

Protecting the Migratory Bird Habitat at Malpeque Bay, Prince Edward Island:
An Identification of the Management Needs

By

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To my partner, Brad, who has gone above and beyond to support me throughout this past year. Thank you.

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ABSTRACT

Malpeque Bay, Prince Edward Island (PEI), was designated as containing “wetlands of international importance” under the Ramsar Convention in 1988 due to its unique ecological features and importance as a resting ground for thousands of migratory birds. As part of Canada’s commitment to this convention, management actions at this site must promote its wise use and, yet, no efforts have been made to develop a management plan. This is in light of existing threats to the birds and their habitat, particularly coastal impacts from climate change, pollution from industrial runoff, the presence of invasive species, and the potential for negative effects to result from aquaculture in the Bay. In addition, while the existing policies and legislation that exist at the provincial, federal, and international level may offer some level of protection to aspects of the Bay, they do not sufficiently protect the whole ecosystem from the posed threats. This is particularly concerning as the province does not currently have the fiscal capacity to develop a management plan for the site and the federal government is unable to provide much directive as it has recently had widespread budget and departmental cuts. Recognizing the existing challenges on PEI in regards to resource management and the continued funding to provincial watershed groups even amidst a deficit, it is suggested that it is most reasonable for the management plan of Malpeque Bay to be adopted into a broader watershed management planning process.

Keywords: conservation; environmental policy; environmental legislation; Malpeque Bay; management planning; migratory birds; Ramsar Convention; threat identification; wetlands.

LIST OF ABBREVIATIONS USED

AWCBI	Alderney West Coast and the Burhou Islands
CBD	Convention on Biological Diversity
COSEWIC	Committee on the Status of Endangered Wildlife
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
FPWC	Federal Policy on Wetland Conservation
LOMA	Large Ocean Management Areas
MCPEI	Mi'kmaq Confederacy of PEI
NAWMP	North American Waterfowl Management Plan
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PEI	Prince Edward Island
PESTE	Political, Economic, Social, Technological, and Environmental
SARA	Species at Risk Act
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development

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1.1 Prince Edward Island

Prince Edward Island (PEI), locally referred to as simply 'the Island', is Canada's smallest province, encompassing 5,646 km² of land. It is found off the coast of eastern Canada in the Gulf of St. Lawrence, separated from New Brunswick and Nova Scotia by the Northumberland Strait. The Island boasts natural features such as rolling hills, white sandy beaches, sandstone cliffs, as well as distinctive red soil (Government of PEI, 2010c). These landscapes, as well as the Island's small size, have contributed to economic dependence on the land and surrounding water's resources through the tourism, fishing, and agriculture industries (Government of PEI, 2010a). The region also has great historical significance to Canada, with Charlottetown hosting the Charlottetown Conference, the first meeting of political representatives to discuss the union of the British North American colonies. This set into motion the formation of the Dominion of Canada in 1867. PEI itself did not become a province until 1873, with delegates not having immediately found the terms of confederation to meet the Island's economic needs and political preferences (Baldwin, 1998). However, long before colonial settlement on PEI, there existed a rich aboriginal history.

1.2 Early history of the Mi'kmaq on PEI

As the glaciers melted 10,600 years before present, Paleo-Indians migrated to the Maritime region. At this time, PEI would have still been connected to the mainland

(Baldwin, 1998). The land connection flooded approximately 5,000 years later, forming the Northumberland Strait and creating an island. The original inhabitants of PEI were hunters and foragers who would have travelled throughout the region seasonally, to gain access to a variety of food resources (Government of PEI, 2010b). Much like these inhabitants, the Mi'kmaq were nomadic. It is thought that Mi'kmaw people first came to PEI in the summer to fish, hunt, and to gather shellfish (Baldwin, 1998). They named the island 'Epekwit' meaning 'cradled in the water' or 'lying parallel next to land' (Weiler, 2008). The people lived with close connections to the land and sea both spiritually, as well as for sustenance. They used stones to form tools, birch and cedar trees to make canoes, and animal hides and eelgrass to keep their wigwams warm in the winter. When Europeans first arrived in the Maritimes, an estimated 18,000 Mi'kmaq were present in the region. The European influence would come to drastically reduce this number, as well as bring major changes to the peoples' way of life (Baldwin, 1998).

Today, Mi'kmaq on PEI are represented by the governments of two First Nations bands: the Abegweit First Nation and the Lennox Island First Nation (Mi'kmaq Resource Centre, 2012). Throughout the long aboriginal history of this region, many places on PEI have held great significance for the Mi'kmaq. This paper focuses on one of these places, Malpeque Bay, an area which was originally called Maqpa'q to signify 'big bay' (Weiler, 2008). Today, the Bay is perhaps most obviously connected to the Mi'kmaw population by virtue of the location of the Lennox Island reserve within the Bay itself. The Bay provides a livelihood for many members of this community who pursue a traditional and commercial lobster fishery and harvest oysters, snow crab, and clams (Lennox Island First Nation, 2010). Other areas, such as Pemamgiag, the sandhills at the opening of the Bay, have great

traditional importance. This particular area, for example, is treasured for the presence of berries and medicinal plants, as a preferable location for fishing and camping, and as a place used for ceremonial purposes (Catto & Catto, 2009).

1.3 Malpeque Bay Ramsar Site

Malpeque Bay is located in Prince County, along PEI's northern shoreline at 46°32'N, 63°48'W, 10km north of Summerside (Figure 1; Canadian Wildlife Service, 2001). In 1988, the site was designated as containing "wetlands of international importance" through the Ramsar Convention on Wetlands. The convention is an intergovernmental treaty that promotes ecological protection and sustainable use of designated wetland sites (Ramsar Convention Secretariat, 2008). This particular site includes coastal and marine wetlands, with salt marshes, shallow estuarine waters, mud flats, and saline ponds. The area also has sandy beaches and sand dunes, including a 25 km long sandspit that protects the Bay from the open tidal waters of the southern Gulf of St Lawrence. A 1 km long opening to the Gulf exists at the north-eastern tip. The shallow waters of the bay provide a habitat for shellfish and finfish and also support vast expanses of eelgrass (*Zostera marina*), which shelters many sources of food for the thousands of migratory birds that flock to this area each year (Canadian Wildlife Service, 2001). Birds that rest in the area surrounding the Bay include thousands of Canada Geese (*Branta canadensis*) during the spring and fall, and the endangered Piping Plover (*Charadrius melodus*), protected under Canada's Species at Risk Act (SARA) since 2003 (SARA Registry, 2012).

