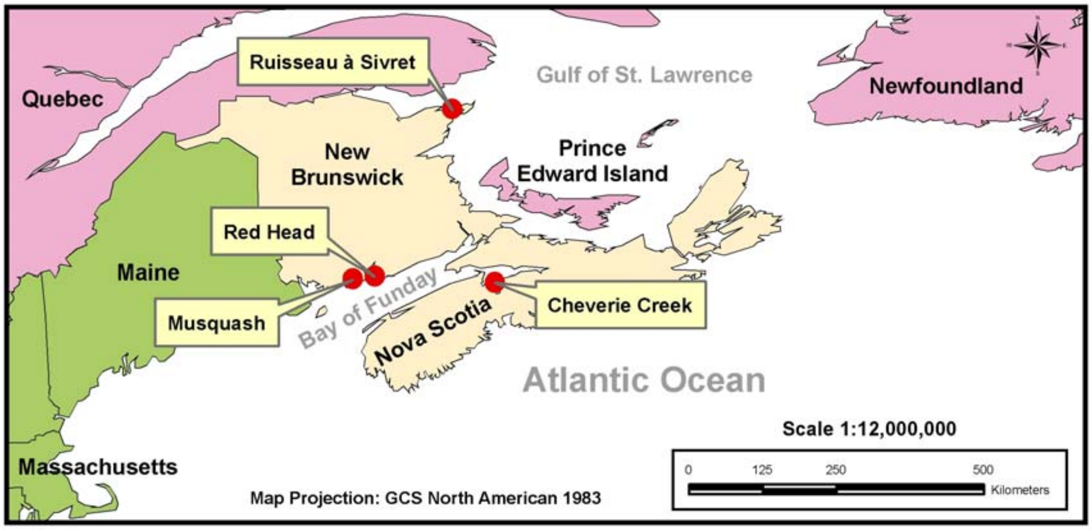
To date, planned salt marsh restorations in the Maritimes have come about due to a variety of reasons and factors, some of which are outlined below:

- Compliance-enforcement. (If a landscape is altered illegally, it must be restored.)
- Restoration of the function and productive capacity of a wetland and/or coastal habitat.
- Opportunity. (Restoration projects have, for the most part, just happened without much regional planning in mind. Scientists and government have not been able to focus on sites that could benefit the most from restoration.)
- Reversal of negative environmental effects. (Examples include the removal of clogged culverts or old unused rail beds.)
- Maintenance. (It can be less expensive to remove a control structure than to maintain it.)
- Improvement of fish passage and/or to increase access by diadromous species.

3.2. Projects in the Maritimes

With the use of key informants’ comments, a short summary of selected restoration projects is discussed below. We focus on restorations at Musquash, NB, Cheverie Creek, NS, Red Head, NB and Ruisseau à Sivret, NB. Their locations are shown in Figure 2.

Figure 2 - Map of Selected Salt Marsh Restoration Sites in the Maritimes



Source: Data provided by ESRI Canada (ESRI Data and Maps). Map prepared by Brian Herteis.

3.2.1. Musquash, NB

Musquash, NB was the first salt marsh restoration set up as a research project with multidisciplinary pre- and post-monitoring and research in New Brunswick (see Plate 2). It is located in southwestern New Brunswick and comprises 15 ha (38 acres) of wetland. At Musquash there was dyked land behind a rail bed and it was reverted back to salt marsh by dismantling 1,097 m (3,600 ft) of the abandoned rail bed. The project began in 2004 and was lead by Ducks Unlimited Canada (DUC), on its own land. Musquash offered an opportunity for pre- and post-monitoring. DUC likes to take part in living research and so the study looked at how long it takes to restore an area to salt marsh, what comes back first, etc. The restoration work was completed in the spring of 2005 and monitoring of the site is on-going.

Plate 2 - Former Agricultural Land at Musquash, NB (Photo: Angela Pitcher)

3.2.2. Cheverie Creek, NS

Cheverie Creek is the first intentional salt marsh restoration that incorporated a full suite of research parameters on the Nova Scotia side of the Bay of Fundy. Cheverie is located near Summerville along the Kempt Shore of the Minas Basin in the upper Bay of Fundy (see Plate 3). An old culvert under Route 215 was restricting tidal flow to the creek and surrounding marsh.

The restoration potential of the site was identified in 2001 through work done by Nova Scotia's EAC and an advisory board made up of academics, government agents, and other stakeholders. The EAC identified all tidal crossings between the Kempt Shore and Shubenacadie River. The EAC wanted a restricted site that would benefit from restoration, a site that would be manageable and inexpensive to restore with simple engineering, and a site that could be used as a demonstration site (i.e. a site that was easily visible and accessible).

Plate 3 - Cheverie Creek, NS (Photo: adapted from http://www.bofep.org/eacsaltmarsh.htm)

The EAC also wanted to strike a balance between economics and community. They wanted their first restoration attempt to be manageable and not too costly. However, they also wanted a site that was within a community that would be accepting of salt marsh restoration. The EAC wanted to capitalize on education, and promote the site. Key informants expressed that the Cheverie area was already active environmentally. There are a number of groups active on environmental issues, including the local school in Summerville.

Plate 4 - Cheverie Creek Before

Plate 5 - Cheverie Creek After

Photos: adapted from http://www.ecologyaction.ca/coastal_issues/coastal_gallery.shtm

The EAC approached the school to see if they were willing to host a public meeting about the project. The school was already a 'Blue School' and had been part of the federal program since 1998. (The program focuses on aquatic health, and funds related projects.) So it was natural for the school to be involved. Grade five and six students showed their projects on the creek during Oceans' Day 2006. Some teachers applied for an Arts Smarts grant to fund a video project and a papier maché replica of the marsh and they were successful. The students in the two grade five-six classes worked with artists, scientists, and a videographer. They videoed the marsh, researched it, and demonstrated what a marsh could do. The video made an argument for salt marsh restoration. An open house was held and the video and the papier maché marsh were shown. Because the students were involved, the parents became involved too, increasing the level of support in the community. The culvert was replaced late in 2005 (see Plates 4 and 5 above) and the community now has plans of their own to build an interpretive centre and a boardwalk.

3.2.3. Red Head, NB

Red Head is found in the city of Saint John, NB. It was a DUC managed fresh water wetland, but had been tidal at one point. There were concerns by the federal Department of Fisheries and Oceans (DFO) that fish habitat may have been altered due to the impoundment. There was some tidal flow to the area, but it was not a salt marsh. There was saltwater coming up past the fishway (or fish ladder) so it made good sense to restore the area to salt marsh. DUC wanted to do the right thing and return it to a tidal system, which was done in 2005. At Red Head there was mixed support because people viewed the new mudflats as muddy and ugly and thus DUC worked hard with education programs and signage. Monitoring of the site is currently on-going.

3.2.4. Ruisseau à Sivret, NB

Ruisseau à Sivret is located in Bas Caraquet, NB. A local landowner had been slowly infilling the creek and marsh for 25 years in order build a road to gain access to a nearby beach. The project was suggested to DUC by the mayor who saw an opportunity to restore a salt marsh. The mayor helped DUC with some of the landowner negotiations. He also helped supervise the work so there was a strong community role. Because of new provincial policies it was seen as a good opportunity to restore a salt marsh. Furthermore, the salt marsh was home to the rare Maritime Ringlet Butterfly, which provided an important reason to restore the habitat. The landowner eventually changed his perception of the marsh and DUC and the community applied to the provincial government for funding. The restoration was completed in 2005 and monitoring of the site is currently on-going.

3.2.5. Other Sites

Table 1 provides a summary of the four selected restoration projects. Some of the key informants also briefly mentioned other smaller restorations in the Maritimes including Newfoundland Creek, NB (the landowner did not want his dyke maintained anymore. The restoration was completed in 2001.), Walton's Creek, NS (a project lead by DUC on NS DNR land and completed in fall 2005), Allain's Creek, NS (restored by DUC in 2000), and Ten Mile House (a restoration in Prince Edward Island in 2001).

Table 1 - A Comparison of Selected Salt Marsh Restoration Projects

Name	Area of Restored Marsh	Challenges	Capacities Built	Comments
Musquash, NB	15 ha	First salt marsh restoration set up in New Brunswick as a research project with multidisciplinary pre-and post-monitoring and research.	Post monitoring skills.	Musquash has been a scientific experiment to learn the processes involved in restoration.
Cheverie Creek, NS	25 ha	First intentional salt marsh restoration that incorporated a full suite of research parameters on the Nova Scotia side of the Bay of Fundy.	The EAC learned all about the process of salt marsh restoration and the benefits of early and ongoing community consultations. Students at the local school learned about marshes and created a video and model of a marsh.	The community was already active environmentally and they have now taken the project further by buying land adjacent to the marsh and have plans to build an interpretive centre and trails.

Name	Area of Restored Marsh	Challenges	Capacities Built	Comments
Red Head, NB	71 ha	Educating the public and gaining their support for the restoration.	Local stakeholders came to understand the importance of natural salt marshes. Ducks Unlimited Canada (DUC) confirmed that educating the public is very important before, during and after a restoration.	Red Head was near an urban area and was a popular fresh water marsh so it was challenging to convince the public that a muddy, smelly salt marsh was better.
Ruisseau à Sivret	16 ha	Convincing a local landowner to stop infilling a marsh stream.	The local community learned supervisory skills, project management, communication, and monitoring.	Ruisseau à Sivret is a good example of a community working together to build capacity and restore an important marsh ecosystem.

4. Ecological Aspects of Salt Marsh Restoration

4.1. Biophysical Description of a Salt Marsh

Salt marshes are ecosystems found within estuaries and sheltered coasts that lie between open salt water and dry land, and are subjected to tidal influence (Adam, 1990). They are characterized by a low slope and a dendritic (tree-like) drainage network made up of tidal channels and pannes (ponds) that cut through a soil of fine sediments (Allen, 2000). In the Bay of Fundy, the seaward margin of prograding marshes is surrounded by extensive mudflats, while on eroding marshes, it is typically characterized by small cliffs, centimetres to a few metres in height (Allen, 2000; Desplanque and Mossman, 2004).

As long as sediment supply is sufficient, marshes can build-up (accrete) vertically and horizontally (seaward). This supply can come from nearby rivers, the erosion of coastal cliffs and intertidal sea-floor, the shells of marine organisms, sewage and industrial waste (Allen, 2000). Sediment builds-up into layers when it is carried directly over the marsh platform by rising water and overflowing tidal channels. The suspended sediment is then redistributed by waves over the marsh and able to settle on the surface once the current slows down and wave activity is low (Davidson-Arnott et al., 2002; van Proosdij et al., 2006b). Stranded ice may also deposit mud on marshes once it melts and in the Cumberland Basin (Upper Bay of Fundy), appears to be the main input of sediments to the high marsh (Ollerhead, 1999; van Proosdij et al., 2006b). The rate at which vertical accretion occurs is controlled by different factors, notably, the sediment supply, the rate and extent at which the marsh is flooded and flooding duration, the efficiency of the drainage system to carry tide waters into the marsh and the density and nature of the vegetation cover which traps the sediment (Allen, 2000; van Proosdij et al., 2006ab).

Salt marshes support salt tolerant plant communities that, in natural and mature marshes, are typically arranged in bands parallel to the water and drainage network - in other words, the elevation gradient of the marsh. Three grass species belonging to the genus *Spartina* dominate the vegetation and occur in association with a number of other characteristic species. Salt water cord grass (*Spartina alterniflora*) communities grow closest to open water, up to about one metre under the mean high water (MHW) level and are flooded daily, 13 to 15% of the time (Shaw and Ceman, 1999). Salt-meadow cord grass (*Spartina patens*) communities grow above the former, and are flooded one to two percent of the time (Shaw and Ceman, 1999). Freshwater cord grass (*Spartina pectinata*) communities grow highest on the marsh where they can only be reached by the highest spring tides and where they also receive freshwater runoff from adjacent uplands (Thomas, 1983).

The marsh edge, creek banks and fringing mudflats of Bay of Fundy marshes are inhabited by a number of small invertebrates who live in the mud, mostly amphipods like the mud shrimp (C*orophium volutator*), worms (*Nereis* spp.), bivalves (the blue mussel, *Mytilus edulis,* and *Macoma baltica*) and marine snails (*Hydrobia minuta* and *Littorina saxatilis*). A few species of small fishes, the mummichog (*Fundulus heteroclitus*) and sticklebacks are permanent residents of the marsh (retreating to pans at low tide) (Thomas, 1983; Rangeley and Singh, 2000). Marshes and adjacent mudflats are also feeding grounds for a number of fish who come to forage at high tide such as the winter flounder, tomcod, and rainbow smelt. Elvers (small adults) of the American eel may migrate up main creeks in the spring (LeBlanc, 1974 in Rangeley and Singh, 2000). Furthermore, Trites et al. (2005), citing Hicklin and Smith (1984), Daborn et al. (1993), and Shepherd et al. (1995) claim that Bay of Fundy mudflats are key feeding grounds for some bird species, notably the semi-palmated sandpiper (*Calidris pusilla*) of which 75 to 95% of the world population stops to forage on *C. volutator* during its fall migration. Other birds who typically forage and use Bay of Fundy marshes as a staging area include the American black duck, American wigeon, Mallard, American green-winged teal, Blue-winged teal, American bittern, Great blue heron, Greater yellowlegs, Common snipe, Canada goose and Nelson sharp-tailed sparrow, a marsh specialist (Deichman, 1999 in Rangeley and Singh, 2000; Maxie and Hamilton, 2006).

4.2. Biophysical Benefits of Restoring Salt Marshes

A salt marsh restoration involves reconnecting the impounded marsh with adjacent coastal waters as a means to restore tidal flow to it as well as dependent natural physical and ecological functions. This can require the full or partial removal of an obstruction, such as a dam or dyke, or in cases where excessive inundation is feared, fitting it with a properly sized and placed culvert or self-regulating tide gate. More complex projects, mainly in the United States, have also involved physically rebuilding marshes that were destroyed by development projects (Adam, 2002; French, 2006).

Some reclaimed marshes are better candidates then others for restoration and experience from projects around the world has often confirmed this (French, 2006). Local environmental and geographical conditions, the nature of the marsh substrate and the use that was made of it while reclaimed, dictate whether in the longer term the marsh will start to recover or rather turn into a mudflat when tidal flow is returned to it (French et al., 2000; French, 2006).

A suitable restoration candidate will be launched, once it is re-inundated, on a trajectory that will eventually see it revert to a functional salt marsh. The chain of events that occurs when the tide is returned to such a site is comprised of physical and biological changes that start occurring almost immediately, while others take longer, up to a hundred years (Crooks et al., 2002; Warren et al., 2002). Short-term change is often characterized by authors as five years and less, while long-term change is viewed as five years and over (Warren et al., 2002; Boumans, 2002). Changes of physical nature that occur either immediately or over a short lapse of time (days, weeks) include increases of salinity levels of the marsh’s groundwater and soil, water table levels and sediment (mineral) supply (Warren et al., 2002). Natural biogeochemical processes resume as the soil becomes waterlogged with salt water, and nutrients such as nitrogen and phosphorus start being assimilated again.

Longer term effects include a gradual elevation increase of the sediment deprived and often subsided marsh surface, through sediment build-up, which usually occurs more rapidly on marshes that are flooded more often (referred to as ‘young’ marshes by many authors) than on ‘mature’ marshes, whose surfaces have reached an elevation in equilibrium with sea level (Allen, 2000; Weinstein and Kreeger, 2002). On the Bay of Fundy, this level lies “near or above the mean high tide level” (Davidson-Arnott et al., 2002), about 1.2 m below the highest astronomical tides (Desplanque and Mossman, 2004). The rate at which a restored marsh will rebuild itself vertically is variable. Mathematical models developed over the years (Davidson-Arnott et al., 2002; Temmerman et al., 2004) combined with field studies (Temmerman et al., 2004) indicate that sediment accumulation rates tend to be higher on marsh platforms below this equilibrium value.

The lower the marsh lays in the tidal frame, the faster the rate of accumulation (as long as the sediment supply is sufficient and can settle). This trend keeps up until the marsh starts approaching equilibrium - and then starts to slow down (otherwise described as an *asymptotic* curve). This can take place in a matter of years on marshes whose elevation is fairly close to natural values at the time of restoration, and decades or more on marshes that have subsided (Temmerman et al., 2004; French, 2006; Cundy et al., 2002). van Proosdij et al. (2006b) found the sedimentation rate on a natural and mature marsh of the Cumberland Basin (Upper Bay of Fundy) to range between 8 mm year $^{-1}$ and 14 mm year $^{-1}$. Chmura et al. (2001) report rates in the Bay of Fundy ranging between 1.3 ±0.4 mm year $^{-1}$ to 4.4 ±1.6 mm year $^{-1}$ for the past 200 years. Finally, Grant wrote in 1975 about a 300 year old corduroy road exposed at low tide on the shore of Fort Beausejour and covered by a one metre thick layer of silt which gives us a rate of about 3 mm year $^{-1}$. Based on the evolution of sedimentation rates described by models, these values give us some insight on what minimal rates of sedimentation could be expected from a recovering site in the Bay of Fundy.