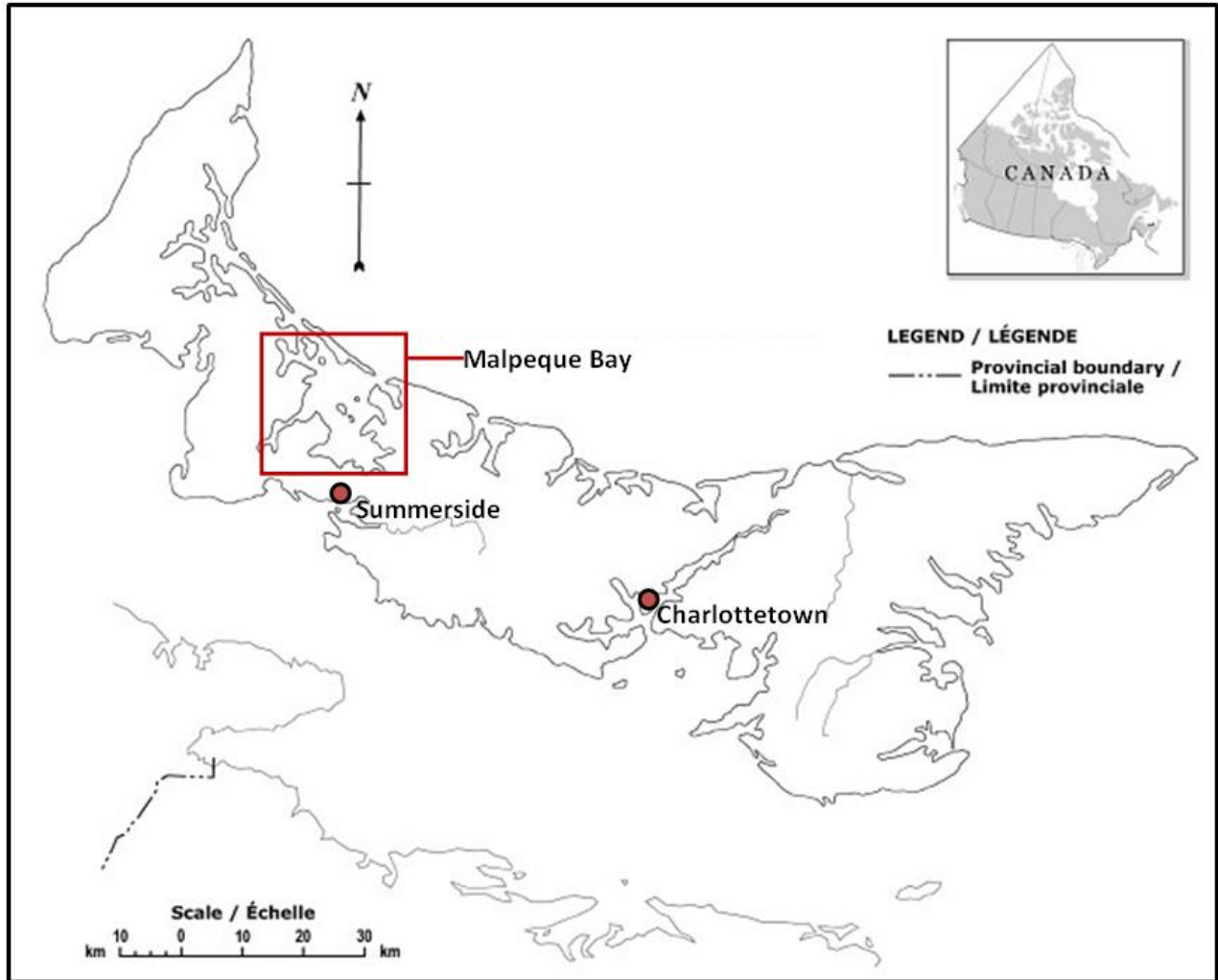


Figure 1. Position of Malpeque Bay on Prince Edward Island (Adapted from Natural Resources Canada, 2001).

1.4 Importance of wetlands

In addition to wetlands acting as a habitat by providing shelter and a food source, they have many other useful functions. These services include water storage and purification, the sequestration of carbon, and the mitigation of storm impacts through the dampening down and absorption of tidal surges. The latter two services are especially important in the context of impending climate changes and predicted impacts (Sarukhan &

Whyte, 2005). In addition to acting as a flood buffer in the case of a tidal surge, coastal wetlands also improve the durability of shorelines, acting as a control for erosion (Dennison & Berry, 1993). There is often also great social and cultural importance placed on wetlands due to their aesthetic, educational, and recreational values (Sarukhan & Whyte, 2005).

1.5 Purpose of this study

Human intervention has contributed to significant global loss of wetlands due to degradation of environmental quality and conversion of wetlands to accommodate various other types of land use (Smardon, 2009). In North America, it has been estimated that 50% of wetlands have been converted for alternate uses in the 20th century (Sarukhan & Whyte, 2005). Wetland loss in PEI can be attributed to draining and infilling for agriculture, coastal cottage developments, as well as urbanization (Department of Fisheries, Aquaculture, and Environment, 2003). The loss of wetlands is of particular ecological concern because of the important environmental services which they provide.

While PEI has committed to no net loss of wetlands or wetland function in their provincial wetland policy, there has not been a formal management plan adopted for the Ramsar site at Malpeque Bay. The problem with this is that potential threats to these wetlands exist, including shellfish farming development, cottage development, agricultural runoff, the spread of invasive species, and sea level rise. This study therefore hypothesizes that increasing threats to Malpeque Bay will result in loss of wetland services and loss of habitat. In particular, the study focuses on habitat loss for migratory birds. This hypothesis

will be tested through a qualitative study of the region and will use parameters for analysis that look at the current legal framework for protecting wetlands and migratory birds on PEI. This study recognizes that there is a need to develop a management plan in this region and, since a considerable amount of time has passed without a plan being developed, the province requires information on how the process of creating this plan should be approached. Therefore, the overarching objective of this paper is to provide recommendations to PEI's Department of Agriculture and Forestry, the authority responsible for managing the Ramsar site, regarding the formation of the management plan for Malpeque Bay.

1.5.1 Document structure and methodology

Chapter 2 will set the context of Malpeque Bay, focusing on its environmental protection. This is accomplished through the use of a political, economic, social, technological, and environmental (PESTE) analysis. These themes are qualitatively analyzed and discussed on a broad scale and then are narrowed into and discussed relating to PEI and the Bay itself. This chapter will put into perspective the importance of the Malpeque Bay wetlands at various levels ranging from local to international. Chapter 3 explores potential threats to the Malpeque Bay region, including those that are in existence currently, as well as those that have potential for the future. These threats are named based on current activities in the region, as well as based on expected changes. A quantitative analysis prioritizes the extent of these threats through a judgement of how likely a threat is to occur and the extent to how damaging impacts of the threat will be. Chapter 4 reviews

existing policies and legislation relating to migratory bird and wetland conservation at an international, federal, and provincial level. This chapter provides an indication of measures that are already protecting the Bay. Chapter 5 uses one other designated Ramsar site as a comparison for how a management plan may be developed. The Ramsar site at Alderney, United Kingdom (UK), is explored due to its shared ecological features with Malpeque Bay, including the fact that the site is part of an island setting. This chapter is intended to point out what is expected in terms of developing a management plan for a Ramsar site. The final chapter, Chapter 6, will discuss any identified gaps in the legal framework required to manage Malpeque Bay. The chapter will submit recommendations to the Province of PEI on how to move forward on developing a management plan that effectively protects the migratory bird habitat at Malpeque Bay.

A PESTE analysis of environmental protection was completed in order to set the context for this study. This investigation involved assessing Canada's existing political, economic, social, technological, and ecological settings. These factors were then explored from the local perspective of PEI, as well as Malpeque Bay. This chapter presents the results of this analysis.

2.1 Political factors

Canada is a parliamentary democracy (Marleau & Montpetit, 2000) headed by a Prime Minister. Individual elected Members of Parliament act as representatives for their local areas, making decisions regarding federal policies, laws, budgets, and actions. Canada, being a federal state, has a common government for subjects of general national concern and separate provincial governments for regional legislating purposes. The Canadian government has the "power to make laws for the peace, order, and good government of Canada" (p. 20) while the provinces govern matters such as setting provincial taxation rates, delivering civil services, providing healthcare and education, governing property rights, and designating municipal boundaries (Forsey, 2012).

Environmental management in Canada is a joint effort between the federal, provincial (or territorial), local, and Aboriginal governments. Matters of environmental protection and conservation are dealt with at a federal level through various acts and the adoption of supportive policies. For example, the *Environmental Protection Act* is the primary piece of federal legislation that works to protect the environment and human

health. The Act has considerable focus on the prevention and management of pollution and also lays out several guiding principles for environmental management in Canada, including the precautionary approach, science-based decision-making, and an ecosystem-based approach to management of natural resources. In addition to this, more specific acts exist. The *Fisheries Act* has sections designed to protect fish and their habitat, the *Migratory Bird Convention Act* regulates human activities that may be harmful to migratory birds, and the *Species at Risk Act* provides legislation to protect species that are at risk of becoming extinct (Environment Canada, 2004a). While all four of the aforementioned Acts have aspects that apply to the protection of Malpeque Bay, the federal government does not have direct and specific legislation for wetlands. However, the country has adopted a *Federal Policy on Wetland Conservation*. This policy commits to protecting wetlands on federal lands, and allowing no net loss of wetlands on such lands (Lynch-Stewart, Kessel-Taylor, & Rubec, 1999).

Under the provincial government of PEI there are a variety of incorporated municipal entities: two cities, seven towns, and 66 communities. Municipal governments have been regarded as legitimate governing bodies at a local or community levels throughout Canada, but the degree of authority devolved to the local level differs in PEI due to its small size and population. In fact, 70% of the province's land base is without a local government as it falls outside of the incorporated areas. This unincorporated area is home to 33% of the province's population. In addition to this, some of the existing local governments are so small that they cannot adequately provide municipal services. This means that the provincial government must often act as a local governing body (Commission on Land and Local Governance, 2009). The existing incorporated and

unincorporated lands, including those that have official plans and by-laws, can be viewed in Figure 2. Surrounding Malpeque Bay, only the small community of Sherbrooke has local planning in place.