The marsh drainage system, another physical attribute of salt marshes, may start restoring itself in a matter of months. New channels may be created by scouring currents where the seawall was breached or removed; old channels may be reactivated; and new ones may also evolve from man-made channels, such as drainage ditches (Allen, 2000; Chmura and MacDonald, 2006). Over time, it develops complexity and sinuosity, creeks of different order (depth and width), and increases over the marsh until a maximum density is achieved (Allen, 2000; Crooks et al., 2002). Where adequate conditions exist, the drainage network can re-establish itself in a matter of decades (Allen, 2000). There are cases where channels were dug out before the restoration to help the development of an efficient drainage network over the marsh and ensure a maximum return of marsh functions (physical and ecological) (Weinstein and Kreeger, 2002).

Studies of marsh restorations carried out in New England over the past 25 years provide an idea of the speed with which some biotic components of marshes may restore themselves. Warren et al. (2002) who reported results from nine separate restored sites found that, compared to the reference marshes, typical assemblages of transient fish (who forage in creeks at high tide) were restored within five years. Roman et al. (2002) found that nekton densities and species richness were similar after one season; Burdick et al.’s data (1997) seem to show that fish species return quickly after a restoration as no significant differences in densities were found between their restored and reference sites, a finding also supported by Simenstad and Thom (1996 in Burdick et al., 1997). Other results from Warren et al. (2002) showed that foraging opportunities for resident fish of the marsh and breeding bird populations took up to 15 years to reach equivalence and 21 years in the case of *Melampus bidendatus* (a species of snail) densities. They also found that bird generalists used the restored sites more than the natural reference sites, a result which is also reported by Maxie and Hamilton (2006).

Salt marsh vegetation was found to re-establish itself at a rate of 0.5% to over 5% of the total area per year (Warren et al., 2002). Roman et al. (2002) found vegetation to be significantly different after one growing season (although, not re-established). At the Musquash, NB restoration site, the vegetation observed since 2004 was that of a salt marsh, although not organized in a natural marsh. Typical brackish/salt marsh species (*Spartina pectinata* and *Carex paleacea*) were observed to have replaced freshwater and woody vegetation on higher ground while creek banks and lower areas were covered with mats of pioneer species such as *Atriplex* spp., *Agrostis stolonifera, Cotunia coronopifolia* (although an uncommon species) and sparse or stunted representatives of low and high marsh dominant species, such as *Spartina alterniflora* (Olsen and Ollerhead, 2006). Normal vegetation assemblages may take years at this site to resemble those of surrounding natural marshes. Crooks et al. (2002) conclude in their study that marsh vegetation can be fully regenerated within 100 years of being naturally restored by dyke breaching.

4.3. Biophysical Parameters for a Successful Restoration

Success in a salt marsh restoration is relative to the criteria set at the beginning of the project which is why, aiming for realistic objectives and a realistic time frame is important, particularly when these are to be cited on legal documents, such as permits, agreements and contracts.

The notion of a successful restoration often implies returning equilibrium to the targeted site, which usually means getting it to revert to its original condition or reach equivalence with a nearby reference marsh in terms of biophysical processes and functions, species assemblages and density, etc. This objective however can be problematic if not unrealistic in some respects (Warren et al., 2002). First, equilibrium may take decades or a century to reach whether looking at parameters such as diversity or density of fish, invertebrates or birds, or sediment accumulation. This is particularly true if the restored marsh remained cut off from tidal action for a long period of time and thus was deeply transformed through subsidence, channel infilling, anthropogenic impacts, etc.

Second, equilibrium may also be based on comparing processes and functions of the restored marsh to that of a natural reference marsh. This can also be problematic as each marsh may remain indefinitely dissimilar as a result of being subjected to different environmental conditions due to its setting or simply intrinsic differences. Equilibrium is also a relative notion which makes it difficult to measure (Warren et al., 2002). Thus, realistic criteria for success could be set with regard to a goal. For instance, if a marsh restoration is to be carried out as part of a coastal management realignment plan whereby the impact of sea level rise and storms are mitigated, than success could be achieved once salt marsh vegetation is well regenerated (and ensures the sustainability of the physical marsh). If the restoration is a conservation initiative, then success could imply restoring ecological functions to a degree that is scientifically sound and satisfying to the eyes of proponents and stakeholders.

A marsh restoration, if it is to be successful both from a conservation and a socio-economic perspective, has to be carried out with some planning, particularly in developed areas where infrastructure may be vulnerable (Roman et al., 1995; Weinstein et al., 2001; Adam, 2002; Crooks et al., 2002; HRTC, 2006). Knowledge of pre-restoration conditions is the first step and involves gathering data about the marsh (Burdick et al., 1997; Neckles and Dionne, 1999; Roman et al., 2002; Warren et al., 2002).

Factors which promote the recovery of a marsh, and thus make it a suitable candidate for restoration are: (1) surface elevation, which at a suitable site should lie higher rather than lower within the tidal prism so as not to create excessive flooding; (2) an ample sediment supply which will accrete over time and offer suitable substrate for plant colonisation; and (3) a sheltered location which promotes optimal (calm) depositional conditions.

The first and perhaps key piece of information that should be documented is the impounded marsh's surface elevation relative to the tides (French, 2006). These data are needed to model how the marsh will be affected by re-inundation, to determine what parts of the marsh are going to be flooded, and estimate how many hours a day and times a year flooding will occur (Roman et al., 1995). This is important as it helps determine the chances of success for the marsh to regenerate itself and then whether the restoration of tidal flow can be carried out abruptly, by simply removing all or parts of the seawall, or gradually, through small breaches in the latter or use of flow-restricting structures such as size specific culverts and tidal gates.

The longer a marsh is cut off from tidal flow, the more likely it is to have subsided (sunk vertically) and be much below current sea level. Historic dykelands for instance, are often tens of centimetres below current sea level. The recently restored marsh at Musquash, NB, for instance was found to be about 50 cm lower than the adjacent natural marshes (Pitcher, 2004). French (2006) writes that there is no "golden value" at which the marsh surface elevation should lie. Projects in the United Kingdom seem to indicate that an elevation that sees the marsh flooded 450-500 times a year is ideal (Toft and Maddrell, 1995 in French, 2006). This value should be determined locally and based on the amount and frequency of flooding natural, mature marshes get in the targeted area.

Boumans et al. (2002) states there are a number of documented cases in the United States (Weinstein et al., 2001; Burdick et al., 1997) of restorations that failed due to uncontrolled inundation over target marshes that had low surface elevations and thus were submerged for exceedingly long periods of time. Too much water on a recovering marsh can inhibit the growth of new vegetation, and ultimately turn it into a mudflat, which also promotes its erosion (Weinstein et al., 2001). Some former dyked marshes in England also bear testimonial that not all marshes are revived once reconnected with tidal flow (even when other conditions for success are met). Although all causes have yet to be pinpointed, wind generated waves that re-suspend sediment from the marsh platform appear to be the main culprit. This phenomenon seems to be particularly associated with geographic conditions that allow the wind to pick up and generate waves over a flooded marsh, namely on exposed coasts and over larger sized marshes (French et al., 2000; French, 2006). Research in the Bay of Fundy does not appear to make mention of marshes that have failed to recover once their seawalls were breached. However, this is not to say it has not or could not happen at the onset of restoration or that these conditions could not develop over time.

French (2006) claims that some authors (Dent et al., 1976; Burd et al., 1994; Woodward, 1998; Boorman and Hazelden, 1995) argue that the former use of a marsh is a major factor in its recovery, with lands used for pastoral purposes (rather than agricultural) having the best chance to recover as a salt marsh. Another debate concerns the removal of seawalls. Experience in the United Kingdom seems to demonstrate that breached seawalls can significantly reduce erosion in recovering marshes compared to marshes that are exposed to open water (French, 1999 in French 2006; Cundy et al., 2002).

Biological and physical characteristics of a marsh such as plant or animal species or the layout of the marsh's channel network should also be documented before a restoration is carried out (this is typically referred to as baseline data) and measured afterwards for a determined number of years, as part of a structured post-monitoring program. These data will be used to monitor change in the restored site – most importantly whether the amount of tidal water flowing to the marsh is sufficient or not, and whether the restoration is progressing at a reasonable pace, based on documented values in the literature and monitoring protocols, or on data from a nearby natural (reference) marsh.

The choice of variables to monitor are up to the involved parties to decide and are discussed in a number of monitoring documents that have been produced in recent years by conservation organizations, such as the Gulf of Maine Council (Neckles and Dionne, 1999; GOMC, 2005). Monitoring programs can be extensive or fairly basic, depending on the means of their proponents and the desired goals. The key is to measure a number of meaningful variables (again, discussed in monitoring documents) using protocols, in such a way that change can be quantified (statistically or using a Geographic Information System where spatial information is concerned). In the 2005 Gulf of Maine protocol, the recommended core variables to monitor are the vegetation (composition, abundance, height and density), groundwater or soil salinity, marsh surface elevation and tidal signal. Optional variables can involve studying birds, fish and invertebrates on the marsh, and additional physical characteristics (Neckles and Dionne, 1999).

4.4. The Restored Salt Marsh: Addressing Concerns

Salt intrusion into potable wells and septic tanks can be a concern for property owners located in or near a flood plain, as the freshwater-saltwater boundary will reposition itself following the restoration. The new location of this boundary will depend on a number of factors, notably substrate type. As this is case specific, a pre-restoration assessment to predict the future position of this interface should be carried out by a geo-engineer. Salt marsh restoration projects on the Herring River (Massachusetts) and Delaware Bay had homeowners' wells sampled and made use of monitoring wells and piezometers to establish baseline (pre-restoration) conditions (HRTC, 2006; Weinstein et al., 2001). Data from these surveys were used to predict how far landward the salt groundwater boundary would migrate, and following restoration, the monitoring wells continue to be used to monitor groundwater quality and elevation.

Flooding from spring or storm tides could also become a concern at some low-lying locations. Site management plans from the Delaware Bay project included provisions assuring that the rate and amplitude of tide related flooding would not exceed pre-restoration conditions. Deed covenants where any infrastructure damaged as a result of the restoration were also recorded. Finally, dykes fitted with drains to evacuate excess water occurring above them were built around the most vulnerable infrastructure, upland of the restored marshes (Weinstein et al., 2001).

5. Social and Economic Valuation

> *"Natural areas continue to be lost across Canada. Undoubtedly, this occurs in part because the goods and services provided by natural areas are not precisely known, despite the fact that recent studies outside of Canada suggest that the economic value of these natural areas to society far outweighs any gains from converting them for human uses such as urban development or intensive agriculture." (Forward by Brian Gray and John Lounds in Olewiler, 2004)*

New Brunswick has roughly 5,500 km of coastline and almost 60% of the province's population lives within 50 km of the coast. Thus, coastal areas support economic, cultural, and recreational activities, as well as a diversity of flora and fauna. The inshore fishery is worth about $125 million annually and the coastal tourism industry (including much ecotourism) is worth almost $750 million annually (Sustainable Planning Branch, 2002). Many of the salt marshes around the Bay of Fundy in New Brunswick were dyked long ago to provide space for agricultural land and other higher uses. Presently, towns, roads, highways, industrial parks, shopping centres and other developments sit on dyked salt marshes. If salt marshes need to be restored to assist with floor control and other vital ecological services, then it is important to measure the competing values in coastal areas. As Walters (1990, 4) states, "Conservation dollars are scarce… and must be used wisely to protect ever-diminishing wildlife and their habitats. It is essential to evaluate conservation projects so that investments are made efficiently." The following subsections explore the variety of social and economic values for both dyked salt marshes, and natural/restored salt marshes.

5.1. Social and Cultural Values of Salt Marshes

> *Olewiler (2004) argues that wetlands and other natural spaces, when left natural, or returned to their natural state, have many benefits to society, but they may be intangible and hard to measure.*

As mentioned earlier, salt marshes provide many ecosystem services including water filtration, flood protection, carbon sinks, and they are home to rich sources of biodiversity. Because of concerns about rising sea level and new scientific understanding about climate change, groups in the Maritimes have begun to breach dams, take out tidal barriers, and restore salt marshes to their natural state. This subsection looks at the social and cultural values of natural and restored salt marshes.

Salt marshes can be valued for their importance to society and for culture. Bryant and Bryant (1998) state that "Individual values accumulate to make up social values, and social values become institutionalized in laws, taxes, parks." It is interesting that environmental impacts can be perfectly accepted in one community, yet fought against in another. According to Bryant and Bryant (1998) social values in the late twentieth century began to return to respect for wetlands and people started taking action to protect them.

While many authors have explored methods to evaluate the economic value of salt marshes (see subsection 5.3), there is less literature on the social values of salt marshes and how to measure them. Olewiler (2004) argues that wetlands and other natural spaces, when left natural, or returned to their natural state, have many benefits to society, but they may be intangible and hard to measure. For example, the author lists protection of genetic material, aesthetic appreciation and wildlife enhancement. Social and cultural value may be more of a feeling. A wetland is important and has value to those who have lived by it all their lives and watched it change and grow with the seasons. There is no price tag for that. There is also the cultural importance and historical importance of marshes that are worth valuing. Marshes can also be valued as great outdoor classrooms.

Olewiler (2004) argues that policy makers need to realize these social and cultural benefits of natural spaces. Olewiler (2004, 2) states,

> Recognition of these benefits by policy makers is another important step in formulating land use policy. We have laws and regulations that apply to private lands (e.g., land use restrictions through zoning, prohibition of building too close to streams and rivers), but regulation to protect the natural capital on private lands is far from comprehensive. Landowners would expect compensation for conserving or enhancing the natural capital on their property when it benefits society and when prior restrictions on land use do not exist. Compensation should cover the opportunity costs of the land – the foregone profits from their next best viable and legal use. Public decision makers face similar dilemmas when assessing development plans for their regions. If they do not recognize the value of the benefits from the goods and services generated by natural capital, they will be more inclined to favour land uses that do generate revenues (for example, property tax revenues and development fees).

5.2. The Economic History of Bay of Fundy Salt Marshes

Aboriginal people harvested resources from the salt marshes of the Bay of Fundy for at least 5,000 years before European settlers arrived. The Mi'kmaq bands used the plants, and hunted the birds and small mammals found in the salt marshes. The Tantramar Marshes are also known to be a meeting place and seasonal camp for the Mi'kmaq people as they moved between coast and forest to collect food and other resources. For centuries since early European settlement salt marshes around the Bay of Fundy in both Nova Scotia and New Brunswick have been dyked, drained, dredged and filled in for a variety of socio-economic uses such as agriculture, urban development, building ports, mosquito control, highways, roads and railroads (Tyrrell, 2005).

Salt marshes around the Bay of Fundy are extremely fertile because of the sediments that high tides deposited on them for thousands of years. In the mid 1600s Acadian settlers arrived in the area and dyked some of the marshland. At the time, it was easier to dyke the marshes than to clear the forests. They built 1.5 m dykes out of earth and sod and aboiteaux (a log sluice with a hinged gate) to allow the dyked land to drain. They found the soil to be very fertile and did not need fertilizer. “Farmland that could produce two tons of hay or 50 bushels of wheat in a season soon became the means of providing most of the colonists' food and clothing and allowed a distinct Acadian society to prosper and grow” (Dept. of Agriculture and Fisheries, 1987).

After the Acadian Expulsion in 1755, New Englanders arrived in the area and cleared upland woods for many of their crops. They still valued the dykelands for hay and pasture though. “In fact, dykeland would sell for the highest per acre prices” (Dept. of Agriculture and Fisheries, 1987). Yorkshire and Loyalist settlers were the next to arrive and by the 1800s they had begun to create new dykelands on a larger scale than had the Acadians. During the 1800s, horses became very important for transportation, mining and logging. Thus, hay became increasingly valuable. “By the early 1900s, there were markets for Fundy hay as far away as Boston. In 1921, prices had reached more than $25.00/ton. Where large tracts of dykeland could be devoted to hay, as in the Tantramar Marshes or at Minudie, some owners made small fortunes” (Dept. of Agriculture and Fisheries, 1987).

Plate 6 - Old Marsh Barn, Tantramar Marshes (Photo: Thaddeus Holownia, http://www.gallery78.com/holowniat.htm)

In the 1920s, fossil fuel engines and cars replaced horses and the price of hay fell to $6.00/ton by 1938. The value of dykeland fell to $65/ha by the 1940s. Many dyked marshlands were abandoned (see Plate 6). During the Depression, many farmers could not maintain their dykes, aboiteaux, ditches, etc. and the federal government as well as the provinces of New Brunswick and Nova Scotia helped share the costs of repairs. In 1948 the Federal Government created the Maritime Marshland Rehabilitation Administration to protect marsh farmlands and to build dykes and large tidal dams. In 1970 the individual provinces took over all government responsibilities for the dykelands. The provinces then focused on increasing the amount of dykelands that could be farmed with modern machinery (Dept. of Agriculture and Fisheries, 1987).

At the end of the 20th century, the dyked farmlands equalled 13,360 ha (33,000 acres). Hay, dairy products, beef, hogs, grain and vegetables were being grown on the dykelands. However, much of the area was, and remains today, out of production. In the late 1980s when the Nova Scotia provincial government published *Maritime Dykelands: The 350 Year Struggle*, they suspected that dyked farmland agriculture would again be on the rise. They hoped that increasing transportation costs might increase the costs of imported food, that upland farming and fertilizing might become too expensive, and that the Maritime region's population might increase due to offshore oil. While imported food has not become too costly, nor has the Maritime population grown that much, some farmers have planted specialty crops and diversified their farms (Dept. of Agriculture and Fisheries, 1987).

The Nova Scotia Department of Agriculture and Fisheries (1987) called dyked salt marshes "a reserve of energy in the form of fertility". At the time of their publication, sales of dykeland were $2,500/ha and they felt this indicated "a growing appreciation of the region's most fertile soil" (Dept. of Agriculture and Fisheries, 1987).

At the turn of the millennium, though, values and perceptions surrounding dyked marshland are changing. The threat of climate change is impacting how people view this land. There are concerns about flooding due to sea level rise, and some urban centres around the Bay of Fundy are encroaching onto dykelands due to commercial and residential development. The vulnerability of these developments to flooding and storm damage is another concern. There are also growing concerns for loss of wildlife habitat.

5.3. The Challenge of Economic Valuation

There are many economic uses of salt marshes such as hunting, fishing, trapping, bird watching, ecotourism, etc. For example, the US Office of Habitat Protection states that:

> The socio-economic value of wetlands comes from direct and indirect use of their resources. Forested wetlands, for example, provide firewood, building materials, and wood for charcoal production. Humans have also used wetlands as a source of medicinal plants and food. An indirect, but well-recognized value of wetlands is their role as nurseries for important commercial and recreational fish species…. Salt marshes and estuaries provide essential habitat for over 75% of the fish caught commercially and 80 to 90% of the fish caught recreationally. All of these species, and many others too numerous to list here, depend on healthy abundant salt marshes to support their populations.

Similarly, Barbier et al. (1997) list direct wetland uses as: fishing, agriculture, fuel wood harvesting, recreation, transport, wildlife harvesting, and peat/energy sources. According to Stokoe et al. (1989a), the dykelands of the upper Bay of Fundy can be used to produce either agricultural products (marketable goods) or wildlife (public goods).

While there are many economic uses and benefits of wetlands, it is still a challenging task to place an economic value on wetlands as wildlife habitat and for their ecological services. Stokoe et al. (1989a, 2) explain, “it is more difficult to capture some of the benefits of increasing wildlife productivity, because these benefits are not embodied in a product which is traded in a market, but are available to everyone without paying.”

Similarly, Olewiler (2004, 6) offers that it is incredibly difficult to measure the economic value of natural capital, such as wetlands. She states,

> First, one cannot sensibly ‘add up’ different types of natural capital in physical units. Twenty tonnes of forest biomass cannot be aggregated in a meaningful way with 20 hectares of wetlands or 100 litres of water purification provided by the wetlands. Monetary conversions help us add up ‘apples and oranges’. Second, decision makers typically use monetary measures to compare land use options. For example, a 10 hectare housing project will generate so many dollars of property tax revenue each year. Having a value of the goods and services generated by the natural capital on that ten hectares will allow the decision maker to compare these alternatives more easily and can help in formulating better regulatory policies.

According to Antwi-Buadum (2003), the science of economic valuation is still developing. Authors have put forth different methods for measuring economic value. Stokoe et al. (1989b) examine willingness to pay, opportunity cost, and cumulative impact assessment. Olewiler (2004) looks at the economic profits of certain activities that take place in wetlands. Antwi-Buadum (2003) uses the alternative cost method, Barbier et al. (1998) uses a concept called total economic value, and De Maio Sukic and Thomassin (2002) use contingent valuation. These methods are explored below and compared in Table 3 at the end of this section.

5.3.1. Willingness to Pay

Stokoe et al. (1989b), as part of the national *Wetlands are not Wastelands* project, employ three methods to evaluate the social and economic benefits of a hypothetical 1,040 ha freshwater wetland on the Minudie, NS dykeland. The authors first examine willingness to pay (WTP) for a freshwater wetland. Through a printed survey or telephone interview, the participants (local naturalists club, fish and game club, local farmers and the general public) were asked to indicate how much they would be willing to pay for the development of a freshwater wetland, and how much they would pay to use the wetland. The results are summarized in Table 2.

Table 2 - Summary of Willingness to pay for a Freshwater Wetland

User Group	Average WTP for the Development of a Freshwater Marsh	Average WTP for use of a Freshwater Marsh (User Fees)
Naturalists	$22.90	$0.90 per visit
Sportsmen	$15.50	$5.30 per person per day
Farmers	No amounts provided	$50 per cow per season
General Public	$25.00	$4.90

Source: Stokoe et al. (1989b)

Stokoe et al. (1989b) considered all the WTP amounts low. They suggested that the naturalists would prefer the area remain as dykeland because of the long history of the site and its scenic values. The sportsmen's numbers were low possibly because there were already many places to hunt in the region. Many hunters have established favourite hunting grounds and they had low income levels too. Farmers did not offer any amounts that they would be willing to pay to develop a wetland on their agricultural fields. They did not see the benefit. The general public offered the highest average WTP at $25 for the development of a wetland. According to Stokoe et al. (1989b), the main reason for visiting a wetland among this group was for sightseeing.

Olewiler (2004) also examined WTP methods. By figuring out how much people are willing to pay for property, pay to travel to ecotourism destinations, pay for other products such as oysters, and people's WTP for environmental quality, one can place a value on the natural resource. Olewiler (2004, 1) makes an interesting point:

> When the community benefits from a landowner's decision to sustain a wetland, the landowner has no ready means of capturing the social and economic benefits generated by the wetland. Hence, the landowner will find it difficult to preserve the wetland, rather than, for example, drain it to use for agriculture or sell to a developer for home construction.

This is the challenge for protecting natural spaces in an economically driven world.

Like Stokoe et al. (1989) and Olewiler (2004), Antwi-Buadum (2003) also looks at WTP. He explains that wetlands have economic value because fishing and recreation take place in wetlands. They bring in profits from permits, equipment, pay passes, travel expenses, etc. Antwi-Buadum (2003) then goes on to explain that we can compare the financial profit of different types of land uses. For example, comparing agriculture to fishing, hunting and trapping in a wetland. However, we would have to argue that even if hunting and trapping bring in fewer profits than agriculture, but are more sustainable and leave a smaller 'footprint', they should be more highly valued. Antwi-Buadum (2003, 9) states, however, "the extent to which land use has altered our ecology and the costs associated with it are not well understood."

"The value of the wetland is the cost savings associated with its use rather than the next best alternative" (Antwi-Buadum, 2003, 12).

De Maio Sukic and Thomassin (2002) also examine WTP, or what they call contingent valuation (CV). They state that it is commonly used to estimate the value of non-market goods, such as wetlands in Canada. De Maio Sukic and Thomassin's study estimates the opportunity cost to owners of New Brunswick salt marshes in agricultural areas of selling their marsh lands to a conservation agency. “Wetlands have been identified as a potential carbon sink that can generate carbon credits while at the same time providing additional ecological services that would support other international environmental commitments” (De Maio Sukic and Thomassin, 2002, 4). There are 3,131 ha of salt marshland along the New Brunswick portion of the Bay of Fundy (Canadian Wildlife Service, 1994 in De Maio Sukic and Thomassin). Government and conservation groups own 958 ha, while private landowners own the remaining 2,173 ha.

CV measures individuals WTP and willingness to accept (WTA) with the use of questionnaires. Study subjects were presented with a range of bids and a certainty range. Respondents were asked how certain they are to pay a specified price or accept a certain payment for something that does not have a set price tag. A mail survey was sent out to 395 potential saltwater wetland landowners in New Brunswick. There was a 49% response rate. The responses were aggregated to arrive at WTP and WTA.

Results indicated that geographical location of the wetland was found to have a significant influence on WTA. Salt marsh in the upper Bay of Fundy was found to have a lower valuation than salt marsh in the outer Bay of Fundy. De Maio Sukic and Thomassin (2002) suggest that the upper regions have the highest tides and dykes are needed to undertake any activity on marshlands there. The lower bay has lower tides and the salt marshes may be easier to access and therefore have a higher value. Preference for selling land was higher among those with more risk taking behaviour and those who had financial difficulties or cash needs. Signing a conservation easement was seen as less risky. Landowners with university level education tend not to accept compensation compared to landowners with secondary or other post secondary education. Landowners who live in New Brunswick had a higher willingness to accept compensation compared to landowners who lived outside the province (De Maio Sukic and Thomassin, 2002).

5.3.2. Alternative Cost Method

Antwi-Buadum (2003) explains the alternative cost method for valuing wetlands. The alternative cost method looks at the next best alternative to the natural processes of wetlands. The author explains that wetlands are highly effective filters, filtering out toxins and maintain water quality. One way to discover the economic value of a wetland is to compare the costs of constructing human-made treatment devices with natural wetland treatment systems. As stated above, wetlands control flooding and thus, they reduce the need for costly human-made structures such as dykes, tidal barriers, dams, etc. “The value of the wetland is the cost savings associated with its use rather than the next best alternative” (Antwi-Buadum, 2003, 12).

Stokoe et al. (1989b) also used the opportunity cost method, or alternative cost method, to measure the value of a hypothetical freshwater wetland at Minudie, NS. They define the opportunity cost method as “evaluating the benefits that are foregone in making one choice over the best alternative choice" (1989b, 22). Specifically, the authors compared the benefits of converting the land to wetland to see if this exceeds the benefits that would be lost by relocating the agricultural activities to an alternate upland location. They looked at expected wildlife benefits in the new wetland such as muskrat harvests and duck hunting, which came to an estimated $105 per hectare per year. The authors also employed the wetland evaluation technique to determine potential wildlife benefits. This technique places values on wetland functions such as heritage, recreation, sediment, groundwater, and wildlife diversity. It was found that a new wetland at Minudie would have high social values for recreation, heritage and wildlife diversity. As well, the new marsh would be effective at flood flow alteration. The authors also looked at the level of fiscal spending to protect local waterfowl and wetlands. At the time, the *North American Waterfowl Management Plan* was investing $5 million to protect 4,000 acres of black duck habitat ($100 per hectare per year) and the Eastern Habitat Joint Venture (EHJV) was spending $10 million to purchase 10,000 ha of habitat ($125 per hectare per year). The authors concluded that there is a lot of variance in the value placed on wetlands and habitat depending on the study. They also argue that there is a lot of uncertainty over the cost and benefit estimates. Stokoe et al. (1989b) also examined the cumulative impact method which uses practical indicators of values derived from various wetland functions such as water quality, toxics, wildlife populations, recreation, educational uses, economic viability, etc. The indicators come from pertinent policy, legislation, and/or existing local community objectives, such as the *North American Waterfowl Management Plan* and the EHJV mentioned above.

5.3.3. Total Economic Valuation

Total economic valuation (TEV) often combines the methods described above to determine use and non values of a natural resource. Barbier et al. (1997) argue that economic values are just one part of decision making. They state, "If researchers are to value wetland uses and decision-makers are to take these into account when making policies that affect wetlands, then a framework for distinguishing and grouping these values is required. The concept of TEV provides such a framework and there is an increasing consensus that it is the most appropriate one to use. Barbier et al. (1997, 14) state:

> Simply put, total economic valuation distinguishes between *use* values and *non-use* values, the latter referring to those current or future (potential) values associated with an environmental resource which rely merely on its continued existence and are unrelated to use (Pearce and Warford, 1993). Typically, use values involve some human 'interaction' with the resource whereas non-use values do not.

Table 3 below describes and compares each of the economic valuation methods presented in the above section. Community capacities necessary to employ each method are also listed.

Table 3 – Comparison of Economic Valuation Methods

Name of Method	Description	Community Capacity to use the Method
Willingness to Pay Methods		
Willingness to pay Stokoe et al. (1989b)	Survey user groups to determine how much they would be willing to pay for the development of a new freshwater wetland and how much they would pay to use it.	These methods could be employed by a community relatively easily. Individual and household questionnaires and/or interviews could be conducted to collect the willingness to pay or sell information. This would provide excellent, detailed, local information.
Willingness to pay Olewiler (2004)	Examine how much people are willing to pay for property, pay to travel to ecotourism destinations, pay for wetland products such as oysters, and people's willingness to pay for environmental quality.	
Willingness to pay Antwi-Buadum (2003)	Compare the costs and profits of agriculture to fishing, hunting and trapping in a wetland.	
Contingent valuation (CV) (or willingness to pay) De Maio Sukic and Thomassin (2002)	Measure how certain an individual is to pay a certain price or accept a certain payment for something that does not have a set price tag.	
Alternative Cost Methods		
Opportunity cost method Stokoe et al. (1989b)	Evaluate the benefits that are foregone in making one choice over the best alternative choice.	A community could only undertake this method if they know the social and economic benefits of the different land uses.
The alternative cost method Antwi-Buadum (2003)	Examine the next best alternative to the natural processes of wetlands. For example, constructing human-made treatment devices, water control structures, etc.	As with examining costs of damages, the alternative cost method would need to be conducted by experts, as the capacity to measure these costs may not be present in all communities.
Total Economic Value		
Total economic value (TEV) Barbier et al. (1997)	Distinguish between use and non-use values; the latter referring to those current or potential values associated with an environmental resource which rely merely on its continued existence and are unrelated to use.	The non-use values of the TEV could be difficult for a local community to measure. They may need to bring in experts.

6. Adaptive Communities

Adaptive capacity is the ability of a community to make adjustments in order to decrease its vulnerabilities, moderate damages, take advantage of opportunities, and cope with the changes. It is a measure of a community's resilience in the face of change. Adaptation could help reduce the many possible impacts of climate change, including sea level rise, in Maritime Canada. This section examines vulnerability and adaptive capacity, barriers and opportunities for communities, determinants of adaptive capacity, and adaptive capacity of selected countries. It concludes with a case study example to illustrate how to measure capacity.

6.1. Vulnerability and Adaptive Capacity

A community may be vulnerable to climate change for a variety of biophysical and socio-economic reasons. The same weather event can have different effects in different communities. Effects differ due to a multitude of socio-economic conditions within individual communities. Many authors discuss the concepts of vulnerability and adaptive capacity related to climate change (Ford and Smit, 2004; Chiotti, 1998; Wall and Marzall, 2006; Smit and Pilifosova, 2003; Klein et al., 1998). A comparison of their work is presented below.

The vulnerability of a community or region depends on the magnitude of the impact and the community's capacity to adapt. Ford and Smit (2004) study adaptive capacity to climate change in Canadian arctic communities. They define vulnerability as "the susceptibility to harm in a system relative to a stimulus or stimuli." The authors explain that there are biophysical vulnerabilities (the nature of the physical event) and social vulnerabilities (social, political or economic conditions that make exposure unsafe). Smit and Pilifosova (2003, 13) state, "There is now broad agreement that the vulnerability of a given system is related both to its exposure to climate change effects (sometimes called initial impacts) and to its capacity to deal with those effects (also called adaptability, coping ability and adaptive capacity)." Klein et al. (1998) argue that urbanization, pollution, and resource depletion are increasing the vulnerability of coastlines to climate change and sea level rise. They claim that coastal vulnerability is a measure of how incapable a community is to dealing with the effects of climate change and sea level rise. It involves biogeophysical, socio-economic, and political factors. In order to assess vulnerability they say that we need to know the anticipated impacts as well as potential adaptation options. The authors explain that there are differences between natural and socio-economic vulnerability. "Socio-economic vulnerability is determined by the impact potential and society's technical, institutional, economic and cultural ability to prevent or cope with these impacts" (Klein et al., 1998).

A community's adaptive capacity will help it to combat the above vulnerabilities. Smit and Pilifosova claim that:

> Adaptation to climate change refers to adjustments in ecological, social and economic systems in response to actual or expected climatic stimuli and their effects or impacts…. Adaptive capacity is the potential or ability of a system, region or community to adapt. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes (2003, 1-3).

Similarly, McCarthy et al. (2001 in Wall and Marzall, 2006) state that adaptive capacity is "the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." Chiotti (1998) describes adaptation as the "measures designed to reduce impacts and vulnerability." Similarly, Wall and Marzall (2006) state that adaptive capacity is the ability to cope with impacts. However, they argue that the term "proactive adaptation" might be better. It calls for a reorganization to accommodate change and results in something new. Wall and Marzall (2006) also add that adaptive capacity requires many resources and that rural Canadian communities need strong social, economic, and environmental systems in order to handle climate change impacts. The authors explain that the level of adaptiveness of a community depends on how its social system is organized in relation to its resource base.