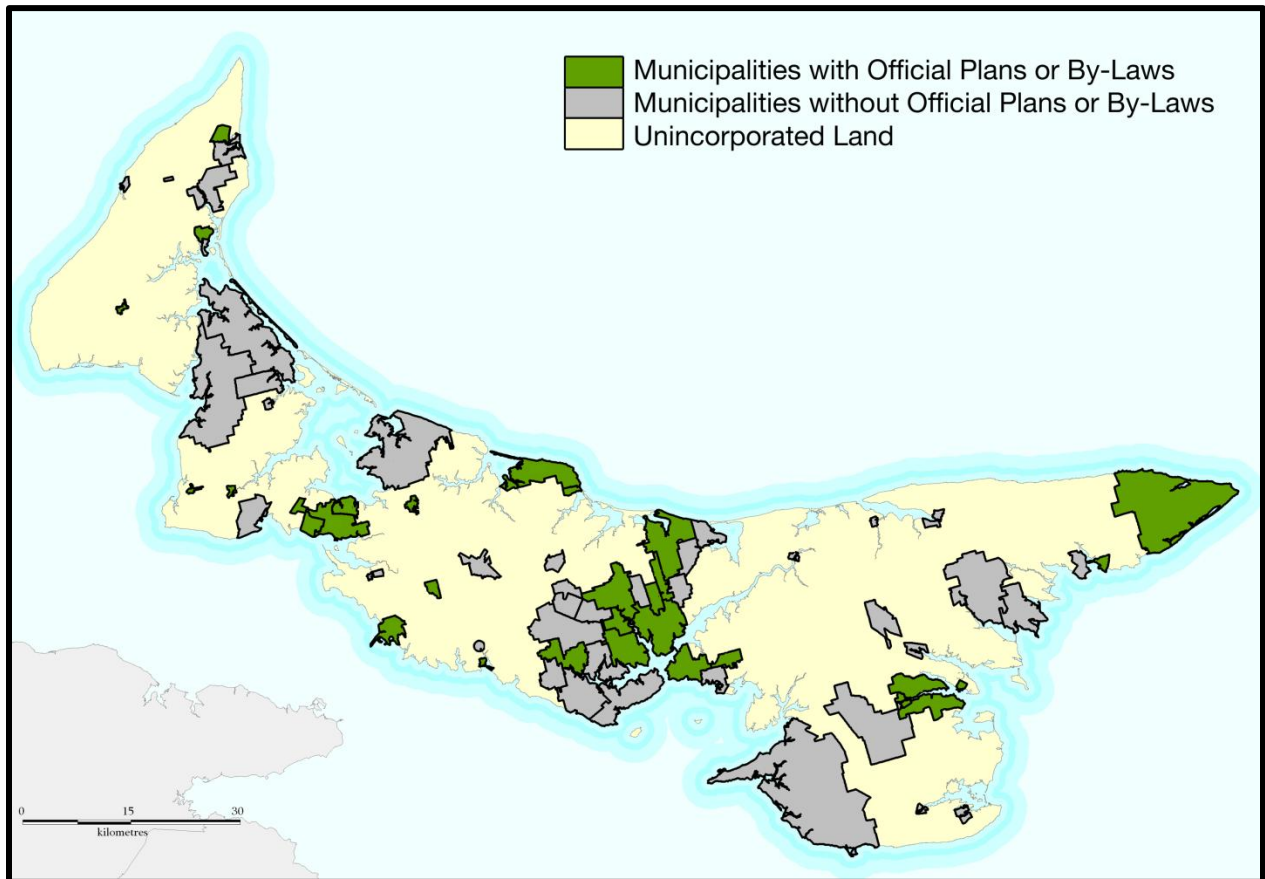


Figure 2. Municipal boundaries of Prince Edward Island (Adapted from Municipal Affairs & Provincial Planning Office, 2011).

The province lacks a comprehensive land use policy but does have several provincial measures that provide protection to the environment, including the wetlands at Malpeque Bay. Much like the Federal government, the Province has a wetland policy that, in short, commits to no net loss of wetlands (Department of Fisheries, Aquaculture and Environment, 2003). Provincial legislation that applies to wetland and migratory bird

conservation includes the *Environmental Protection Act*, the *Wildlife Conservation Act*, the *Planning Act*, and even the *Pesticides Control Act*. This last example is important to Malpeque Bay because farms surround the Ramsar site. Specific to the Bay, the Department of Agriculture and Forestry (formerly the Department of Fisheries, Aquaculture, and Environment) is the designated managerial authority for the Ramsar site (Rosemary Curley, personal communication, May 17, 2012).

In addition to federal and provincial legislation and policies influencing the protection of Malpeque Bay, is the role of the Lennox Island First Nation. On PEI, the Mi'kmaq Confederacy of PEI (MCPEI) exists as a Tribal Council and Provincial Territorial Organization which involves the Abegweit and Lennox Island Band Councils. The organization provides a provincial forum for First Nations issues on PEI and provides advisory services, including integrated resource management (MCPEI, n.d.). While much resource management on Lennox Island has pertained to the existing traditional and commercial fishery (Novaczek, Angus & Lewis, 2009), there are other initiatives in progress that affect Malpeque Bay. For example, a proposal has been put forward to the federal Minister of the Environment by MCPEI to form a co-managed protected area on Hog Island (Jesse Francis, personal communication, May 18, 2012). In addition, whereas it is usually the responsibility of Environment Canada to manage and monitor SARA species and their habitat, negotiations are ongoing between the federal government and MCPEI for the Lennox Island First Nation to manage SARA species on reserve lands in the Bay (Randy Angus, personal communication, May 2012).

2.2 Economic factors

The Canadian economy has been experiencing steady economic growth, with an increase of 4.1% in Gross Domestic Product (GDP) between 2011 and the first quarter of 2012, valued at \$1,765.2 billion. Federal expenditures outweighed incoming revenue in this quarter by \$28.8 billion which added to the national deficit. The national unemployment rate rested at 7.3%. Among the workforce of 17.5 million people, employment has increased by 1.2% since 2011. Over this period, the national average weekly earnings also increased conservatively, by 2.06% to \$888.34 per week (Statistics Canada, 2012b).

Comparatively, the employed residents of PEI comprise 72,000 people. The unemployment rate of 11.3% is higher than the national average, while average weekly earnings are lower, at \$754.18 (Statistics Canada, 2012c). Specific to Prince County, where Malpeque Bay is located, the unemployment rate is 13.6%, which is higher than the provincial average. In this region, the most prominent industry is agriculture. Farming and other resource-based primary industries employ a workforce of 4,160, or 17.4% of employed people in Prince County (Statistics Canada, 2007). This is comparable to the rest of the province where agriculture, fisheries, and tourism remain the dominant industries (Department of Finance, Energy, and Municipal Affairs, 2012a).

In relation to conservation of the Malpeque Bay Ramsar site, it is important to note that the economy of the Island relies largely on the natural resources of land and waters. Both federal and provincial governments make monetary allocations for endeavours to protect these environments. The provincial budget for PEI, which was released on April 18, 2012, provides estimates for the expected generation of revenue and expenditures over the 2012-2013 time periods. The Department of Forestry and Agriculture, the authority

generally responsible for environmental protection, is expected to spend over \$37 million in total. Of this, \$1.14 million will be spent on the administration and management of fish and wildlife resources, including conservation and protection, while \$718,000 will be spent on investigation and enforcement of wildlife and environmental laws (Department of Finance, Energy and Municipal Affairs, 2012b). Considering that over half of these funds are designated for salaries alone, it is apparent that funds to take measures to adequately protect the environment are not always available.

2.3 Social factors

The population of Canada increased by 5.9% between 2006 and 2011 from roughly 31.61 million to 33.48 million. On Prince Edward Island, this growth was experienced at a lower rate, 3.2%, with the population growing from 135,851 to 140,204 residents. PEI's small landmass supports a population density of 24.7 people per km² in comparison to the national average of 3.7 people per km². The median age in 2011 nationwide was 40.6 with 83.2% of the population over the age of 15. These numbers are similar on PEI, with a median age of 42.8 and 83.6% of people over the age of 15 (Statistics Canada, 2012d). These figures, both nationally and provincially, represent an aging population; in 2006 median ages were 39.5 for Canada and 40.8 for PEI (Statistics Canada, 2011). The population is also migrating out of province at a faster rate than the in-migration to PEI (Department of Finance and Municipal Affairs, 2011). In the 2006 census, 1,730 people were identified as having Aboriginal status on PEI—1.29% of the Island's population (Statistics Canada, 2009).

An aging population has various social implications, including the potential for increasing health care costs and a workforce that is decreasing, which may increase the cost of labour. Societal changes can be seen in PEI's agricultural industry. In 2011, Island farm operators had an average age of 54.2, in comparison to 51.4 in 2006. In addition to this, the number of farms has decreased since 2006 (from 1,700 to 1,495), as has the amount of land taken up by agriculture (619,885 to 594,324 acres; Statistics Canada, 2012a). An aging and migrating population are sure to bring change to the traditional livelihoods on the Island.