> *Adaptive capacity is the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.*

One method of measuring community adaptive capacity is the amoeba model (Wall, 2006). It involves measuring various indicators within social, human, institutional, natural, and economic resources. Indicators within social resources could be things such as level of voluntary involvement in community groups, and number of community events. An indicator of human resources could be the Dependency Ratio and indicators under economic resources could include economic diversity, employment rates, income, etc. Scores or values for each indicator are plotted on a grid, showing the relative strength of a community's capacities or resources. Visually the plotted scores resemble an amoeba.

Thus, adaptive capacity is influenced by a wide range of socio-economic factors. Economic factors include economic growth, infrastructure, available technology and the extent to which resources are distributed evenly in a community. Social factors include networks, institutions, social capital, and experience with previous risk (Ford and Smit, 2004).

According to Smithers and Smit (1997 in Ford and Smit, 2004), "Adaptive capacity relates to communities' resilience, flexibility, and robustness." Similarly, Klein et al. (1998) discuss the concept of coastal resilience in the Netherlands. "Coastal resilience is a measure of the system's capacity to respond to the consequences of perturbation" (Klein and Nicholls, 1998 in Klein et al., 1998). Klein et al. (1998) state, "Coastal resilience has morphological, ecological and socio-economic components, each of which represents another aspect of the coastal system's adaptive capacity to perturbation." Coastal resilience is seen as a cost effective way to prepare and deal with climate change and sea level rise along the coast while still focusing on development.

6.2. Barriers and Opportunities Facing Communities

The key informants and Salt Marsh Restoration Workshop participants reported various challenges, barriers and vulnerabilities of restoration projects including lack of funding, lack of experience, lack of awareness and support among the public, lack of awareness and commitment from government, logistical problems, and stakeholder and land use conflicts. Key informants also commented on the unique opportunities that some of the local communities and residents presented.

6.2.1. Lack of Funding and Unexpected Costs

By far, funding was the most important challenge faced by many of the key informants or the project teams they were involved in. The permits, consultants and studies can be costly. The search for adequate funding must also be balanced with the other components of a project such as the science and monitoring, coordinating volunteers, public education, and government lobbying.

Unforeseen circumstances caused some project costs to increase unexpectedly. For example, there was a contamination issue at Musquash. There was the possibility of creosote soaked timbers under the rail bed. A study was needed to determine the extent of this problem and to develop mitigation plans. DUC had to dispose of the timbers carefully. There can always be surprises and they often require additional funds. It is important to have a well thought out budget and to expect surprises along the way. All costs need to be considered, not just those related to the physical restoration.

Restoration projects can take several years to complete and there can be a challenge in getting multiyear funding. It is hard for communities to obtain funding for a five year project for example. However, some argue the funding situation has improved. Five years ago it was hard to find anyone to fund or partner on a salt marsh restoration project. At Newfoundland Creek, DUC wanted to restore 200 acres at a cost of less than $10,000 but they could not find anyone to fund it. Today, with compensation money from development projects such as twinning highways, it is easier to find funding and in much larger sums.

6.2.2. Lack of Experience

Salt marsh restoration is a relatively new activity in Maritime Canada. No one worked on these issues until recently, although Environment Canada had done some tidal barrier work. When work began on the restoration at Cheverie Creek, no one in Nova Scotia at the federal or provincial government levels was doing anything with salt marsh restoration so the project helped to build awareness. The EAC produced materials, etc., and they went to academics for help with the science and monitoring. There were lots of helpful people around, but experience was scarce. The project was a learning experience not only for the EAC but for the whole community, including students at the elementary school, parents and teachers. The community also learned about the local history of the marsh from older people in the area.

Advances in salt marsh restoration have been made over the last five years. Five years ago it was difficult to find funding, difficult to get Maritimers to attend meetings on restoration, and some groups were still focused on creating freshwater impoundments on reclaimed marshland. Today salt marsh restoration has become more popular; last year there was a national conference on the topic, and now all groups involved are on the same page and see the marshes more holistically. However, there is still the need for better coordination and communication among all of the groups who deal with salt marsh restoration. Furthermore, while advances are being made, the Maritimes are still about twenty years behind New England in terms of salt marsh restoration.

6.2.3. Lack of Public Awareness and Education

In general, communities lack awareness about the value of salt marshes and the reasons for restoration. For example, one key informant (who worked for the provincial government creating freshwater marshes on farmland) said the biggest challenge was overcoming local perceptions about wetlands and their value. Farmers did not see the value; they did not understand that wetland habitat is threatened. The loss of wetlands surprised many local people. The biggest challenge was to demonstrate the need for the project. In general the public does not have a good understanding of salt marsh restoration or the values of salt marshes. More training is needed for the public, engineers, judges, and others.

Similarly, at the Salt Marsh Restoration Workshop, the most common resource that was identified as lacking was education. Specifically, education about climate change, sea level rise, the usefulness of coastal salt marshes as an adaptation strategy, and the potential impacts of a restoration project is needed. This lack of awareness was identified as a major cause of concern and a potential reason why salt marsh restoration or any adaptation strategy might be met with opposition.

6.2.4. Lack of Government Commitment, Will and Communication

Government departments also need education and awareness and the lack of these presents challenges. For example, one key informant from the federal government said that from her perspective there is a need to get provincial and federal departments responsible for agriculture, public works, and transport to understand the options and importance of salt marsh restoration. Furthermore, the lack of political will and leadership from the upper levels within government is a huge barrier to restoration projects. For example, the removal of the Petitcodiac Causeway has not taken place because of this lack of will.

In addition, inadequate inter-agency communication and coordination limits the ease with which groups can restore salt marsh. For example, if the departments of transport

(DOTs) in the Maritime region could be in regular conversation with fisheries and wildlife experts, the departments could be made aware of the impacts of tidally-restrictive culverts (old or new) on salt marsh habitat.

Lastly, government institutions within Nova Scotia, whose role it is to protect dykelands and fish habitat, do not have a mandate for salt marsh restoration and they do not have the budget. This is a huge barrier for any restoration project. There is contradictory jurisdiction over marshland because it is neither land nor sea.

6.2.5. Logistical and Technical Problems

Apart from working around high tides and bad weather, all restoration projects have their share of unique logistical and technical problems. Some that were mentioned during the key informant interviews include people having problems with how to do the restoration, what equipment to use, needing permission to go on other people's property, impacts on neighbouring properties, etc. Logistical challenges are often dealt with by spending more money. The cost of removing potentially toxic materials at Musquash was unexpected. They had to do soil testing for creosote. Ninety percent of the work during a restoration project can be spent dealing with technical and social requirements such as who owns the land, is there access, do they have public support, etc. Other problems to consider include where and how to dispose of the dyke materials, the complexities of reconnecting drainage systems that may have upstream and/or downstream consequences, the possible need to remove terrestrial vegetation (trees and bushes) and more.

6.2.6. Land Use and Stakeholder Conflicts

Key informants mentioned minor stakeholder issues and what was done to address them. For example, at Red Head the duck hunters were opposed to the restoration. As a solution DUC installed a trail, nature park, and interpretive signs to help educate the public, with the trail closed to the public during duck hunting season. The public is generally upset immediately following dyke removal because there is a lot of exposed mud where there used to be water. However, some people are starting to understand the benefits of salt marshes and restorations. At Cheverie, property owners were concerned about the loss of bass fishing and increased mosquitoes. However, the project team sought people who owned the adjacent properties first so that stakeholder concerns or conflicts could be dealt with early. At Musquash, even with agreements in place, when landowners saw the tide approaching their land, they "got excited". In other words, conflicts can begin after a dyke is removed. Landowners can be in agreement until they think their land may be flooded.

One federal government key informant summed up the issue of stakeholders well when he explained that even if the community is behind you, if the affected landowner is not in agreement, the project cannot move forward. Many of these coastal areas, whether dykeland or salt marsh, are privately owned. This means that to undertake any work on the property, the consent of the landowner is mandatory.

The above conflicts arise in places where the dykes protect valuable agricultural land and important human development. One such example is the CN Rail line and Trans Canada Highway that link Nova Scotia to the rest of Canada. Consensus was reached during the Salt Marsh Restoration Workshop that restoration was not an option in this case and that maintenance and reinforcement of this dyke should be made a priority. Similarly, the same conclusion was reached for most scenarios in which the protected dykeland was being actively used. Moreover, a shift in land use from dykeland or development to coastal salt marsh would also involve economic tradeoffs. Such tradeoffs would include the cost of moving vital infrastructure and development as well as the potential agricultural production that would be foregone. Therefore, current land uses including transport, development and agriculture could be a barrier to using salt marsh restoration as an adaptation to climate change.

6.2.7. Unique Qualities in Every Community

Key informants were asked if they felt that there was anything unique about the communities where the restoration projects took place which may have contributed to their success. Support and interest in restoration will depend on the relationships of individuals to the site. It is about “cumulative personal interest and personal attachment,” said one key informant. Local people at both Musquash and Cheverie possessed characteristics that helped the projects become successes. For example, these residents may have felt a special connection to their local environments, including the marshes.

At Musquash local people were already lobbying for the area to become a Marine Protected Area (MPA). The community went beyond the DUC-led restoration as well. They wanted more protection for the estuary, 75% of which was already protected.

In Cheverie, there were quite a few local community groups that were already active on environmental issues such as forestry, watersheds, and blood worm harvesting. It may not have been a big leap for them to get involved with salt marsh restoration. The community was already aware and active. Coming in from away and convincing local groups that salt marsh restoration was important was not that difficult for the EAC. Cheverie is surrounded by an active community, one that does things. Cheverie area residents wanted the culvert removed and they would not take no for an answer. The school was very supportive of the project, and the community embraced the idea too. This made restoration exciting and positively influenced DOT and the Nova Scotia Department of Public Works.

6.3. Determinants of Adaptive Capacity

Some authors (Smit and Pilifosova, 2003; Taylor, 2003; Chisholm et al., 2004; Yohe and Schlesinger, 2002; Wall and Marzall, 2006) offer suggestions to combat risks from climate change and sea level rise by looking at the determinants of adaptiveness, or capacity elements. Adaptation responses for dealing with climate change are “almost infinite” (Smit and Pilifosova, 2003, 10). However, the authors go on to offer a word of caution:

> Adaptation measures are very specific to a particular location and situation. What may work in one place or with one socio-economic group may not work or may not be feasible elsewhere. Furthermore, there is a need to tailor adaptations to fit each case and circumstance. This means that it is essentially impossible to specify or develop appropriate and applicable adaptation measures without detailed knowledge of the system or community for which the adaptation is intended. This knowledge would need to include the nature of the vulnerability and how it is dealt with now to avoid proposing naively inapplicable, or even harmful or maladaptive, measures (2003, 11).

Regardless the literature offers the following determinants of adaptive capacity: economic wealth, technology, information and skills, infrastructure, institutions, social capital and equity. These determinants are closely interconnected. Smit and Pilifosova continue by explaining that successful adaptation includes embracing change, effective use of skills as well as social networks and infrastructure and how well these can deal with risk and distribute resources fairly:

> Successful adaptation also requires a recognition of the necessity to adapt, knowledge about available options, the capacity to assess them and the ability to implement the most suitable ones (Fankhauser and Tol, 1997), all of which rely on the wide availability of information and skills. Ability to adapt is often dependent on the effectiveness of social networks and infrastructure (Toman and Bierbaum, 1996)…. Similarly, adaptation is related to the stability and capacity of institutions to manage risks associated with climate and other conditions (Smith and Lenhart, 1996; Huq et al., 1999). It is also widely recognized that adaptive capacity is greater if social, cultural, and political institutions ensure that the allocation of power and access to resources are distributed equitably (Adger and Kelly, 1999; Handmer et al., 1999; Toth, 1999) (2003, 15).

Concrete actions exist for Maritime communities to become more adaptable to climate change. Taylor (2003) suggests that single industry communities need to diversify their economics, improve health infrastructure in order to deal with increased health risks from climate change (disease, water quality, etc.), and incorporate adaptation plans into transportation, settlement, and land use plans of the future. The author argues that new building codes and construction standards may be needed to deal with changes. He also suggests incorporating threats due to climate change into the planning of emergency operations, weather warning systems, sewers, coastal roads, property rights, property values, etc. Taylor (2003) urges that reliable and clean drinking water, irrigation and soil moisture management, pest and disease control will all be needed in the future. He also urges that biodiversity be maintained, and to be aware of threats from migrating southern species. Taylor (2003) also suggests that the costs of turning private land into flooded public land (such as restored salt marshes) should be examined.

For Yohe and Schlesinger (2002), determinants of adaptive capacity include the availability of technological resources, availability of resources, the structure of critical institutions, human capital (including education and personal security) social capital, access to risk spreading processes, the ability of decision makers to manage information, and public perception about the source of stress and public exposure to local manifestations.

Wall and Marzall (2006) suggest a variety of resources that are important for determining and building adaptive capacity including social resources such as people helping people, community attachment, sense of community, social cohesion, etc. The authors argue that there needs to be a strong sense of cohesion or togetherness within a community, which may contribute to support for community-wide initiatives such as adopting adaptation strategies. In addition, human resources include collective skills, knowledge, life experiences, physical capabilities, the productive population (dependency ratio), and education levels. They suggest that more adults than children and seniors are needed for positive community resilience. Institutional resources are also needed and include political connections, utilities, infrastructure, emergency measures organizations, health and communications services. A community needs to be able to disseminate useful information. Natural resources such as clean air, water, etc. need to be able to support economic activities (forestry, fishery, mining, farming, etc.). Economic resources are important and include employment level, the percentage of workers with secure jobs, and whether or not a town is dependent on one resource.

> *Some determinants of adaptive capacity are economic wealth, technology, education and skills, infrastructure, institutions, social capital, equity, resource availability, structure of critical institutions, information management.*

The list of determinants or capacities for a community to be adaptive is extensive. Table 4 provides a synthesis of the capacities discussed and organizes them in categories.

Table 4 - Adaptive Capacities According to the Literature

Determinant	Capacities
Economic Capacities	• High income levels • Diverse economic resources and activities (e.g. single industry communities need to diversify) • High employment level • High percentage of workers with secure jobs
Technological Capacities	• Availability of technological options
Knowledge and Skill Capacities	• Availability of sound scientific and other information • Accurate public perceptions of climate change • Dissemination of useful information • Effective use of skills

Determinant	Capacities
Infrastructure Capacities	• High quality infrastructure • Health infrastructure to deal with increased health risks • Ability to incorporate adaptation plans into transportation and utilities • High quality emergency operations, weather warning systems, sewers, coastal roads
Institutional Capacities	• Effective structure of critical institutions • Institutions are effective at dealing with risk and distribute resources fairly • Effective political connections • Effective and knowledgeable emergency measures organizations • Effective health and communications services
Social Capacities	• Effective social resources and networks • Presence of people helping people • High community attachment • Positive sense of community • High level of social cohesion • High levels of support for community-wide initiatives such as adopting adaptation strategies
Human Resource Capacities	• Adequate education levels • Decision makers have the ability to manage information • Helpful collective life experiences • Good physical capabilities (healthy and fit) • Low dependency ratio (more productive individuals of working age compared to number of seniors and children)
Land Use Planning Capacities	• Effective at dealing with changes through new building codes and construction standards • Ability to address property rights and values • Positive landowner attitudes • Natural resources should are in good shape including clean air, clean water, etc.

Table 4 presents universal determinants of adaptive capacity to deal with climate change. The following subsection compares Canada's adaptive capacity to that of other countries.

6.4. Global Differences in Adaptive Capacity

Some authors have looked at the adaptive capacity of particular regions and countries. A common thread is that regions that are less developed, less economically diverse, and economically poorer have more challenges adapting to climate change.

There is expected to be considerable change in Canadian climate, but because Canada is a developed country, Chiotti (1998) argues that we are one of the countries best able to adapt to changes in our environment. He says that our vulnerability is low because of our large national wealth, our ability to use technology, our high skill level, and our emergency response systems. Chiotti (1998) claims that our adaptive capacity is higher than most other countries in the world. Still, Chiotti (1998) claims that successful adaptation in many regions of Canada and in different economic sectors will vary and depend on "the flexibility and capacity of individuals, localities, industries, and other decision makers to respond, as well as upon the rate and magnitude of climate change." Chiotti goes on to suggest that adaptation can empower Canadians to not only reduce impacts from climate change but to also realize new opportunities from the change.

Similar to Chiotti's comments about Canadian adaptive capacity, Yohe and Schlesinger (2002) look at the adaptive capacity of communities along the eastern coast of the United States. They argue that adaptation to sea level rise in that area will be effective at reducing associated economic costs. Reasons include: many protection options exist, resources are plentiful, emergency management organizations are well supported and process information well, property rights are defined, property owners have access to insurance, and the public knows the risks associated with living near the coast. The authors argue that protective measures may be questionable along the coast, but that long term retreat inland is a viable option. However, according to Yohe and Schlesinger (2002), "It remains to be seen, however, if organizing research around the determinants of adaptive capacity would be an effective diagnostic tool in cases where the evidence is not as clear as it is in the United States."