Prince Edward Islanders have developed a reputation for being resistant to change, especially when outside factors are seen to be the drivers (Commission on Land and Local Governance, 2009). When environmental legislation first came into place on PEI, it was to preserve resources for economic gain, and Islanders were resistant due to the new limitations this placed on their activities. Island residents do face unique challenges compared to mainland Canada because environmental issues are amplified due to the lack of space (MacIntyre, 2011). The small area and limited resources thus play a role in influencing the culture of PEI especially in fostering an understanding of the dependence of the Island on a healthy natural environment. An example where community members have been heavily involved in environmental issues is the case of watershed management. Due to a growing number of concerns in relation to water quality, over 30 community-led watershed groups have formed throughout the province that work to plan, monitor, and manage the province's water sources (Bardati, 2011). Although these groups do face challenges, their existence does show that an environmental ethic exists within PEI's society. Residents' concerns have also been expressed specific to Malpeque Bay. In

response to interest in developing a 40 turbine wind farm in the region in the early 2000s, a community group entitled “Preserve Malpeque” was formed and managed to gather over 400 signatures in a petition to stop the development (“Petition”, 2003).

The Mi’kmaq culture presents a different view on environmental protection. While areas of Malpeque Bay represent great cultural, economic, and nutritional value, the reasons for conservation of the Bay go beyond that. The term ‘Netukulimk’ is similar in meaning to ‘resource management’ but also infers specific values. It refers to harvesting resources in a way that does not endanger the ecosystem’s natural functions, and sharing the natural resources that do exist. It encompasses using traditional knowledge to gain an understanding of the environment and considers that the environment must be preserved for future generations to survive (Berneshawi, 1997). Mi’kmaq society exhibits strong cultural links with nature, which in turn impacts the peoples’ viewpoints of environmental protection.

2.4 Technological factors

Canada strives to be a country known for its innovation, with some success. Historically, the nation has had great success in research and development based in post-secondary institutions. In fact, Canada ranks first, compared to other Organisation for Economic Co-operation and Development (OECD) countries, in the proportion of residents with post-secondary education. While Canada ranks higher than average for its innovation in some industries (e.g. the paper and lumber industry, the oil and gas extraction industry), there are short comings in others, such as investments in machinery and equipment (Science, Technology and Innovation Council Secretariat, 2011). Although Canada ranks

low in terms of research and development on an international level, there is still national recognition that investment in science and technology is required for economic success, job creation, and improving the quality of life for Canadian citizens (Industry Canada, 2009). The relevance of science and technology development to protecting coastal environments like Malpeque Bay is that management and policy decisions need to be based on sound science (Cicin-Sain and Knecht, 1998). However, recent job and funding cuts reflected in the current government's budget, Bill C-38, suggest that the federal government is stepping away from investing in science that supports conservation, and is instead focusing on investing in industries that are profit-driven.

With the focus on traditional resource-based industries on PEI, the province may not be viewed as the most innovative of the Canadian provinces. However, the province has recognised the need to diversify their industries and has had success in doing so. Wind energy is one of the biggest technological successes on PEI, with wind energy technologies having been tested in the province since the 1980s. This research led to Atlantic Canada's first commercial wind farm being established on the Island in 1991. The province has set a goal to have 30% of their electricity provided by wind power by 2013, allowing PEI to become more self-sufficient and a leader in providing a clean energy source (Department of Environment, Energy and Forestry, 2008b). In addition, the Government of PEI has created an *Island Prosperity Strategy* which aims to strive towards innovation and strategically develop industries and sectors. This has contributed to advances in wind technology, information technology, aerospace, and bioscience (Department of Innovation and Advanced Learning, 2010). For example, a \$30 million bioscience research centre will be constructed in Charlottetown (PEI BioAlliance, 2012), providing the infrastructure needed

for this field to develop on the island. While these technological advances may not have an obvious link to Malpeque Bay, they represent attitudes that are ecologically conscious and that value scientific research. These approaches are important components in environmental conservation.

2.5 Ecological factors

Canada, with its vast landscape, covers a variety of ecosystems – from mountainous ranges in the west to Arctic tundra in the north to the sand and sandstone shores in the east. These changing topographies create a range of climates and susceptibilities to human impacts, and elicit varying levels of environmental protection. Of particular note is the topic of climate change and the different ways by which areas are predicted to be affected. Over the past 50 years, Canada has warmed 1.3°C on average and, while the trend is expected to continue across the country, the north and the prairies are expected to experience the greatest temperature increases. Canada is also expected to experience increases in precipitation on average, especially in the north. Again, this trend is expected to vary by region with areas of southern Ontario projected to experience lower levels of precipitation in the winter. Changes in temperature and precipitation will affect agriculture, forest productivity, water availability, and existing infrastructure, to name a few. Coastal areas will have additional challenges in the realm of a changing climate with sea level rise expected to increase and storm surges expected to become more extreme and more frequent. Where global projections have estimated that sea level will rise by 0.18 to 0.58 metres by 2100, the amount of increase on Canadian coastlines will be more severe in some regions, such as Atlantic Canada, where the land is subsiding (Warren & Egginton, 2008).

As discussed, Environment Canada is the leading federal department that deals with environmental issues in Canada, including those related to protection and conservation. While citizen groups and non-governmental organizations (NGOs) also play an important role in such matters, nationwide standards and legislation are the purview of the government. Wetlands are recognized as critical ecosystems that are valued for their ecological functions, including their importance as habitats for migratory birds. As estimates indicate that Canada contains as much as 25% of the world's wetlands, their protection is of benefit on an international level. Wetland loss has happened across the country, with 20 million hectares being drained, or lost by other means, since the 1800s. This includes 65% of Atlantic Canada's salt marshes. To combat this, the federal government has set a goal to have no net loss of wetlands on federal lands (Canadian Wildlife Service, 1991). However, this means that less than a third of wetlands are protected at a national level, leaving most conservation efforts up to provinces and private land owners (Durigon, Hickey & Kosoy, 2012). While bird populations may be threatened by factors such as climate change, pollution, and disease, habitat loss is the most important cause of declines in bird species (Wells, 2007). Therefore, protection of bird habitats, such as wetlands, is key to their survival.

The natural landscapes of PEI include wet lowlands in the west, rolling hills in the central and eastern regions, and areas of relative flatness, all interspersed with vegetation of the Acadian forest type (Department of Agriculture and Forestry, 2012). These landscapes are shaped by the province's underlying sedimentary bedrock. The primary soils formed by these rocks are high in iron oxide, accounting for the Island's characteristic red soil. Red sandstone cliffs dominate the southern coastline while sandy beaches are

commonly found along the northern shore (Catto & Catto, 2009). The fragile nature of sandstone bedrock and sandy sediments makes the island prone to erosion. The provincial government has established buffer zones around waterways to reduce anthropogenic acceleration of soil erosion (Department of Environment, Energy and Forestry, 2011). With the effects of climate change, the rate of erosion is only expected to worsen, however. This rate will be affected by increasing sea level and changing patterns of precipitation, as well as expected increases in storm frequency and intensity. As an island with a low-lying coast that is currently subsiding, PEI is predicted to be highly sensitive to sea level rise (Figure 3; Vasseur & Catto, 2007).

Malpeque Bay is a representation of a coastal lagoon landscape on PEI. The bay is relatively shallow, with depths not exceeding 8 metres, and is protected from the Gulf of St. Lawrence by a 25 km long sandspit and dune formation at the northern tip. Water is exchanged with the Gulf through a 1 km wide channel at the end of the sandspit and is also exchanged with coastal rivers and creeks, creating an estuarine environment (Canadian Wildlife Service, 2001). The boundaries of the watershed can be seen in Figure 4. This region of PEI is of special ecological significance due to the presence of both wetlands and sand dunes—areas that are recognized by the province as ecologically significant sites that should remain in a natural state (Department of Environment, Energy and Forestry, 2011). Wetlands occupy only 5.2% of PEI's land area, just under 30,000 hectares of coverage. It is not known what amount of wetlands have been lost over the past 350 years but drainage for agriculture, forested land clearance, peat moss mining and stream damming have all taken their toll. Less than 21% (6,234 hectares) of the existing wetlands are classified as coastal, a small area for the nearly 3000 km of coastline in PEI (Department of Fisheries,

Aquaculture, and Environment, 2003). According to Malpeque Bay's Ramsar designation, the site contains six types of coastal and marine wetlands. These are:

1. Marine waters
2. Rocky marine shores and offshore islands
3. Sand, shingle or pebble beaches
4. Estuarine waters
5. Intertidal mud, sand, or salt flats
6. Intertidal marshes (Canadian Wildlife Service, 2001)

The sand dune system existing in Malpeque Bay is ecologically significant as the dunes found in this region are among the least common in Atlantic Canada. The sandhills which protect Malpeque Bay from the high wave energy of the Gulf are one example. Not only are the transverse and parabolic dunes at the tip of the bay (at Hog Island) among the highest in Atlantic Canada, they are found in a fairly undisturbed state. In addition to this, the sandhills host rare plant species, including the Beach Pinweed (*Lechea maritima*), the Purple Crowberry (*Empetrum eamesii*), and the Gulf of St. Lawrence Aster (*Symphotrichum laurentianum*; Basquill, 2012). These barrier islands require a steady supply of sand to replenish beaches after sand is transported away by long shore currents. However, sand supply can be impeded by development along the coast or by the destruction of dunes, which act as natural temporary storage units for sand. The dunes at Hog Island are also threatened by sea level rise as they are being eroded on the Gulf side by wave action. Higher water levels restrict the degree to which the island can migrate inland (Catto & Catto, 2009).