Canada's vulnerability to climate change is low because of our large national wealth, our ability to use technology, our high skill level, and our emergency response systems.

Klein et al. (1998) study adaptive capacity in the Netherlands. Dyke construction and drainage were the first large scale human impacts on the Dutch coastal system. Currently in the Netherlands, about 55% of the land area is below mean sea level. This includes many major cities and infrastructure. Maintaining the dykes and protecting these low lying areas is of huge importance to the Dutch and because they have not allowed the land and ocean to interact naturally they seem to have no option but to continue to maintain dykes, and other hard sea defence structures. "Presently, however, natural and socio-economic adaptive processes are constrained, owing to the limited availability of land and the diminished resilience and flexibility that have resulted from technological solutions and legal provisions. This is increasingly leading to conflicts between housing, agriculture, industry, recreation and nature and landscape conservation" (Klein et al., 1998).

The unnatural rigid coastline, however, is not compatible with accelerated sea level rise and ever-intensifying stakeholder conflicts. It will require more and more money and effort to maintain the current coastline into the future. The World Wildlife Fund for Nature proposed *Growing with the Sea* which offers the opportunity for change. It suggests building with the ocean instead of working against it. It proposes a variety of win-win situations such as maintaining the natural flood protection function of coastal sand dunes, allows coastal erosion and space for natural dynamic dune processes, allows low lying areas to be flooded with fresh water so as to filter water for drinking, and other uses. Klein et al. explain "experiences with managed retreat… are as yet not very successful, mostly because of the lack of public acceptance" (1998). Thus, even if a country is developed, has the knowledge and funds available to adapt, public acceptance may be a challenge. As is explained in section 7, public education needs to be an important part of the public consultation process.

The developing world may not be as well prepared for the impacts of climate change compared to developed countries. According to Smit and Pilifosova, “Bangladesh and Florida may have somewhat similar exposures to sea level rise, but they have quite different adaptive capacities, and thus they have different vulnerabilities. Obviously, within any region, communities will have different exposures and different adaptive capacities, based on socioeconomic and other conditions, resulting in different vulnerabilities” (2003, 14). The authors say that adaptive capacity depends on “resilience, stability, robustness, flexibility, and other characteristics of a system” (Smit and Pilifosova, 2003, 14). Adaptive capacity involves dealing with risk, being prepared and coping with changes.

According to Chiotti (1998), the countries most vulnerable to climate change are small island nations (due to sea level rise), as well as poor counties. Poor counties are vulnerable because of their poverty and lack of ability to respond to disasters. “The ability to respond effectively to climate change is dependent upon the ability of the characteristics of the human system to sustain environmental shocks and stresses, as much as upon the nature of the system” (Smit, 1993 in Chiotti, 1998).

Although the developing world may be more vulnerable to climate change, Dixon (2005) suggests ways to build adaptive capacity for developing countries. The author studied indigenous knowledge and wetland sustainability in Ethiopia. Indigenous knowledge, adaptive capacity and resilience are “the shared norms and values, knowledge and networks intrinsic to a community” (Dixon, 2005). Discussions were conducted with various community members. Each session lasted two to three hours, and sessions were held in several communities. Dixon examined how farmers acquired knowledge. Dixon (2005) argues that sustainable natural resource management in developing countries depends on indigenous knowledge and adaptation, which Dixon refers to as the ability to obtain new information, and incorporate it into management practices. He concluded that everyone has access to indigenous knowledge and so it is an appropriate resource for building adaptive capacity in developing countries.

Dixon found that certain factors lead to sustainable management and increased adaptive capacity. The author states: “The exchange of information through informal communication networks plays an important role in facilitating innovation and adaptation, principally because knowledge is not shared equally throughout a society” (Dixon, 2005). Greater innovation, communication and coordination in a community were found to lead to environmental improvements in developing countries. “In addition, where farmer to farmer communication is abundant, and where stakeholders have organized themselves without any external interference, the capacity... to adapt to changes is strengthened, and this is reflected in what appear to be environmentally sustainable wetland management strategies” (Dixon, 2005).

Climate change will have different impacts in different regions, countries and communities because of widely differing physical, natural, economic, social, cultural and historical factors and influences. Each community has a different history, different people and different skills. A community’s adaptive capacity depends on how all of these different elements interact. The next subsection presents a case study on the Tantramar, NB region.

6.5. Measuring Adaptive Capacity to Prepare for a Flooding Event: Case Study on Tantramar, NB

Incorporating capacity elements from the literature review, key informant interviews and our first workshop on salt marsh restoration, we developed a working tool (referred to as the Measuring Adaptive Capacity Tool) to measure a community's adaptive capacity to take actions and adopt strategies that deal with sea level rise and reduce negative impacts and risks associated with a major flooding event (see Appendix B). As described in the introduction, this measurement tool was tested during a November 2006 Measuring Adaptive Capacity Workshop with stakeholders from the Sackville and Tantramar, NB area.

One way to deal with flood impact reduction is to adapt and change by taking action in advance to reduce potential negative consequences. In order to understand a community's capacity for adaptation, there is a need to understand or measure each relevant capacity area in a community by bringing leaders and stakeholders together to assess their community and its current skills. Community stakeholders can assess their community's collective ability to make choices, plan ahead, and take certain actions to decrease risks. The process of assessing capacity using the Capacity Tool provides clues about what a community can do to build its capacity for taking action. For example, if knowledge about sea level rise is found to be low, then community leaders might decide to focus their efforts on developing public education programs. The five capacity items in the tool are:

- Knowledge resources (about climate change, adaptation options, technical skills)
- Institutional resources (emergency measures organization, municipal plan, elected leadership)
- Economic resources (income levels, funding for dyke maintenance and for storm water management)
- Human resources (education levels, leadership skills)
- Social resources (social cohesion, networks, volunteers)

Both residents and community leaders need to possess the above resources for a community to be effective in planning ahead and reducing risks. Within the tool (see Appendix B) there are specific capacity areas directed at local residents and others directed specifically at stakeholders and community leaders.

The knowledge base of a community is an important capacity area to measure when planning to decrease the negative impacts of sea level rise and flooding. It is important for any coastal community to ensure that its residents understand climate change and sea level rise and their potential impacts. It is helpful for the residents to understand adaptation options, such as salt marsh restoration, and what might be best for them and their community. It is also vital that local people understand the importance of dykes and that they may be protecting more than agricultural land, such as houses, roads and infrastructure. Community leaders should also have some specific skills and knowledge in order to deal with sea level rise. They too need to understand climate change, adaptation options, and have basic scientific knowledge. They need to be able to assess their local dykes and possess technical skills such as using GIS. Community officials also need to have effective communication tools and know how to use them in order to inform their residents about the risks of sea level rise.

Institutional resources are mainly focused on stakeholders and community leaders because they are the ones who operate the institutions. Specifically, it is important for a community to have elected leadership that can make appropriate choices for dealing with climate change. It is also vital that community leaders be able to manage information well in advance of a flood risk such as obtaining information on flood plain locations and informing residents. There needs to be an effective and forward thinking municipal plan that incorporates the potential risks of flooding.

Capacity to deal with economic resources also rests mainly with community officials. A community needs to have a budget that allows for funding for adaptation research and dyke maintenance (if it falls within its jurisdiction), and access to provincial and federal funding as well.

Human resources are also important. If residents possess leadership skills, are well educated and innovative, their community as a whole will be better prepared to accept adaptive measures to dealing with sea level rise. For community officials it is helpful if they have existing experience writing funding applications and have been innovative in dealing with other community challenges.

Finally, social resources are important for both residents and community leaders to possess. If residents feel a sense of attachment, pride, and cohesion they will be more likely to band together and take action to reduce risks. Likewise, it is crucial that stakeholders and community leaders have good external social networks so that they may access important resources in other communities or with the provincial or federal governments.

6.5.1. Using A Community Tool to Measure Capacity

The Measuring Adaptive Capacity Tool could be used by any community wishing to assess its adaptive capacity for dealing with sea level rise and addressing risks before they occur. The results may point to specific action items which a community could work on to build its capacity. It can also point to areas of strength which could be leveraged or employed to get the process of adaptation moving in a community.

We suggest that the table be completed by a group of stakeholders: community leaders and other officials with broad knowledge of their community, its residents and its resources. A group discussion should be facilitated around adaptive capacity and what it means. The table should then be filled out either as a group (by discussing each capacity item together) or individually. The table asks participants to identify the current status of each capacity area, as well as the importance of the capacity for their specific community. For example, what is the current status of local municipal leadership? How important is local municipal leadership in taking action to reduce risks? Results should then be compared and discussed and tallied. Frequently identified strengths (high scores) and weaknesses (low scores) should be discussed and a list created. Then the group can go through the list and suggest methods for building capacity in the areas that are weak and to take action in leveraging strengths to help reduce risks.

During the workshop, most participants found that most of the capacity areas are necessary for measuring adaptive capacity for reducing flood related risks in the Tantramar area. However, a few areas received low scores (scores of one or two out of five) including dependency ratio, knowledge about salt marshes, and knowledge about adaptation options. Other communities undertaking this exercise may feel that different capacity areas listed in the table are not applicable to their situation and thus, they could be removed after initial tests of the table.

6.5.2. Adaptive Capacity Areas that may be Lacking

Although we conducted a test of the tool in the Tantramar area, some of the results are likely to be universal. There are generally some capacities that are likely to be universally lacking or weak regardless of the community. For example, insufficient knowledge about climate change and sea level rise was mentioned during both of our spring and fall workshops, as well as by key informants and in the literature. Specifically, during the fall workshop on measuring adaptive capacity for the Tantramar area, participants identified further important capacity items which many communities should pay close attention to such as knowledge about the local dyke system. Tantramar area residents know the dykes exist but they do not know how important they are, or what would happen if they are breached. According to a tally of the capacity tables collected from participants, other areas of low capacity are general leadership skills, communication tools, external social networks, available technology to reinforce dykes, and ability to restore salt marshes.

6.5.3. Methods of Building Adaptive Capacity

Due to the lack of general awareness about climate change, sea level rise and dykes in Tantramar, the main methods of building capacity focused on public awareness campaigns, which could be appropriate in many communities (and is similar to the findings from our spring 2006 workshop on salt marsh restoration). During the Measuring Adaptive Capacity Workshop it was said that the public should be made aware of the concern that exists and have a better appreciation for the importance of the dykes. There is a need to challenge the mentality that dykes are only there to protect agricultural land. In addition, impacts need to be presented in a way that demonstrates how people will be individually and personally impacted. People would likely be interested to know the impacts and threats to their personal property. They need to know how the dykes protect their life.

Ideas for a campaign include demonstration projects, brochures, fact sheets mailed to all households, and using local media such as radio stations and newspapers. It might also be effective to hear stories by older community members. There is a relationship between understanding and experience. Long time residents in a community would have a different knowledge base due to living through past floods compared to newcomers and younger residents. Education about the dykes should also be present in the school system. This could act as a way to create buy-in from a community to create solutions. More local scientific data will also be needed to assist in communicating the importance of the sea level rise risk.

Apart from building public awareness, it would be ideal to meet with the local Member of the Legislative Assembly (MLA) and provide detailed information about the potential risks of sea level rise for the local community. The MLA should be provided with visual representations of what the potential flood risk would look like. Increased public awareness might also assist in lobbying the government for financial support for preventative initiatives. Local Planning Commissions have a role to play in planning as well. The development of land use planning can help to minimize risk. Finally, it was suggested that increased networking and collaboration among stakeholders are needed to develop community-based solutions and proactive measures which can be taken collectively.

The results of the above exercise in the Tantramar area are similar to those found in the literature and in talking to key informants. Further ideas for building capacity are presented in the next four sections including education and awareness efforts, the importance of community consultations, the need to understand the policy environment surrounding salt marsh restoration, and some specific recommendations for communities considering salt marsh restoration.

7. Education and Awareness

When a community group decides to restore a salt marsh because of its ecosystem services, economic, and/or social values, it is very important to educate the local community and stakeholders. Duerden (2004) suggests that social scientists are best suited to research how physical changes in climate and the environment will be "translated through the filter of human activity and interaction at the community level." Duerden's study examines "the role of social scientists in assessing impacts of climate change on communities in northern Canada." He argues that many studies have focused on large scale impacts and changes from climate change, but that human activity is highly localized. Impacts will take place at the community level and differ from community to community due to geography, demographics, economic diversity, education, awareness, and past experience and resiliency to change.

Duerden argues that while there is much physical evidence for climate change in northern Canada, little is known about these changes on human activities. Key issues such as local conditions, local attitudes, cultural history, and economic relationships will affect responses to change. Communities in the same climate/eco-zone may still experience different impacts from identical climate-related events because of a host of differences. Geographical site, culture, economy, social history, land use practices, demography, a community's view of reality, etc. all contribute to how a community will react and adapt (or not adapt). For example, Duerden describes a prairie mining town filled with transient younger workers who make some money and do not stay long. They will not know that the environment used to be different in the past. They are less likely to complain about changes compared to long-term residents or to residents of communities with long ties to the land. As well, "recently established businesses may view the changing world as the norm; others might cease to exist, perhaps to be replaced by businesses more attuned to the emerging environment" (Duerden, 2004).

Thus, each community is unique and will react and adapt to climate change and sea level rise in different ways. They will also have different reactions to different adaptation plans, such as salt marsh restoration. Therefore, there is value in education and awareness campaigns as a precursor to and during restoration activities. As discussed earlier, salt marsh restoration teams that spent time educating the local public at all stages of a project met less resistance. The following subsections examine building knowledge through education strategies and priority site assessments.

7.1. Education and Awareness Strategies from the Salt Marsh Restoration Workshop

The final session of the Salt Marsh Restoration Workshop involved developing educational strategies to help build awareness and community capacity. Workshop participants were asked about who needs to be educated, what information they need, how the information will be delivered, and who will deliver it. Workshop participants felt that communities and the general public, developers, both students and teachers, federal and provincial governments, landowners, and planners all require education and awareness. Workshop participants felt that a variety of information needs to be disseminated including community specific effects of climate change, impact scenarios and vulnerabilities of individual communities, values and uses of salt marshes, adaptive ability of salt marshes, historic and current uses of dykelands, relevant legislation and policy, other adaptation options.

Reaching the target audiences listed above will inevitably require specific strategies and mechanisms to deliver the information most effectively. Moreover, even within each of the above categories the education process can be best served if strategies and mechanisms are decided on a case-by-case basis and not applied in a generic fashion. Some examples that were developed during the workshop are listed below:

- Workshops with stakeholders
- Wetlands as part of school curriculum
- Databases
- Environmental messages on every day items such as disposable coffee cups
- Educational bill boards
- Climate change video games
- Field trips
- Community events
- Television commercials and features similar to ‘Heritage Moments’
- Interpretive services at wetland areas
- ‘Adopt-a-Marsh’ campaigns

The above list is similar to the ideas for building knowledge resources generated during the Measuring Adaptive Capacity Workshop (see subsection 6.6) such as public education using pamphlets and local media. The Measuring Adaptive Capacity Workshop report also listed networking and collaboration, including the local planning commission, obtaining local scientific data on sea level rise, and talking with local MLAs as strategies.

7.2. Criteria Required to Assess Dykes for Restoration Potential

One main deficiency in building community capacity is the current lack of methods and education to assess dyked and drained salt marshes for their restoration potential. For some dykes, such as the Aulac dyke (see Plate 7), which protects an historic site, houses, roads and other infrastructure, the decision to build a new stronger dyke was probably an easy one. Other sites may require more thought and careful consideration. What does a community need to know about the dyke, the adjacent lands and uses, etc.?

Plate 7 - Dyke at Aulac, NB Near Fort Beauséjour (Photo: Keith Singh)

Salt Marsh Restoration Workshop participants were asked to develop a preliminary list of criteria that may be used to assess dyke infrastructure and adaptation strategies. Participants were not asked to place a value on individual criterion because each community or group considering salt marsh restoration will have different priorities and circumstances to consider. The criteria according to workshop participants are listed in Table 5.

Table 5 - Criteria for Assessing Dyke Infrastructure

Criteria	Detail
Risk assessment	• The vulnerability of a community to sea level rise and climate change
Stakeholder opinions	• Viewpoints of stakeholders • Who owns the land and what they want from it • What the community wants • Whether or not there is a community consensus (or close enough) for action
Physical characteristics of the dyke	• Age and condition of the dyke • Height of the dyke • Status of existing dyke or obstruction (culvert, causeway, dam, etc.)
Physical characteristics of the dykeland	• Current status of the dykeland (whether or not it is in use and for what) • Historic land use • Whether or not historical land uses are tied to a community's sense of heritage
The costs and benefits of adaptation	• Whether or not a project is funded • Technical feasibility of restoration • What resources and capacities a community possesses • Potential environmental significance of a restored marsh
Policy considerations	• What relevant policy and legislation allows with respect to dyke maintenance and construction.