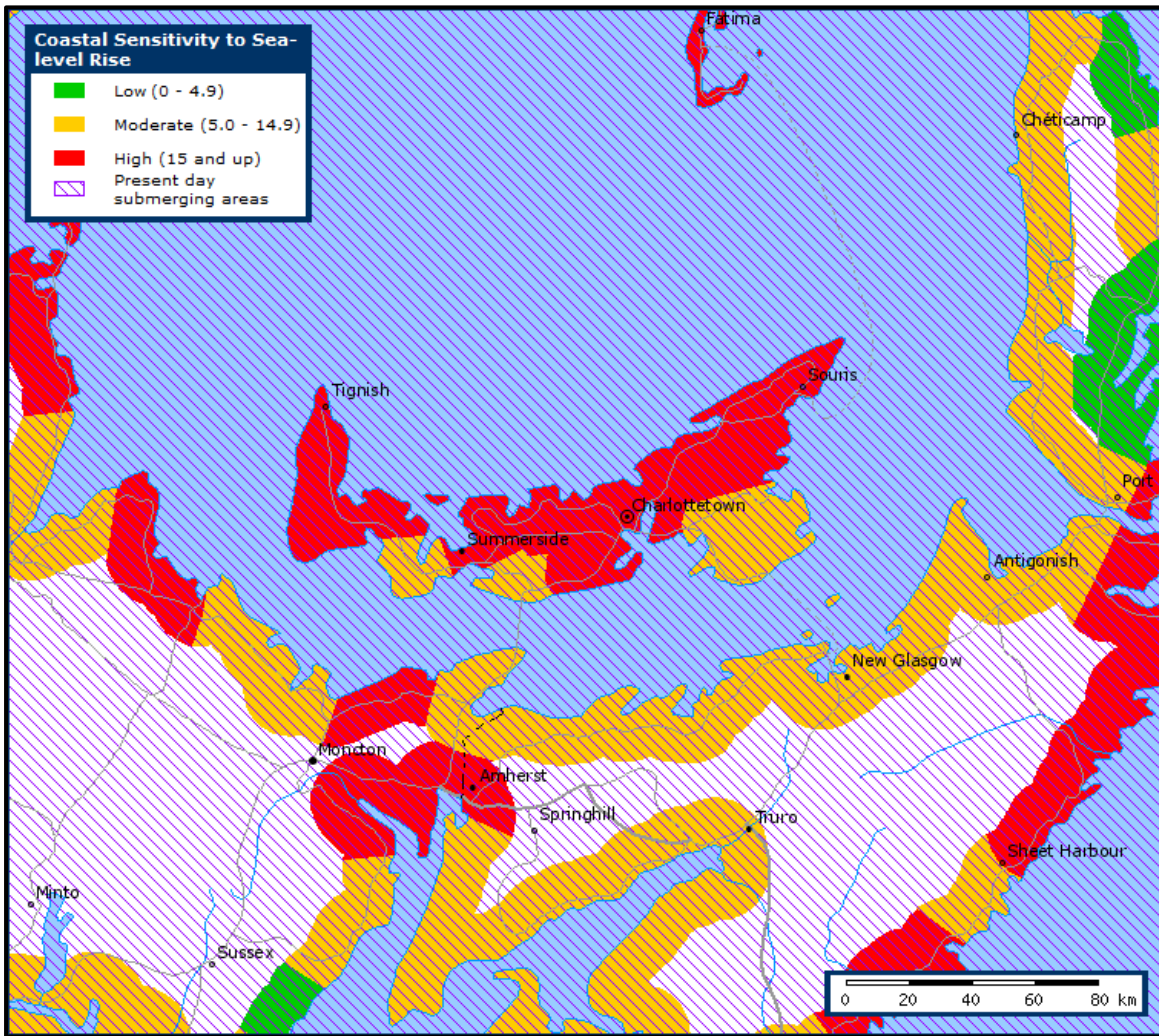


Figure 3. Coastline sensitivity to sea level rise in south-eastern Canada (Adapted from Shaw et al., 1988).



Figure 4. Boundaries of the Malpeque Bay Ramsar site (Adapted from Important Bird Areas Canada, 2010).

The physical features of Malpeque Bay form a habitat that is attractive to wildlife. The productive, shallow waters act as a nursery for finfish and shellfish. The conditions are ideal for the Malpeque Bay oysters, which are fished and farmed within the region for their prized taste. The waters are also ideal for the growth of eelgrass which covers 3,800 hectares of the bottom of the Bay. This grass is alluring for thousands of migratory birds. The presence of large numbers of these birds is what caused this area to be designated as a site of international importance (Canadian Wildlife Service, 2001). Upwards of 14,000 Canada Geese in the spring and 20,000 in the fall can be found resting along the shores of the Bay, as they migrate to and from Newfoundland. These birds feed on the flats of eelgrass and tend to congregate at Courtin Island, Darnley Basin, and the mouth of Indian River. Other birds found in large numbers in the fall include: 3,000 Red-breasted Merganser (*Mergus serrator*), 1,200 Greater Scaup (*Athya marila*), 1,500 Black Duck (*Anas rubripes*), and 750 Green Teal (*Anas crecca carolinensis*). Pintail (*Anas acuta*), Goldeneye (*Bucephala clangula*), and Scoter (*Melanitta sp.*) are present in smaller numbers. Various seabird colonies nest in Malpeque Bay as well, including 300 Great Blue Heron (*Ardea herodias*) at Courtin Island. The Double-crested Cormorant (*Phalacrocorax auritus*) also utilizes the Bay, with colonies at Little Courtin Island and Ram Island. In between 4,000 to 5,000 nests of cormorants are found each season, an estimated representation of 2% of the Canadian population (Canadian Wildlife Service, 2001; Important Bird Areas Canada, 2012). Population estimates must be viewed with caution, however, as there have not been any recent surveys of this area.

One of the most noteworthy fauna found within the Bay is the Piping Plover which is found amongst the shorebirds that inhabit the area from mid-July to early fall (Canadian

Wildlife Service, 2001). This species comes to Atlantic Canada to breed after wintering in the Southeastern United States and the Caribbean. As this species has been listed by SARA as endangered (SARA Registry, 2012), the protection of its habitat is critical. The Plovers have been found at the head of Malpeque Bay at the Conway Sandhills, on Hog Island, and at Darnley Point. Population counts have varied – from 22 present individuals on these beaches in 1991 to 8 individuals in 1996 (Important Bird Areas Canada, 2012). Again, it is hard to come to any conclusions about the population, based on these singular surveys.

While Malpeque Bay as a whole does not have any specific conservation measures in place, there are existing efforts to protect some of the habitat. However, much of this protection seems to be granted on paper only, without actual management efforts put into place. For example, all wetlands in the province are protected under the province's *Environmental Protection Act*, a small 316 hectare area at Indian River has been designated as a provincial *Wildlife Management Area*, and Courtin Island has been designated as a provincial *Natural Area* (Canadian Wildlife Service, 2001). In addition, two provincial parks (Belmont and Cabot Beach) are found along the shores of the Bay. Only at Cabot Beach is there any sort of active protection, however (Rosemary Curley, personal communication, May 17, 2012). Private initiatives have also contributed to conservation efforts. For example, through the North American Waterfowl Management Plan (NAWMP), partnerships have been established with non-governmental organizations such as the Island Nature Trust. These efforts led to the purchase of Bird Island in the Bay which now acts as a private conservation area (NAWMP, n.d.).

While Malpeque Bay lies within a relatively unpopulated area of PEI and does contain natural areas in good condition, there are both human induced and natural hazards that threaten the migratory birds, their food sources, and their habitats. These dangers could cause significant damage to the existing wetlands and sandy shores and could lead to the diminishment of bird populations. If Canada has not developed a management plan and policies to reduce the vulnerability of the Bay to these risks, our commitment to the Ramsar convention is not being upheld. In order to develop a management plan, threats must be discussed in terms of their existence, as well as in terms of the level of threat that they pose. In this chapter, existing threats to Malpeque Bay are discussed in detail and are then examined for the extent to which they pose a hazard for migratory birds and their habitat.