Having the above information will greatly increase community knowledge and allow communities to make the right decisions for their future with respect to climate change and sea level rise. During the Measuring Adaptive Capacity Workshop the need for more local data and more awareness about the dykes was also mentioned. However, it was pointed out that not all communities have jurisdiction over the local dyke system and collaboration with the provincial government and other stakeholders would be required to fully assess the dykes.

8. Community Consultations

Community consultation, like education, is important at all stages of a restoration project. "Salt marsh restoration goals should reflect perceptions and values of residents, especially in areas having high population density" (Casagrande, 1997, 62). Local values need to be examined and may include recreation, aesthetics, and other intangible values. Casagrande (1997, 63) cites Lasswell (1971) and Kellert and Clark (1991) when he states, "Development of public policy (e.g., establishing restoration goals) requires an understanding of human values and perceptions in order to insure that policies are effective and justified." The opinions of local residents and stakeholders should be critical in the development of restoring a salt marsh. It is vital that the public be consulted, that their concerns and questions are addressed, and that they are engaged in the process. The following subsections describe when consultations are legally required as well as some examples of different consultation measures employed in past restoration projects in the Maritimes according to key informants.

8.1. Consultation Triggers

In New Brunswick if the wetland project site is greater than two hectares, the restoration requires a mandatory environmental impact assessment (EIA) and an EIA requires public consultation. The government requires good public consultation in the EIA process such as flyers, open houses and going door-to-door. The government of New Brunswick looks at projects on a case-by-case basis to see what sort of consultation would be best for the EIA.

Community consultations are not always required. Enforcement cases do not require community consultation. The environmental problem (e.g. infilling of a marsh) is simply repaired and the area is returned to its original natural state.

In addition, community consultation may be required but may prove very difficult in remote, unpopulated areas. For example, the government of New Brunswick tries to include the public as much as possible. But there are large areas of the province that are vacant and remote; no people live there and so public consultations can be difficult because people are not always around.

8.2. Consultation Methods

This section examines the various steps taken to consult the local communities around Musquash, Cheverie and Red Head. According to the key informants these three sites involved the largest community consultation efforts.

The public at Musquash was consulted before the project began and before permits were obtained. DUC publicized the project in the local paper, erected a sign on the future project site and contacted local MLAs and other stakeholders via the mail. They held public meetings where they laid out photographs and plans which local citizens could comment on, discuss potential effects, identify advantages and discuss concerns.

DUC then wrote a report on the public meetings. One DUC employee even published his name and phone number as the contact person for the project so people could reach him if they had concerns or questions. This person reportedly received many phone calls from concerned citizens even after the restoration project had begun. Negotiations with the landowners were undertaken and agreements between DUC and the landowners were signed. At times this was very challenging. There was one man who lived on the marsh and he took a lot of convincing before he was in agreement. DUC ended up building a new dyke just around his land.

It is most important to talk to landowners first, especially those who have or will have agreements with project proponents (e.g. DUC). Community meetings should happen next where as much information as possible is provided. DUC always has partners in their projects and their relationship with the New Brunswick government is good partly because it is part of the EHJV, where NGOs, federal and provincial governments work together to follow the North American Waterfowl Management Plan, a continental plan to increase waterfowl habitat in North America.

The Musquash project and its consultations were positive experiences. The general community was supportive of the restoration and there was already a push in the community to make Musquash the first MPA in New Brunswick. Community members were said to be happy because they now have more marine habitat, instead of an old rail bed.

At Cheverie Creek, the first step involved identifying property owners with land all the way back along the creek. Letters were drafted by the EAC to property owners. After the letters went out, there were phone calls and even kitchen table meetings with some of the landowners.

Once the EAC got approval to monitor the site, they enlarged their focus to the whole community. EAC employees and volunteers attended local meetings, wrote articles for the school newsletter and the Hants Shore Health newsletter, and submitted at least one article a year to the local paper. They also had a kiosk at the Avon Emporium with updates, photos, etc. They gave one public presentation per year between 2002 and 2005. They also sent letters with updates and plans a couple of times per year to property owners, and to others who became interested. The EAC also partnered with the school, made presentations for the students and teachers, and held other educational events. They hosted a community hike on the marsh along with people from the Gulf of Maine Council. One key informant from the local community said that an EAC person took her out to the culvert near the beginning of the project and told her to look back to the marsh. She said she had always looked out to the beach and the bay when she went to that site. This EAC representative helped open her eyes to the importance of the marsh.

Each new step of the project involved another community meeting. Sometimes meetings were held at the school and at other times in community centres. EAC people would describe the project, talk about the problems, discuss the background, give an update, and the steps taken as well. The EAC also met with councillors of the West Hants Municipal government and with the Regional Development Authority (RDA). They sent updates to MLAs and Members of Parliament (MPs) offices and sent notices of meetings to the DOT and DFO. The EAC wanted to make sure they kept people informed and aware.

The Cheverie project was pro-active and stewardship based. The EAC spent a lot of time and effort on education. The project went ahead because of these educational efforts. The EAC even used the video made by grade five and six students while lobbying governments to move forward with the project.

Interestingly, the key informants involved with Cheverie Creek had slightly different views on how the community reacted to the consultations and to the project in general. One key informant said that right from the beginning, the response was very receptive and supportive. He did have some interesting conversations with local landowners and he addressed their concerns with a walk around the site. While nothing negative arose, he tried hard to find answers to all questions. Over time, more and more people attended the meetings. There was increased involvement, as well as some indifference. Most people just wanted a chance to be heard, to say their piece. With each year, the school got more involved. He said it was great how much the school embraced the idea.

Another positive response came from a federal government key informant who said the project generated a lot of public interest. The community planned a celebration on June15th, 2006. She said the EAC took ‘before’ pictures and the students at the local elementary school will be taking ‘after’ photos as well.

A key informant from the Cheverie area mentioned that local people were naturally sceptical and had questions and concerns. The EAC tried to answer them all and worked to keep the issue in the forefront for the public by holding walking tours of the beach and interviewing community members about how the creek used to be before the culvert was put in. She also explained that there was a spit of gravel, which people used to fish off, but that changed with the increased water flow. The EAC told people that if there were any hindrances to fishermen that things would be done to help them.

A volunteer with an NGO said that local people were initially interested or curious, but not engaged. However, the school principal was very engaged and appreciated people doing local science and bringing it into the school. There were some fairly active groups in the area and some people saw links between restoring the marsh and their own projects so they wanted to know more. It was these people who became the most engaged. The first community meeting did not attract that many people, but the second was much larger. At this time, many concerns were brought forward including concerns about impacts on a barrier beach on the other side of the culvert that people fish from. So the EAC redoubled its efforts to talk with people and explain the project.

The municipality has bought a seven hectare (17 acre) corner property next to the creek. The newly formed Cheverie Crossway Salt Marsh Society has plans to build an interpretive centre and boardwalk. They are now working with the Dalhousie School of Architecture to develop the building and trails. The fixing of a culvert has been a catalyst for a bigger initiative. They want to attract tourists to the area and make visits an educational experience. The EAC is playing a supportive role only in this next phase of the project.

Red Head Marsh restoration was much less positive than restorations in Musquash and Cheverie. About 50% of the community was in favour of the restoration, which restored the marsh to what it looked like 40 years ago. It was a 57 ha (140 acre) wetland in the City of Saint John and the last area where people could go bird watching. Thus, there were negative comments after the restoration. Where there had been water and ducks, there were mudflats, no birds, and it smelled. This was not appealing to people in the urban area. The local public still did not understand the benefits of salt marshes, but people's reactions became more positive over time. Right after the project, people were not happy, but now they see the benefits of the salt marsh. Community support is required for a salt marsh restoration to be successful, and the public needs to be educated. See Table 6 for a summary list of community consultation ideas.

Table 6 - Community Consultation Ideas

Community Consultation Ideas
• Publishing articles in local papers • Posting signs • Mailing letters and updates • Holding community meetings • Offering a hotline for questions and concerns • Publishing newsletters • Having an information kiosk at a prominent community spot • Sending plans and updates to local landowners • Making presentations to students and teachers • Conducting marsh walks • Holding individual kitchen table meetings

8.3. Reasons for Discontent Among Community Stakeholders

Key informants explained that the public has been supportive of restoration projects in general, but that there are always some people who are not happy. Key informants provided reasons for discontent witnessed through consultations.

One key informant explains to people that changes will take a few years. However, no matter what, some people will never be happy. Most people are in favour of a project until they see the bare dirt. There was one man once who was quite upset that his favourite wetland had been drained. He said the ducks were gone. DUC did helicopter surveys and actually found more ducks in the area than before; however, they were not close to shore, where they had been. This man said that they were probably just decoys. A very small percent of the population will never be happy with what they are told.

A key informant from the government of New Brunswick said that in general restoration projects have been positive. People are unhappy if someone else has broken the law. When people have violated regulations governing wetland protection, they will say that the land is not wetland, or that they did not know the rules. They get mad when they thought they could build on their land and they find out they cannot. They want to know when the rules changed because they see their neighbours did the same thing years ago. They feel the government is taking away their development rights. People see salt marshes as an easy place to build upon. However, people are learning that wetlands (including salt marshes) are important habitat. People are beginning to report the actions of their neighbours. They like having birds around, and may have moved to the area for the peacefulness of the salt marsh.

A key informant from the federal government and one from an NGO both said that they would never push a restoration project on a community that did not want it. One said that if a community is convinced the project is not a good idea, DFO will walk away from the project. They do not want to force salt marsh restoration on anyone. They provide a list of potential project sites to proponents (corporations, organizations, DOT, etc.). Then DFO plays a regulatory or negotiation role. They will help the proponents if they need it. Anyone who works with communities needs a sensitivity to respect local people, or you have no business working in communities. The other key informant said, specifically of Cheverie, that if there were major concerns or opposition, the project would have been scratched. There would have been no point in doing the project if it got a bad reaction.

> *Anyone who works with communities needs a sensitivity to respect the local people, or you have no business working in communities.*

8.4. Lessons Learned: Advice for Community Consultations

Although the key informants are considered experts in their fields, many of them expressed how they would do things differently in terms of community consultations. Those wishing to undertake restoration projects may benefit from their experiences. For example, one key informant explained that Musquash went smoothly but Red Head was “pretty fiery,” with six to eight “trouble makers” at an evening meeting. If similar projects are done, there should be more focus on education before hand such as with demonstrations, slideshows, explaining how salt marshes work, why they are beneficial and why they should be restored.

The general process of really making an effort right from the start worked well at Cheverie. The EAC talked to property owners, schools, communities, which worked for them, but may not in every case. If money was no object, they would have had a better field crew for Cheverie. They only had internship funding so they were not able to keep the same people on throughout the duration of the project. However, they were fortunate to have consistent funding for the project manager.

It was reported that having good communication during the consultation process is extremely important. A project cannot be done without communicating with communities. There will always be obvious concerns, fears about issues like property loss, cows that cannot graze, farmers who cannot hay, etc. It is important to bring the community together in one spot and to go to the community to do presentations and meetings.

9. The Policy Environment

The following discussion on policy focuses on salt marsh restoration around the Bay of Fundy. It incorporates information and research from key informants, a review of federal and provincial policies and legislation, as well as the June 2006 Salt Marsh Restoration Workshop.

9.1. Current Policy Environment for Restoration

The political framework that a community would find itself in while undertaking a salt marsh restoration around the Bay of Fundy includes both federal and provincial legislation and regulations because of the meeting of two jurisdictions in the coastal region. The federal government has jurisdiction over all coastal and inland fisheries and by extension fish habitat, pursuant to s. 91(12) of the *Constitution Act*, which would include coastal salt marshes. However, provincial jurisdiction starts at the higher high water large tide (HHWLT) mark extending landward and would likely include upper marsh areas (depending on the specific marsh in question), as well as responsibility for all dyke infrastructure which was passed from federal to provincial jurisdiction in 1970, a change to the *Maritime Marshlands Rehabilitation Act* (MMRA) of 1948. Beyond legislation, communities will also need to be aware of federal and provincial wetland policies to insure that a proposed restoration fits into the broader federal and provincial vision for Canada's wetlands.

9.1.1. Federal Policy

The conservation of wetlands in Canada has been formally discussed in the federal government since at least the mid 1980s. The *Federal Policy on Wetland Conservation* was created in 1991. Although it is not legally binding it does lay out a preferred course of action with regard to wetlands. The policy states that Canada has about one quarter of the planet's wetlands, or 127 million ha. However, wetlands have been dyked, drained and destroyed mainly for agricultural purposes, which account for 85% of total known conversions (Government of Canada, 1991). In Atlantic Canada, 65% of salt marshes have been dyked. The Federal Policy explains the government's role in wetland conservation:

> Although wetland is a shared federal, provincial and territorial responsibility, the federal government has a particular role to play. Wetlands are critical to federal responsibilities for maintaining the quality of the environment, migratory bird populations, inland and ocean fisheries, and international or transboundary resources such as water and wildlife (Government of Canada, 1991, 4).

Seven strategies are described to reach the government's goal to "Promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future" (Government of Canada, 1991, 5). The strategies include developing public awareness, managing wetlands on federal lands and waters through other federal programs, promoting wetland conservation in federal protected areas, enhancing cooperation, conserving wetlands of significance to Canadians, using a sound scientific basis for policy making, and promoting international actions. Furthermore, a goal of this policy and those of several provinces have committed to a "no net loss of wetland functions." Unavoidable losses are dealt with through compensation activities such as wetland restoration, creation or preservation. The Federal Policy does not provide guidelines for compensation, but the North American Wetlands Conservation Council (Canada) has and it recommends restoration and diligent monitoring over other ways of compensating for lost wetlands.

For the federal government this regulation, administered through the *Canadian Environmental Assessment Act* 1992 c.37, applies to all federal programs, services, expenditures, lands and waters. It does not have jurisdiction over provincial or private lands. Developments and activities on federal wetlands are subject to a federal environmental impact assessment.

Apart from the *Environmental Assessment Act*, three other federal acts concern wetlands: *Fisheries Act*, *Migratory Bird Convention Act*, and the *Canada Wildlife Act*. The *Fisheries Act* is important because salt marshes and wetlands in general provide fish habitat for a variety of species at varying stages of their life cycles as well as food vital to many fish species' survival. Thus wetlands fall under the authority of the *Fisheries Act*. Of particular importance is section 35 (1) which states, "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat." This section of the *Fisheries Act* (often referred to as HADD - harmful alteration, disruption or destruction) offers a useful legislative tool to conserve fish habitat including wetlands.

The *Migratory Bird Convention Act* is another tool that may be used for the protection of wetlands. Since migratory birds cross a number of political boundaries (both domestic and international) in their travels, they fall under the jurisdiction of the federal government while in Canada. As seen in section 4 of the Act, its purpose is to insure Canada is "protecting and conserving migratory birds — as populations and individual birds — and their nests." By extension this affords wetlands a measure of legislative protection because many house the nests of migratory birds. However, it should be noted that to date the legislative potential of this Act to preserve wetlands has gone largely unfulfilled.

Similar to the *Migratory Birds Convention Act*, the *Canada Wildlife Act* protects Canadian wildlife and, by extension, their habitat. As seen in section 4 of the Act:

> (4) The provisions of this Act respecting wildlife apply in respect of
> (a) any animal, plant or other organism belonging to a species that is wild by nature or that is not easily distinguishable from such a species; and
> (b) the habitat of any such animal, plant or other organism.

In addition it allows for the creation of special areas for the protection of wildlife and their habitat.

9.1.2. New Brunswick Policy

In New Brunswick, wetlands, including coastal salt marshes, are the joint responsibility of the Department of Environment and Local Government and the Department of Natural Resources. According to Austen and Hanson (2006), the main wetland management tool in the province is the *New Brunswick Wetlands Conservation Policy*, introduced in 2002. Its main priority is no net loss of provincially significant wetland habitat. All salt marshes in the province are considered provincially significant and will “receive the highest degree of protection.” For all other wetland types, the aim is no net loss of wetland function, and this applies to both public and private lands. The *Clean Environment Act* requires projects of one hectare or more to apply for a Watercourse and Wetland Alteration Permit (s.3(11.1)). The *Watercourse and Wetland Alteration Regulation* identifies which watercourse and wetland alterations require a permit. According to s. 3(1.1) of the *Watercourse and Wetland Alteration Regulation* it is stated that:

> A person is exempt from the requirement to obtain a permit under paragraph 15(1)(b) of the Act if the person is undertaking or proceeding with a project or structure involving any alteration of or to a wetland that is less than one hectare in area and is not contiguous to a water course.

Projects that will impact two hectares or more of wetland require a provincial environmental impact assessment (c.c-6, Schedule A). The *Environmental Impact Assessment Act* outlines the intricacies of the environmental assessment process in New Brunswick. Of particular importance is section v of Schedule A which lists “all enterprises, activities, projects, structures, works or programs affecting two hectares of bog, marsh, swamp or other wetland” as an activity causing “a significant environmental impact” and thus requiring an environmental assessment of some type.

Therefore, from the regulations and legislation laid out above it is clear that wetland alterations of greater than two hectares require an environmental assessment along with an alteration permit, alterations between one and two hectares requires only an alteration permit, and alterations of less than one hectare (when isolated from a water course) are only subject to New Brunswick’s wetland policies.

Furthermore, the New Brunswick government does not support proposed activities in or within 30 m of a provincially significant water way unless the activities include restoring a wetland or are deemed necessary after an EIA. Adverse affects of projects in or within 30 m of all other wetlands greater than one hectare are subject to a review process and a three step approach is followed: avoidance of negative impacts, minimize activity, and specific mitigation techniques.

New Brunswick Coastal Areas Protection Policy was introduced in 2002 and also offers extensive protection to salt marshes on both private and public lands. Its objectives are to reduce threats to personal safety, minimize water contamination, maintain coastal areas as natural buffers against storm surges, maintain flora and fauna, and reduce repair costs from erosion and storm damage. The policy outlines three “sensitivity zones” and the acceptable activities in each. The most relevant to the discussion here is zone A. This zone is closest to the water, includes coastal salt marshes, and has the strictest development allowances. The intent here is to reduce the number of structures that could be damaged by storms and to “allow dyked marshland to naturally revert to salt water marshes by removing control structures.”

The policy recognizes the current existence of agricultural activity, hay storage, commercial fisheries and transportation. Similar to the *Wetland Conservation Policy*, development in or within 30 m of a salt marsh is highly restricted. This policy is still awaiting implementation and will require cooperation from municipal governments because coastal features will be rezoned to prevent further development (Austen and Hanson, 2006). The *Municipalities Act* gives municipal governments the authority to zone land for different uses within the municipal limits pursuant to s. 27.2(3) of the Act. In other words, coastal municipalities control what types of development, if any, are allowed in coastal regions within municipal limits.

9.1.3. Nova Scotia Policy

The Nova Scotia Department of Agriculture maintains 240 km of dykes that protect 17,300 ha of dykeland. Dykelands in Nova Scotia protect more than 600 residential and commercial buildings, 25 kms of railway and 80 kms of paved roads, and more than 126 km of power lines (Nova Scotia Department of Natural Resources).

In Nova Scotia, the authority for assessing impacts to wetlands lies with the Department of Environment and Labour. Wetlands are now managed under the *Policy Respecting Alternation of Wetlands*. The policy requires that approval is needed for any activity that alters an existing wetland. This used to happen under the Wetlands Directive (1995). The policy applies to private and provincial lands only. It does not apply to federal or First Nations lands, nor to mudflats, tide ponds, coastal lagoons, or artificial wetlands such as sewage lagoons. Some of these may fall under regulations made by the Nova Scotia Department of Natural Resources or DFO. Alteration refers to filling, draining, flooding, or excavating. An approval is not issued if there are reasonable alternatives or if the alteration is solely for aesthetic reasons. There are no size limitations; all activities require approval under the *Environment Act* (s.29 (16)) *Activity Designation Regulations*. Approvals are issued through the Nova Scotia Department of Environment and Labour. The size of an alteration or wetland affected does not matter, but if two or more hectares are affected, an environmental impact assessment is required. The regulations list the watercourse alterations that require approval from the minister. For example s. 5(1) lists a number of alterations including “the diversion of a watercourse from its natural channel” and “any other alteration of a surface watercourse or the flow of the water therein” as requiring the minister’s approval. An application for approval includes information on the wetland, purpose and description of the alteration and information on the property. It is important to note that the Policy does not commit to no net loss of wetlands of wetland functions. However, in considering applications, the inspector must use the mitigation sequence to avoid impacts, minimize unavoidable impacts, and compensate for residual impacts that cannot be minimized. In terms of compensation, restoration or enhancement is preferred.

It is interesting to note that if an environmental assessment is triggered, the wetland approval process will not continue until the EA process is complete. An EA is triggered if two or more hectares of wetland will be disrupted. The wetland approval process costs $25 and the EA costs much more. Other permits or approvals that may be needed can be found in the *Navigable Water Protection Act* of 1985 (Transport Canada), the *Use of Crown Lands Act* (Nova Scotia Department of Natural Resources (NS DNR)), and possible building permits obtained from local municipalities.

The essence of the *Agricultural Marshland Conservation Act* is captured in s. 4(1) and (2) which state:

> (1) Subject to the approval of the Governor in Council, the Minister may construct works to develop marshland for agricultural purposes.
> (2) The Minister may reconstruct, repair, operate and maintain any works for the protection, drainage and improvement of marshland for agricultural purposes.

Furthermore, the Act lays out the role and authority of current marsh bodies as well as recognizes marsh bodies originally formed under the MMRA. In June of 1948 the MMRA was passed and over the next decade the dykes would see the greatest changes in their history (Provincial Government of Nova Scotia, 1987). The MMRA put responsibility for the construction of dykes squarely with the federal government and at its height the MMRA had a staff of 75 people, most of whom were engineers (Department of Agriculture and Fisheries, 1987). Moreover, dykeland farmers who wanted work done in their area were forced to gather the signatures of two thirds of the dykeland owners in their region. These groups of dykeland owners formed incorporated groups known as marsh bodies. Today there are relatively few marsh bodies with active groups of dykeland owners who still meet annually; however, marsh bodies are still used for management purposes, as well as to locate specific marshes geographically (Department of Agriculture and Fisheries, 1987).

Despite the construction of dykes by the federal government, today they take no part in their management. In fact, since 1970 it has been the responsibility of the provincial governments to maintain, move and raise the dykes as needed (Department of Agriculture and Fisheries, 1987).

The *Municipal Government Act* gives municipalities in Nova Scotia the authority to decide upon and enforce zoning in the same manner as the Municipalities Act does in New Brunswick.

As noted, fish habitat falls under the jurisdiction of the federal government and the Fisheries Act but it is also regulated to a certain extent by the Nova Scotia provincial government. The *Canada - Nova Scotia Memorandum of Understanding on Fish Habitat* (MOU) exists between the two governments. The MOU is relevant to wetlands because, as in the case of Her Majesty the Queen v. Richard Bagnell, wetlands can be considered fish habitat. As stated in the MOU:

> This agreement is intended to facilitate a collaborative approach to increase certainty, consistency, efficiency and effectiveness in the conservation, protection and enhancement of fish habitat in Nova Scotia according to the provisions of the relevant federal and provincial legislation, regulations, policies and programs.

A check list of regulations and policy that should be considered during salt marsh restoration projects is featured in Table 7 below.

Table 7 - Federal and Provincial Regulations and Policies

Government	Regulations and Policies
Government of Canada	• *Federal Policy on Wetland Conservation* • *Canadian Environmental Assessment Act* • *Fisheries Act* • *Migratory Bird Act* • *Canada Wildlife Act*
Government of New Brunswick	• *New Brunswick Wetlands Conservation Policy* • *Clean Environment Act* • *Watercourse and Wetland Alteration* • *Environmental Impact Assessment* • *New Brunswick Coastal Areas Protection Policy* • *Municipalities Act*
Government of Nova Scotia	• *Policy Respecting Alteration of Wetlands* • *Environment Act* • *Navigable Water Protection Act* • *Use of Crown Lands Act* • *Agricultural Marshland Conservation Act* • *Municipal Government Act* • *Canada - Nova Scotia: Memorandum of Understanding on Fish Habitat*

9.2. Policies that Create Barriers for Restoration

Key informants were asked for their opinions regarding existing policies and legislation which directly impacted their restoration projects. They said that some of the new wetland policies make the job of restoring wetlands easier, while others make it more difficult. For example, HADDs within the federal *Fisheries Act* make restoration easier because they require a restoration project be completed to satisfy compensation agreements for other development projects such as highway construction. In contrast, the EIA process (whether federal or provincial) is quite slow, rigorous and costly, making restoration more difficult to achieve. An NGO representative explained that the

EIA process is long. The EIA for Musquash was quite long and the government kept coming back with more questions. The permitting cost for Musquash was 12% of the total project cost. For Cheverie, the long term benefit outweighed the short term impacts so the Nova Scotia government did not trigger an EIA, nor did DFO trigger a Canadian Environmental Assessment (CEA). Some of the key informants believe there needs to be exceptions in the federal and provincial EA or EIA legislation for salt marsh restoration.

Some of the key informants mentioned the New Brunswick government's Watercourse and Wetland Alteration permits. These permits are reported to take several months to obtain and it is important for people to realize the impact this may have for their project timeline. DFO, Environment Canada (EC), NB DNR, and the public are all consulted by the proponent before a permit is issued. The process is cumbersome but is argued to have a positive impact on restoration. Key informants feel that the *New Brunswick Wetlands Policy* has helped to raise awareness of wetlands along the coast for conservation. All key informants – government officials, NGO representatives, and community leaders – stated that the government officials involved in the projects they worked on were very helpful. One key informant said that they are supportive despite bureaucratic red tape.

The above issues are not barriers per se, but deterrents. The process of obtaining permits and assessments may be long and expensive, but salt marsh restoration is still possible. Furthermore, the main barrier to restoration is not found in policies and legislation, but is the lack of knowledge and study about salt marsh restoration. There have been few discussion papers on Canadian wetland policy, especially salt marsh policy (Austen and Hanson, 2006). While there are some jurisdictional issues in the coastal zone, there are no policies that truly prohibit salt marsh restoration, but salt marsh restoration remains a new idea and is not yet on the minds of the general public. Climate change is a confusing topic for many, and the general public lacks understanding of the issues, including sea level rise.

9.3. International Policy

The value of salt marshes is increasingly being recognized by governing bodies not only in Canada, but around the world and this has been the basis for legislation to ensure their conservation. The Ramsar Convention on Wetlands signed in Ramsar, Iran in 1971 was one of the major international efforts to protect wetlands (including salt marshes). There are currently 1630 designated “Wetlands of International Importance” (145.6 million ha) throughout the world, including three on the Bay of Fundy (www.ramsar.org). More recently, the European Union proclaimed its *Habitats Directive*, which includes a no net loss policy of wetlands and other habitats (Crooks et al., 2002). The United States' *Clean Water Act* (section 404) has been the trigger for numerous restorations or creations of salt marshes (Adam, 2002). In the New England states, both New Jersey and Delaware have programs to protect wetlands through long-term deeds (Weinstein et al., 2001). Connecticut's *Tidal Wetland Act* has helped preserve 5,900 ha of salt marsh since 1969 and is complemented by the Connecticut *Coastal Management Act* (1980) which specifically encourages the restoration of degraded wetlands. As of 1999, 57 salt marshes had been restored in Connecticut and the American government's Department of Environment Protection now has a Wetland Restoration Unit (Warren et al., 2002).

9.4. Policy Recommendations

In both New Brunswick and Nova Scotia, a number of applicable policies need to become legislation. The length of time it takes to obtain permits and environmental impact assessments may be a deterrent or challenge for some, as indicated by the key informants. There is also the desire to exclude or expedite salt marsh restoration projects from these permits and assessments.

According to Austen and Hanson (2006) there is a need for evaluation. They state that in New Brunswick there is no policy or program evaluation and that in Nova Scotia, there is a means of evaluation, but no goal against which to measure success. Nova Scotia does not have "no net loss of wetland function" or any similar goals. Austen and Hanson (2006) argue that evaluation is needed in order to see if the policies are creating the desired outcomes. Do the tools work? Is progress being made? What is progress? Furthermore, they claim that no jurisdictions in Atlantic Canada are recording area of wetland lost to new developments, area of wetland loss avoided, area of wetland loss prevented through minimization, or the area of wetland gained through compensation including restoration.

The main barrier to restoration may not be related to policy, but to lack of education and awareness about climate change and sea level rise. Salt marsh restoration is not seen as a priority yet; it is not in the forefront of the public mind. Thus, our recommendation is to generate funding to support education initiatives and those who want to restore wetlands. In addition, all salt marsh restoration projects should have educational components before the restoration begins, during the construction phase, and after the work is done. Key informants wished that they had been able to focus more on education at the beginning of their projects. Some felt that the public and stakeholders would have understood the issues better and been more accepting of the projects. In addition, projects such as Cheverie Creek, where interpretive panels and board walks can be erected are invaluable not only for increasing education and awareness, but building community spirit as well.

In summary, the general policy environment is more positive than negative toward salt marsh restoration, but remains in its infancy. It is not that there are many barriers preventing restoration, but that policies are still in development, and experience and education about salt marsh restoration is still growing. Communities and NGOs simply need to get out and start restoring more salt marshes. They also need to work in partnership with the federal and provincial governments to develop more effective policies where, perhaps, restorations can be expedited through the EIA processes, common goals can be reached, and methods of evaluation can be created.

10. Building Capacity: Recommendations for Communities

This research project examined the conditions under which a community might be inclined to restore a local dyked or drained marsh into salt marsh. We focused on ecological, economical, social and political conditions during literature reviews, interviews with experts and two stakeholder workshops. Through these activities we have developed a list of recommendations for successful community-based salt marsh restoration projects. Key informants, workshop participants and the literature reviewed stressed the importance of public education and stewardship, the need for leadership, communication with local people as well as gaining their support for the project, taking a holistic approach, and what to do before, during and after a restoration.

10.1. Education and Stewardship

The need for education and awareness was a common theme in the literature, key informant interviews and during both workshops. A restoration project needs to start with an appreciation of ecology; there needs to be education. It is really important to teach the public that birds use the wetlands, that there are particular kinds of vegetation in wetlands, and about their general functioning. Love, ownership, stewardship, and local monitoring are important components of the education process. Understanding the education aspect is so important. There are implications for biologists, policy makers in all levels of government, judges, etc. If the restored site is easily visible, this helps with education as it gets people talking about the project. A community considering salt marsh restoration should also educate themselves about their local marsh. People need to know and understand the science behind the ecological restoration. A community should start by getting some basic information (e.g. the location, what the stresses are on it, etc.). There may also need to be a connection to the area that will be restored. With Cheverie some people got involved because of the fish, some for the birds. There needs to be the desire to take action. It is good if the restoration can tie in with existing concerns.

Key informants, workshop participants and the literature reviewed stressed the importance of public education and stewardship, the need for leadership, communication with local people as well as gaining their support for the project, taking a holistic approach, and what to do before, during and after a restoration.

Participants in both the Salt Marsh Restoration Workshop and the Measuring Adaptive Capacity Workshop expressed that for a community to make a responsible decision with respect to sea level rise and salt marshes, it needs appropriate information and the knowledge capacity to interpret it. Information about an existing dyke in the area, current land uses, alternative adaptation strategies, the functions and adaptive ability of salt marshes and potential restoration benefits for the community are all vital to making an informed decision. However, it is also important to note that uncertainty and knowledge gaps are not an excuse for inaction. Once the information is known to a few there is a need to disseminate it to the community and public at large. Efficient mechanisms of information dissemination are typically community groups and NGOs or even motivated individuals. In any case it is vital to create general awareness around an issue if the goal is to employ a community adaptation strategy.

10.2. Leadership

Some of the key informants stressed that a community interested in pursuing a restoration should have a good leader or manager and that the group leading the project should have a capable reputation. Grass roots community groups need the confidence of the community. People need to know that the group is capable of knowing what to do. They need to be qualified. It is really important to have someone who is responsible for the overall project and to coordinate all of the partners. Project leaders need to know the steps involved, what to do and who to talk to. Groups also need someone to really drive the project and be the main contact person. It would be effective to have one liaison person who is 100% dedicated to the project over the long term, which could be five to ten years. The organization also needs to care for its community and the environment. The EAC got involved in local issues in the Cheverie area and this helped gain acceptance in the community.

Similarly, the importance of a community leader was brought up many times during the Salt Marsh Restoration Workshop. Community leaders offer a useful way of reaching all types of stakeholders, particularly in rural communities where people are often more sceptical of advice coming from outside. In these situations having the message come from within the community tends to help local people see it with an added measure of legitimacy. A community leader can also create a personal connection between the adaptation strategy and the local people so that the strategy can be adopted as the community's own. Moreover, this personalization of the problem (sea level rise) and the adaptation strategy helps to combat complacency by spelling out how exactly individuals will be affected if the status quo is maintained. Going forward, this may help to eliminate the need for a catastrophic event to spur people into action. Local leaders also have a way of creating and maintaining a grassroots momentum that is difficult to access from typical top-down approaches like federally sponsored programs (although both approaches have a role to play). By continually having the issue on a community's radar, awareness and education around the situation and its adaptation naturally increase and this momentum can then be used to overcome the inertia of complacency and make real, on the ground changes in preparation for the future.