3.1 Climate change

As discussed in Chapter 2, expected changes in climate pose a great threat to PEI's coastlines. Specific to the coastal migratory bird habitats at Malpeque Bay is the hazard of flooding, whether temporary or permanent, from expected sea-level rise and increasing storm frequency and severity. The most reliable data for sea-level rise for PEI, measured at Charlottetown, suggests that sea-level has risen at a rate of 32 cm per century since the early 1900s, accounting for both land subsidence and change in water level. However, this rate is expected to accelerate and the sea is projected to rise by an average of 0.7 to 1.1 metres by 2100 in Charlottetown. As the sea-level rises, storm surges will potentially propel water further inland, causing greater intensity of flooding (Shaw, 2001).

Coastal wetlands, such as those present in the Bay, will be inundated or displaced as the sea-level rises. While some wetlands can combat rising water levels through sedimentation, sediment build-up occurs more gradually in a tidal setting (Nicholls & Mimura, 1998). Sediment transfer rates are fairly high along the barrier islands that protect the Bay but are low inside the estuary (Davies, 2011) which suggests that sediment would not build up in the wetlands quickly. Additionally, even if wetlands migrate inland as the sea gradually rises, net loss still may occur as generally there is not an equivalent area of undeveloped, low-lying land to migrate into. The opportunity for landward migration represents the potential adaptive capacity of wetlands facing changes in climate (Nicholls & Mimura, 1998). It has also been suggested that salt marshes may offer some buffering capacity towards storm surges, mitigating the impacts and lessening the force of wave action (Singh, Walters, & Ollerhead, 2007). The presence of wetlands, thus, may potentially act as natural barrier to flooding caused by a changing climate. However, the degree to which such a barrier is effective will be influenced by the rate at which sea-level rises, as well as the intensity of specific storm surge incidents.

The sandy beaches and dune systems present in the Bay are also at risk from changes in sea-level. Hog Island, which forms the sandy barrier at the northern end of Malpeque Bay, is at greater risk of inundation compared to the interior coastline of the Bay (Figure 5; Davies, 2011). Currently, this barrier provides protection from the high wave action of the Gulf of St. Lawrence. Changes in, or even full disappearance of this Island would certainly change the dynamics of the Bay – bringing in more saline waters, changing the level of productivity, and creating a less sheltered and better-flushed environment. A changing climate affects the rate at which shorelines erode. The rate of erosion on PEI's

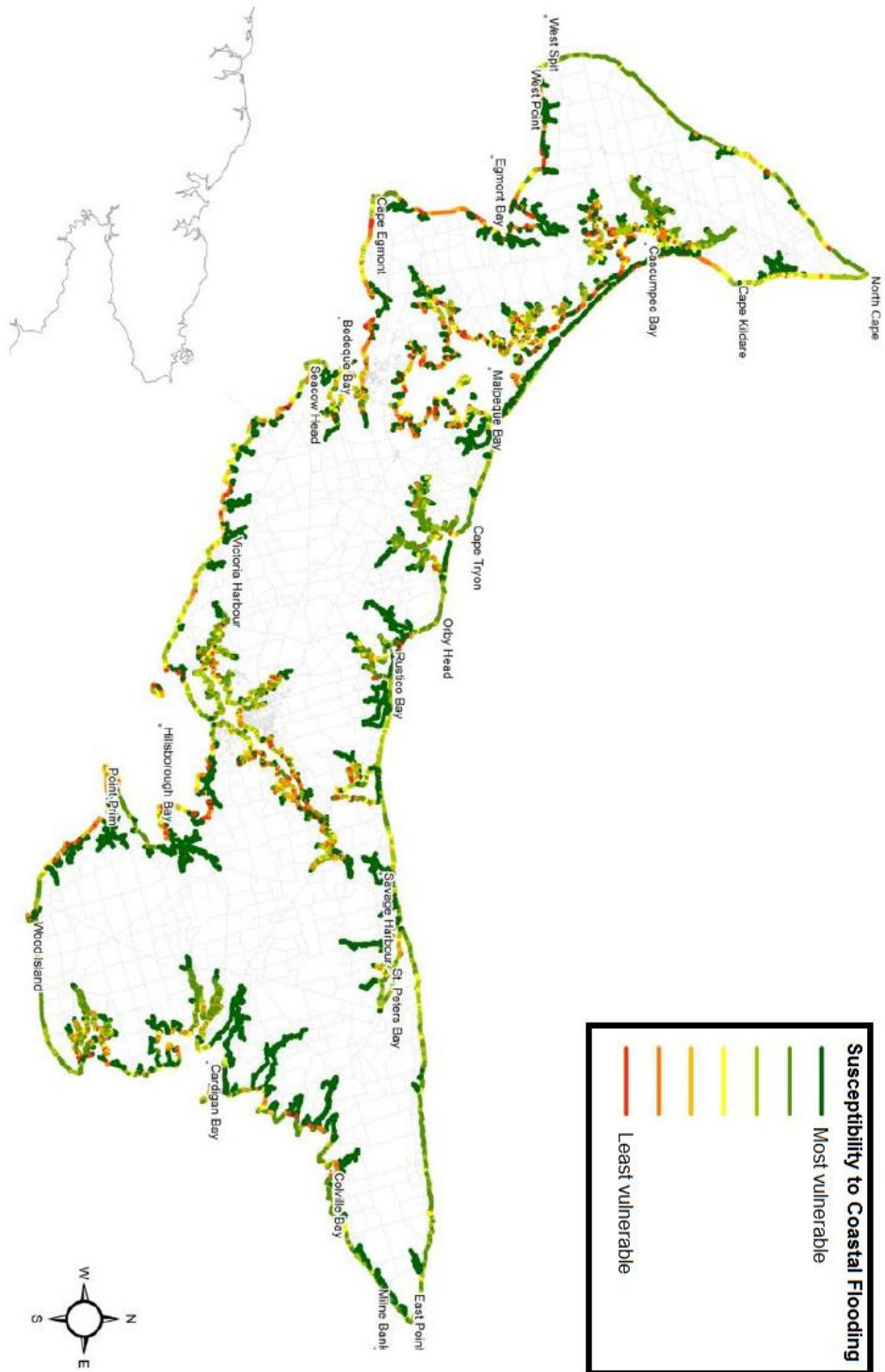


Figure 5. Susceptibility of PEI's coastlines to flooding (Adapted from Davies, 2011).

sandstone and shale coastlines has already been exhibiting an accelerated rate. From 1968 to 2010, the average annual erosion rate was 28 cm per year but, in observing data recorded from 2000 to 2010, the average erosion rate increased to 40 cm per year (Webster, 2012). With the expectation of more frequent, stronger storms, this rate is expected to further increase. Warmer winter temperatures result in reduced sea ice formation, subsequently causing a greater erosional impact when winter storms occur (Catto & Catto, 2009). Erosion will continue as shorelines retreat and adapt to a higher sea level and as the coast is exposed to high energy wave action during storm events (Shaw, 2001). With Hog Island in particular, one concern is that as the dunes will not be able retreat landward as the Island is eroded from the Gulf side and as the sea level rises on the Malpeque Bay side (Catto & Catto, 2009).

3.2 Industrial threats

The economy surrounding Malpeque Bay is reliant on industries that depend on natural resources of land and water, with fisheries, aquaculture and agriculture dominating. There are potential threats that result directly from these economic activities and, if these industries experience growth (e.g. as warmer temperatures extend the frost-free crop growing period), greater risks to the Bay may ensue.

3.2.1 Aquaculture and fisheries

Blue mussels (*Mytilus edulis*) and American oysters (*Crassostrea virginica*) are farmed in the waters of Malpeque Bay. Generally, larval shellfish (or spat) are collected from the wild by using a substrate to which the larvae attach. Once large enough, juvenile

oysters are either spread out in beds (along the bottom of the Bay) or are suspended in holding bags, cages, or on ropes. Mussels are placed in tubular nets which are then attached to ropes, allowing the mussels to grow suspended in the water column (Department of Fisheries and Oceans [DFO], 2005). Because of concern about the number and density of shellfish aquaculture sites in Island bays and the potential for negative effects from these sites, a moratorium was placed on all new aquaculture lease applications in 1999. However, this ban was partially lifted in 2006 to allow the development of new off-bottom oyster cultivation. The ban on applications for new mussel farm leases remains in place (DFO, 2011a). There is interest, however, in allowing further development in Malpeque Bay. As of 2008, shellfish farming occupied approximately 7% of the water area in the Bay and, as such, the Bay has been suggested as a designated area for shellfish aquaculture expansion (MacEwen, Gaudet & Scarth, 2008). Malpeque Bay is said to be suitable as it is the only remaining bay on PEI that is not already over capacitated with aquaculture, according to Bill Drost, PEI's area director for the DFO ("Fishermen oppose", 2009). The position of MCPEI stands at one that both welcomes the economic opportunity that the potential to acquire new leases would bring but also stands in a position that is concerned about the ecological impacts. Thus, MCPEI would oppose expansion until the carrying capacity and full ecological impacts relative to aquaculture in the Bay are understood (Randy Angus, personal communication, August 13 2012).

Expanding aquaculture in Malpeque Bay would put it at greater risk from negative effects that may result from this industry. MacEwen et al. (2008) surveyed stakeholders of the shellfish aquaculture industry at Malpeque Bay to identify the issues and risks that expanding farming practices would create. Environmental impacts discussed included the

potential increase in numbers of invasive species (e.g. tunicates, green crab), creation of organic and chemical waste, alteration of fish habitat and fish behavior, diminishment of water quality (e.g. bacteria and viruses), alteration of bottom sediments, and increased pollution from boats and gear (MacEwen et al., 2008). Environmental impacts from shellfish aquaculture have been well document in Nova Scotia. For example, faecal depositions from mussel farms have been shown to lead to sedimentation below culture site. This causes concern as increased sedimentation creates a greater oxygen demand by benthic organisms. This can potentially lead to anaerobic conditions which could alter species composition of nearby flora and fauna (Grant et al., 1995), also impacting food webs. Hypothetically, if bottom sediments are altered in Malpeque Bay then eelgrass growth patterns could be affected, which in turn would limit a large food source for Canada geese. Aquaculture stakeholders in the Bay have also expressed direct concerns regarding how aquaculture expansion would affect migratory birds, including how habitats will be altered for waterfowl that require use of the water column, and how migratory birds will react to disturbances, such as increased boat traffic (MacEwen et al., 2008). Bird populations are known to already be intentionally disturbed by humans through current aquaculture practices. Loud noisemaking devices are used to deter ducks from consuming mussels at aquaculture site (DFO, 2012), steering them away from areas in which they naturally feed.

The primary fishery in Malpeque Bay is the lobster fishery, which exists both as an aboriginal and a non-aboriginal commercial fishery. A wild oyster fishery is also carried out in the shallow coastal waters of the Bay (MacEwen et al., 2008). Poorly regulated commercial fisheries have the potential to decimate species through overfishing. While the

likeliness of this happening in Malpeque Bay may be debatable, there is potential for shellfish populations to decline as a result of any fishery which could, for example, alter the food dynamics in the Bay. If there are fewer lobsters then fewer larvae are produced, limiting a food source for migratory birds. Potential direct impacts on migratory birds are disturbance by boat traffic, gear entanglement, and gear ingestion. Atlantic Canada has a history of serial collapses of marine fisheries, with the collapse of Atlantic cod (*Gadus morhua*) being particularly devastating (Hutchings & Reynolds, 2004). This has recognition on PEI that fishers need to fish at sustainable levels so that populations do not decline further than they already have. In fact, lobster licenses have even been purchased by the government in order to reduce fishing effort in the Northumberland Strait on the south coast of the province (Department of Fisheries, Aquaculture and Rural Development, 2011). Thus, it seems less likely that fishing effort will increase in the Bay, in contrast to potential development in the aquaculture industry.

3.2.2 Runoff from agriculture, forestry, and industrial processing

Malpeque Bay acts as a drainage basin, whereby the watersheds of multiple rivers and streams discharge directly into the estuary. MCPEI has identified 24 watersheds which drain into the Bay (see full list in Appendix A). The lands which drain into many of these water sources are occupied by industrial agriculture and forestry (Randy Angus, personal communication, May 17, 2012). Surface waters that drain into the Malpeque Bay watershed may carry substances that contribute to the degradation of water quality. Specific concerns for birds relate to the potential for food sources to become contaminated, for the dispersal

of toxins that may be harmful to migratory birds, and general water quality degradation (e.g. anoxic conditions, eutrophication).

Bare soil, often present in farming cycles, is particularly sensitive to erosion during periods of rainfall or high wind. Some farming practices, such as non-conservation based tillage, impede percolation of water into the soil (Environment Canada, 2001). Water that cannot percolate can runoff into nearby waterways, carrying eroded soil that may contain pesticides or fertilizers. Sediments entering water also increase the turbidity of the water column which can in turn reduce aquatic plant photosynthesis or smother bottom-dwelling organisms. Agriculture runoff increases phosphorus and nitrogen levels in waterways, encouraging algal growth (eutrophication) which decreases oxygen levels. Other nutrients, some pesticides, heavy metals found in soils and pathogens found in soils may be toxic or lethal to some organisms (Environment Canada, 2001). Most fish kills in PEI rivers and estuaries have been attributed to agricultural practices (Department of Environment, Energy and Forestry, 2011).

Like agriculture, the forestry industry may degrade water quality because tree removal encourages soil erosion. This is primarily because healthy forests cycle water and nutrients locally, with little drainage to waterways. This cycle is disrupted with tree removal, allowing runoff with greater nitrogen and sediment concentrations (Environment Canada, 2001).

Water quality may also be reduced by wastes released from processing facilities. Adjacent to Malpeque Bay, there are four fish processing plants and two industrial food processing plants. One plant in particular indirectly discharges its waste into Malpeque Bay. The Cavendish Farm plant in New Annan releases treated waste into the watershed of

the Barbara Weit River, which connects to the Bay via Webber Cove (Chiasson, 2004). In 2004, this company was charged with allowing leachate from organic waste to be disposed into a tributary of the river (Environment Canada, 2004b). Wastes may also enter into the Bay from non-industrial sources such as the individual septic systems of cottages and homes, or from the runoff of nearby roadways, which would include wastes from vehicles (e.g. oils, coolant chemicals).

3.2.3 Wind energy development

The most immediate concern with wind farm development and migratory birds is the potential for bird mortality resulting from the collision with turbine structures and their blades, particularly if farms are closely placed to bird colonies or feeding grounds. Although collision rates have been shown to generally be quite low, mortality rates may increase depending on site proximity to bird populations. Other issues relate to the need for birds to expend more energy to avoid wind farms and the potential for farms to be built on, or in interference with, bird habitat (Snyder & Kaiser, 2009). Currently, there are not any large-scale wind farm developments in the vicinity of Malpeque Bay. There are four wind turbines installed in the city of Summerside at the mouth of the Bay, standing each at 80 metres tall (“Summerside wind”, 2010). The province sees potential in expanding wind farms on the Island as a means to promote self-sufficiency and to promote sustainable energy production. High wind speeds throughout the province make this feasible. A large area at the northeastern tip of the Bay has been selected as a “designated area for wind development” (Figure 6; Department of Environment, Energy, and Forestry, 2008b). As mentioned, an attempt to develop a 40 turbine wind farm close to the Bay in the early

2000s was quickly met with public disapproval (“Petition”, 2003). A major concern was the proximity of this proposed development to migratory bird populations. The perceived threats were related to bird collisions with turbine blades and the potential for birds to be disturbed and displaced both during construction of the farms, as well as in the long term. Concerns were also expressed about habitat being lost by turbine placement, and the potential for bird behaviors to be altered if disturbed by the presence of the turbines (MacDonald, 2006).