10.3. Communication, Involvement, and Support

Key informants mentioned the importance of good communication during the entire restoration process. It is important to keep the local community, landowners, partners, and others informed and up-to-date. Key informants also stressed the importance of involving the local community and obtaining their support for the project.

It is important to get support from a community before starting a project. Good communication is needed right from the beginning. Reasons for the restoration should be clearly communicated. Involve the stakeholders – it helps to build community support. It is good to communicate at a group level and also individually because not everyone will speak up at a large meeting and in small towns. One on one conversations often work best. Clearly demonstrate the benefits of the project, and make sure to calm all fears. If there will be a lot of impact on the land, then it will be important to show the value of the restoration. Good communication with the partners and governing agencies involved is important.

Salt marsh restoration can happen, but it is critical to work effectively with people at the local level. It was good that the EAC became involved with the school in Cheverie because then the students spoke to their parents about the restoration. It is important to engage a cross section of people including women's groups, church groups, municipal planners, local business groups, etc., and to include them before or at the same time as naturalist clubs, watershed groups, and others who are normally asked to be involved. Often naturalist groups are not that big or as wide reaching as a church or business group. Restorations cannot be seen as elitist exercises. While communication with local people and gaining their support is very important, it can also be the hardest part of a project. There are all sorts of engineers to do the technical work, but it takes a special person with the right people skills to relate to the public and landowners. It is critical to involve landowners right from the start – even before starting a project. At Musquash DUC was out asking people what they thought of the idea of removing the rail bed before the project began.

Restoring a salt marsh should not only focus on restoring tidal flow, but also on restoring or maintaining the buffer area and upland regions around the marsh. We need to be careful about developing around marshes.

10.4. Budgeting and Project Scope

Advice about time and money was provided by many key informants and workshop participants. Even the most practical and useful adaptation strategy is of no use without the financial means to implement it. Thus, obtaining funding is very important. It was also stressed in the key informant interviews, that careful budgeting is required (including funding for unexpected complications) and that all aspects of a project must be considered.

A couple of key informants noted the importance of a timeline for a large scale restoration project. Projects will take a long time, longer than planned and may not look like the original design. Projects can take many different courses. For example, a lot of bigger things needed to happen to get a small project completed at Cheverie. A community needs the investment of time which is the most important and the most challenging.

10.5. Take a Holistic Approach

Only one of the key informants mentioned the importance of taking a holistic ecological approach. Restoring a salt marsh should not only focus on restoring tidal flow, but also on restoring or maintaining the buffer area and upland regions around the marsh. We need to be careful about developing around marshes. The tide may still flow in and out even with residential, cottage, industrial and commercial developments around it, but the buffer zones need to be maintained for the health of the wildlife – birds, fish, mammals, etc. It is important to maintain the buffer zones and the upland regions also need to be protected. In the Bay of Fundy, most marshes are small and while they may seem insignificant alone, collectively they are important. Human activity around the marsh, including noise, all terrain vehicle trails, etc., may negatively impact species. We cannot do anything with existing developments, but we need to protect the marshes from further development. There is more to restoration than just restoring tidal flow.

10.6. Things to do Before, During and After a Restoration

All salt marsh restoration projects encounter different circumstances and require different methods. Logistics can create many challenges. The key informants mentioned that there are many logistical things to consider for a restoration project to run smoothly and successfully. In fact, three key informants said you must “get your ducks in a row”. The key informants listed a variety of things they or their organizations did before, during and after the restorations, which may be useful to community groups considering restoration. See Table 8.

Table 8 - What to do Before, During and After a Restoration

Timing	Activity
Before	• Identify a project area for the restoration • Obtain permission from the landowners to restore the marsh (or purchase the property) • Survey the site • Conduct public education and promotion regarding the values of salt marshes • Hold public consultations • Obtain landowner buy-in and stakeholder investment • Review restoration protocols • Apply for appropriate permits • Evaluate technical considerations • Examine project limitations and potential impacts • Gather different partners together • Have an advisory committee made up of provincial, federal and academic representatives • Monitor and evaluate the site • Take pre-restoration photographs • Develop a budget (and budget high to cover unexpected situations) • Write proposals and acquire funding • Have a restoration schedule and a project plan • Schedule work around the tides • Contract the work as necessary
During	• Implement the restoration • Monitor changes • Avoid working during the high spring and fall tides • Supervise the project • Communicate with stakeholders about the project • Use the local school for meetings and presentations • Decrease reliance on the advisory committee

Timing	Activity
After	• Monitor the site • Have community meetings • Take post-restoration photographs • Have a community celebration • Develop trails, boardwalks, etc.

11. Conclusions

There are various options to dealing with sea level rise. We can retreat from the coast and leave our homes and towns to the force of the sea. We can accommodate the change and try to live with it by reinforcing or realigning the dykes. Or, we can protect ourselves by adapting to the change naturally as with salt marsh restoration (Government of Canada, 2004). Salt marsh restoration can be a good adaptation strategy to sea level rise. However, this response requires a certain adaptive capacity. Some communities have more adaptive capacity than others due to the strength of their social, economic and environmental systems, equitable resource allocation, high skill levels, and the ability to disseminate useful information. Each community is unique and each has different vulnerabilities and strengths which contribute to their adaptive capacity. A community may choose to restore a salt marsh for its ecosystem, economic and/or social values, or for other reasons. Restoration projects require good community consultation and engagement, as well as public education to be successful. In summary, Table 9 is an amalgamation of research compiled from the literature, key informants, and both workshops. It summarizes the list of key capacity elements that will help a community undertake adaptive strategies to address climate change and sea level rise. The more strength that a community has in each of the elements, the greater likelihood of it succeeding in adapting. Communities may choose to address their weaker areas and build capacity in one or more of the elements. The capacity areas are all important, but within individual communities, some will be more important than others.

Table 9 - Community Capacity Elements Helpful in Adapting to Climate Change

Community Capacity Elements Helpful in Adapting to Climate Change
• Knowledge Resources • Institutional Resources • Economic Resources • Human Resources • Social Resources

Our research also indicated that there are some gaps in the literature and room for future research into salt marsh restoration as a response to climate change.

11.1. Gaps in Knowledge

The idea of climate change is not new, nor is the awareness of sea level rise. There is a lot of literature on the science of climate change and predictions about its impacts. There is a fair amount of literature on adaptive capacity of communities to deal with different kinds of climate change, including sea level rise. There are case studies from all over the world, in developed and developing countries. However, the process of adaptation has not been well studied (Government of Canada, 2004). Nor is there much literature on the variables or indicators that could measure adaptive capacity. Studies are also missing on the role of community consultations, engagements, public education, and best practices in the salt marsh restoration process. Finally, while authors are examining different ways to measure the economic value of wetlands and other natural capital, the measurement of social values of wetlands is not as well developed.

Gaps in general awareness became evident during the Salt Marsh Restoration Workshop. There were three main areas of concern for us. The first was the lack of understanding about the connection between salt marshes and their ability to adapt to sea level rise. Many participants had never been exposed to the idea of using coastal salt marshes to adapt to climate change. There are evident gaps in general public awareness about wetland ecosystems, salt marsh restoration, and the links to climate change and sea level rise.

The second gap was the lack of community-specific data available about sea level rise and climate change. People need more information about sea level rise, climate change, and its potential impacts, not only globally, but more importantly, in their region or community. Unfortunately, much of this information either does not exist or is not in a form that is readily accessible to the public.

The third gap was a misunderstanding that advocating for salt marsh restoration is synonymous with advocating for the removal of all dykes. Salt marsh restoration is not necessarily dependent on dyke removal. For example, dyke realignment or managed retreat refers to strategically moving dyke infrastructure back from the coastline, thus allowing the natural re-growth of salt marsh ecosystems. Another example is the enlargement or replacement of an inadequate culvert. The Cheverie Creek restoration site provides an excellent example of this. Furthermore, salt marsh restoration will not be possible everywhere. In some places, where vital infrastructure exists, such as highways, rail lines, etc., reinforcing the dykes may be the only truly viable option. However, in some places, where agricultural land has been abandoned for example, restoring salt marshes is possible and preferable.

11.2. Next Steps

Climate change adaptation and salt marsh restoration remain relatively new research domains. Thus, there are areas that are in need of research attention. Human responses to climate change should be explored. Vulnerability and adaptive capacity studies should be undertaken. Communities should assess their adaptive capacity with the Measuring Adaptive Capacity Tool included in Appendix B. We are unable to list which capacity areas communities should focus on building. It is an individual community exercise. A future study could examine community adaptive capacity by using the Capacity Tool to study various types of communities. There is also the need to gather local information about climate change processes, sea level data, and zones of vulnerability. Criteria for assessing dyke infrastructure are needed and policy needs to be developed. More research is also needed to document the process of managing salt marsh restoration projects including best practices and the role of community consultations. Work to develop methods to evaluate the economic and social values of salt marshes should continue.

Perhaps most importantly, awareness about climate change, sea level rise and the potential of salt marshes in adapting to these changes needs to be at the forefront of the public's mind. Maritime Canada is home to many potential restoration sites. As more restoration work is accomplished and research is undertaken we will be able to establish best practices, funding protocols, and build adaptive capacity.

It is our hope that communities, groups and governments wishing to undertake salt marsh restoration will take the lessons learned from this report, along with the Measuring Adaptive Capacity Tool in Appendix B, to measure their own capacity levels, look at their own situations, and design successful restoration projects that are suited to the local environment, ecology, community and stakeholders.

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Appendix A – Key Informant Questionnaire

Exploring Salt Marsh Restoration as a Community Adaptation to Climate Change and Sea Level Rise in Maritime Canada

Key Informant Interview

Date: ____________________
Interviewer: _______________
Interviewee code: __________

I am with the Rural and Small Town Programme at Mount A and we are studying salt marsh restoration as a community adaptive response to sea level rise and climate change. I am conducting key informant interviews with key people who took part in salt marsh restoration projects in the Maritimes. You have been selected for an interview because of your involvement with salt marsh restorations projects. The goals of this interview are to gather information about the tools that communities might need if they are considering restoration projects and what challenges they might face along the way. Thank you for taking the time to chat with me!

Part 1 - Background About You and the Project

1. What restoration project(s) were you involved with?

2. Why was this site(s) chosen to be restored?

3. What is the history of the project(s)? (Was the decision influenced by economics, ecosystem health, community support, etc.?)

4. What was your role in the restoration project(s)?

Part 2 - Community Consultations

5. Did you (or the project team) take steps to consult (engage, educate, etc.) the community? If so, what were they? And at what stage(s) in the project did they take place?

6. How did the community react to the consultations?

7. How did the community react to the restoration project in general?

8. Did their reactions change over time? How? Why do you feel they changed?

9. If you were to do the project again, would you change anything with regards to community consultations? With regards to the entire project?

Part 3 - Policy and Government Issues

10. What policies and legislation had an impact (positive or negative) on the restoration project?

11. What types of permits and approvals were required? Were there any problems associated with these? Were there any unwritten rules?

12. Were government officials helpful during the project? Please explain.

13. Did you know where to go for the kinds of advice you needed? Did anything surprise you about the process to follow?

Part 4 - Challenges and Conflicts

14. What barriers and challenges came up along the way? How were they dealt with?

15. Were there any stakeholder conflicts? How were they dealt with?

Part 5 - Factors for a Successful Marsh Restoration Project

16. How did your group prepare to undertake salt marsh restoration? What kinds of strategies did you employ? What was important?

17. Was there anything unique about the local community that helped it (or hindered it) in accepting salt marsh restoration?

18. In your opinion, what are some of the community factors necessary for a community to undertake a successful restoration project?

19. What advice would you give to those considering salt marsh restoration? Why?

Part 6 - Conclusion

20. Is there anything else you would like to add that you felt was not covered in this interview?

21. Can you suggest anyone else I should interview about salt marsh restoration projects?

22. We are also organizing a workshop for communities who have not yet undertaken a salt marsh restoration project. Do you have any suggestions for invitees?

23. Would you like a copy of final report? YES NO
    Contact details (e-mail): ________________

Appendix B – Measuring Adaptive Capacity Tool

This table helps to identify a community's adaptive capacity and ability to reduce negative impacts of a potential flood event. For each item, assess whether or not the capacity is present in the community, and its quality (on a scale of 1 to 5). Then assess how important you feel having that capacity is for the community to adapt to climate change and sea level rise, and for reducing the risks associated with flooding in the community/region. Some capacity items are directed at the general public, while others are specific to stakeholder groups and community officials found within the community/region. You may wish to add additional capacity items specific to your community or region.

Capacity Area (For undertaking an adaptation to sea level rise and to minimize negative impacts of sea level rise ahead of time)	**Current Status** 0 = non-existent 1= very poor 5 = excellent	**Importance** (For taking action to reduce risk) 1= not at all 5 = extremely	**Comments**
Knowledge Resources			
For the General Public			
Basic climate change awareness (Is the public aware of climate change and sea level rise impacts in the local area?)			
Adaptation options (Does the general community have a basic understanding of different adaptation options?)			
General scientific knowledge (Does the public possess general scientific knowledge?)			
General knowledge about the dykes (Does the general public understand the importance of the dykes?)			
Basic salt marsh awareness (Does the public have basic knowledge about salt marshes and their adaptive abilities?)			
Other:			
Other:			
For Stakeholders and Community Leaders			
Reasonable understanding of climate change and the risks of sea level rise (Are stakeholders aware of climate change and sea level rise impacts in the local area?)			
Adaptation options (Do stakeholders have knowledge about adaptation options, such as reinforcing, realigning, or removing the dykes?)			
Scientific knowledge (Do stakeholders possess a high level scientific knowledge?)			
Knowledge about the dykes (Are stakeholders and officials well educated about dyke infrastructure around the community including vulnerable areas, areas at risk of erosion and breaches, etc?)			

Capacity Area (For undertaking an adaptation to sea level rise and to minimize negative impacts of sea level rise ahead of time)	**Current Status** 0 = non-existent 1= very poor 5 = excellent	**Importance** (For taking action to reduce risk) 1= not at all 5 = extremely	**Comments**
Salt marsh knowledge (Do community leaders/officials have knowledge about salt marshes?)			
Dyke assessments (Is there an ability to carry out local dyke assessments?)			
Technical skills (Are there technological skills, such as GIS mapping, flood zone maps, etc. present in the community?)			
Access to technology (Is there access to climate change models for planning ahead?)			
Communication tools (Do community leaders have communication and marketing tools and the means to spread general awareness about sea level rise, risks, and preparedness?)			
Other:			
Other:			
Institutional Resources			
For Stakeholders and Community Leaders			
Elected officials (What is the ability of elected leaders in the community to make choices related to climate change?)			
Information management (Can community leaders manage information ahead of time to decrease risks such as collecting information on flood plains, etc.?)			
Information dissemination (Do community leaders have the ability to share the information they have about climate change and possible adaptation strategies?)			
Effective municipal plan (Is there a plan that is adaptive, forward thinking, and addresses the sea level rise risk?)			
Groups that offer awareness about climate change, wetlands, etc. (Are there environmental action groups or similar groups present in the community?)			
Other:			
Other:			
Economic Resources			
For Stakeholders and Community Leaders			
Municipal/community budget for adaptation activities (Has funding been allocated for adaptation activities?)			
Provincial funding for adaptation activities (Does the community have access to funding?)			
Federal funding for adaptation activities (Does the community have access to funding?)			
Funding for storm water management (Is there adequate funding for storm water management?)			
Funding for dyke maintenance (Is there adequate funding to properly maintain local dykes?)			
Other:			
Other:			

Capacity Area (For undertaking an adaptation to sea level rise and to minimize negative impacts of sea level rise ahead of time)	**Current Status** 0 = non-existent 1= very poor 5 = excellent	**Importance** (For taking action to reduce risk) 1= not at all 5 = extremely	**Comments**
Human Resources			
For the General Public			
Leadership (Apart from elected officials, are there many people in the community with leadership abilities?)			
Relatively few dependent youth and seniors compared to those of working age (Are there enough capable individuals with the ability to be adaptive?)			
Education level (In general, is the community's population well educated?)			
Innovation (Are there many creative/innovative individuals in the community?)			
Other:			
Other:			
For Stakeholders and Community Leaders			
Innovation (Are there many creative/innovative individuals among the stakeholders and community officials?)			
Funding applications (Do stakeholders have experience writing successful funding applications for community projects?)			
Other:			
Other:			
Social Resources			
For the General Public			
Community attachment (Do local people have a sense of place and want to be in the community?)			
Community cohesion (Is there a sense of togetherness and that people are more or less on the same page in the community?)			
Internal social networks (In general are internal social networks strong and effective amongst the residents of the community?)			
Voluntary involvement (Does the community have a lot of active volunteers?)			
Pride in community (Are residents proud of the community?)			
Willingness to work together (Are residents keen to help each other and work together to overcome challenges?)			
Other:			
Other:			
For Stakeholders and Community Leaders			
External social networks (Are external social networks strong and effective between stakeholders and/or the municipality and outside resources such as government, organizations, etc.?)			
Other:			
Other:			