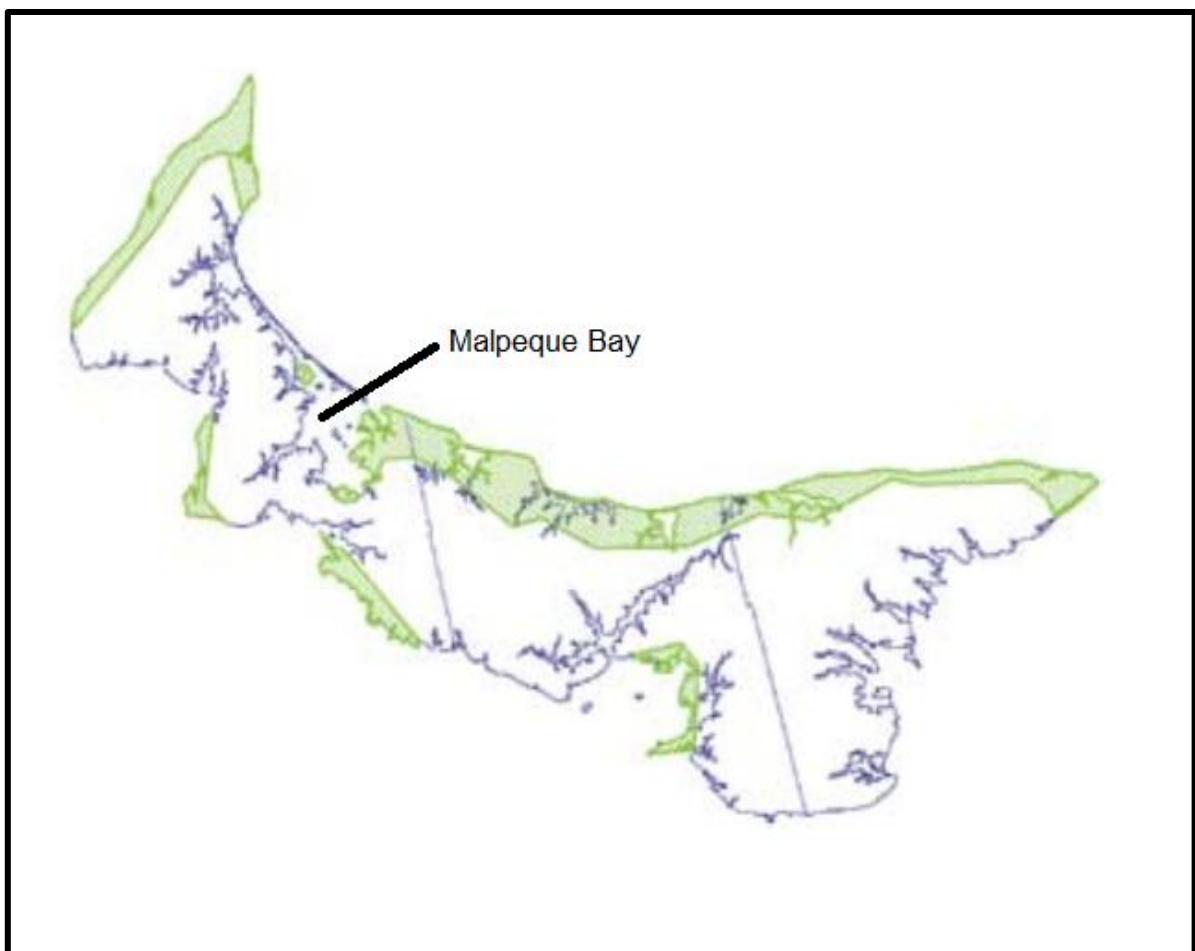


Figure 6. Designated areas of interest on PEI for wind energy development (Adapted from Department of Environment, Energy, and Forestry, 2008b)

3.3 Direct human disruption

Habitat loss and degradation is considered to be the largest contributing factor in the worldwide loss of biodiversity, including bird populations. Whether it has been intentional or not, humans have directly destroyed bird habitats, causing bird mortalities (Wells, 2007). In the context of PEI, land has been cleared for agricultural, residential, industrial, and tourism purposes. Sensitive ecosystems have been damaged by these clearances, as well as by direct recreational use.

3.3.1 Land clearance and development

Historically, vast expanses of land on PEI were cleared for agriculture. This included the drainage of habitats such as wetlands, which presumably had an impact on migratory bird habitat in the past. The amount of land dedicated to agriculture has generally been decreasing on the island since the mid-1980s, and there is increased awareness about negative impacts that the industry creates. PEI has adopted practices to reduce the impacts that agriculture may have on sensitive ecosystems. For example, the province has adopted a 15 meter buffer zone from developing near watercourse or wetlands (Commission on Land and Local Governance, 2009). It seems unlikely that land will continue to be cleared for agriculture in the near future because, there trend is for people to abandon rural ways of life for cities.

Perhaps a more pressing concern is the development of coastal waterfowl habitat for tourism purposes, including the creation of summer cottage subdivisions. Currently, land adjacent to Malpeque Bay is for sale for this very purpose (personal observation, May 18, 2012). Cottage developments have been identified as a direct threat to coastal wetlands

by the province in their Wetland Policy (Department of Agriculture and Forestry, 1995) and general concern for land development in the Ramsar area has been expressed by Environment Canada (Canadian Wildlife Service, 2001). While watercourse development restrictions would apply, cottages could still be built close to bird habitats, especially on popular waterfront lots. At this point, however, the supply of cottage lots for sale on PEI far exceeds the demand (Commission on Land and Local Governance, 2009).

Another concern is that coastal development for tourism may include building wharves for water access or, in the realm of climate change, building hard structures to protect the coastline against erosion and flooding, even though seawalls may actually promote downstream erosion and alter sedimentation patterns by redirecting wave energy (Klein et al., 2001). Hard structures limit the potential for natural inland migration of sensitive coastal ecosystems such as wetlands and beaches, preventing their adaptation to sea-level rise (Fanning & Burbridge, 2009). Thus, even when built with good intentions, coastal infrastructure may contribute to habitat loss.

3.3.2 Recreation

Hunting was once seen as a significant threat to bird populations but the threat has since diminished because fewer people now pursue this form of recreation, and throughout Canada, the hunting of migratory birds is highly regulated (Wells, 2009). On PEI, hunters must be in possession of a *Migratory Game Bird Hunting Permit* as well as a provincial hunting permit. Depending on the species of interest, the season falls roughly between September and December. This coincides with the presence of large numbers of waterfowl and geese in Malpeque Bay and is not when the vulnerable Piping Plover is present. One

species of concern that is present during this time is Barrow's Goldeneye, considered a *Species of Special Concern* under SARA. Any unintentional shooting of this species must be reported, and being in possession of more than one of these birds is illegal (Environment Canada, 2012).

As a popular tourist destination known for its aesthetically pleasing landscapes, PEI has levels of recreational activity along the coasts that contribute to habitat degradation. This is particularly the case in areas that are vulnerable to human presence, such as dunes. Trampling of dune systems has contributed to dune blowout and deflation, as has the use of off-road vehicles and the burning of bonfires in these areas. These activities also inhibit eroded dunes from being able to self-replenish (Catto & Catto, 2009). As bird populations are present within the sensitive landscapes at Malpeque Bay (e.g. Piping Plovers on Hog Island), increased visitation to these areas makes bird habitats may become vulnerable to the direct effects of recreational use.

3.4 Invasive species

Invasive species are considered a major threat to biodiversity worldwide. They are organisms that are transported out of their native range of habitat and colonize new ecosystems or localities. Humans have accelerated the rate at which alien species infiltrate new habitats. Some methods by which this has happened in marine and coastal ecosystems include transport in ballast water, hull fouling, and through aquaculture. Invasive species may compete with native species for space and food, predate local species, alter habitats, and introduce pathogens (Claudi, Nantel & Muckle-Jeffs, 2002). On PEI, invasive species have flourished due to aquaculture practices. Invasive tunicates have proliferated in PEI's

waters and two species, *Styela clava* and *Ciona intestinalis*, have been particularly troublesome for shellfish aquaculture as they tend to grow on lines, buoys and other infrastructure (Arens et al., 2011). Calcium hydroxide is used as a chemical treatment to remove these species from aquaculture lines, which has potential to alter estuary pH and be damaging to larvae. However, the bulk of impact from using this treatment is assumed to be limited due to tidal mixing (Locke et al., 2009). While tunicates may not be in direct competition with birds, they cause alterations in the marine environment and could affect food chain dynamics in Malpeque Bay. Another invader of PEI's coastlines is the Green Crab (*Carcinus maenas*). While there has been at least one sighting of this species in Malpeque Bay, a large population has not yet been established as it has elsewhere around the province (Klassen & Locke, 2007). This species consumes eelgrass and thus directly competes for food with Canada geese (Hanson, 2004). Another invasive species known to occur in the Gulf of St. Lawrence is the dinoflagellate *Alexandrium pseudogonyaulax* which produces Goniodomin A, a known toxin. Such toxins can cause mortality in aquatic species, including birds (Dufour et al., 2010).

3.5 Ranking the threats

In order to rank the threats from the most to least threatening, I have considered the likelihood that a threat will cause damage to birds or bird habitats, and the severity of the impacts arising from each threat. Identified threats were entered into a risk matrix that considered both likelihood and severity of impact (Figure 7). Based on this matrix the threats were rated numerically with 1 being the most threatening and 9 being the least threatening. The final ranking and justification for classification can be found in Table 1.

Climate change, which involves the cumulative effects of sea-level rise, coastal erosion and greater storm surges, was determined to be the most serious threat.

It must be noted that ranks were based on qualitative deductive reasoning. Once a formal management plan is adopted for Malpeque Bay, these threats should be ranked quantitatively using calculated probabilities to provide supporting evidence for policy development. For example, the Government of Canada has developed a threats calculator through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This calculator uses quantitative data to classify threats to wildlife, including the proportion of an ecosystem or population that would be affected by a threat (the scope), the level of damage that the threat could pose (the severity), and how immediate the threat is (the timing) (COSEWIC, 2012).

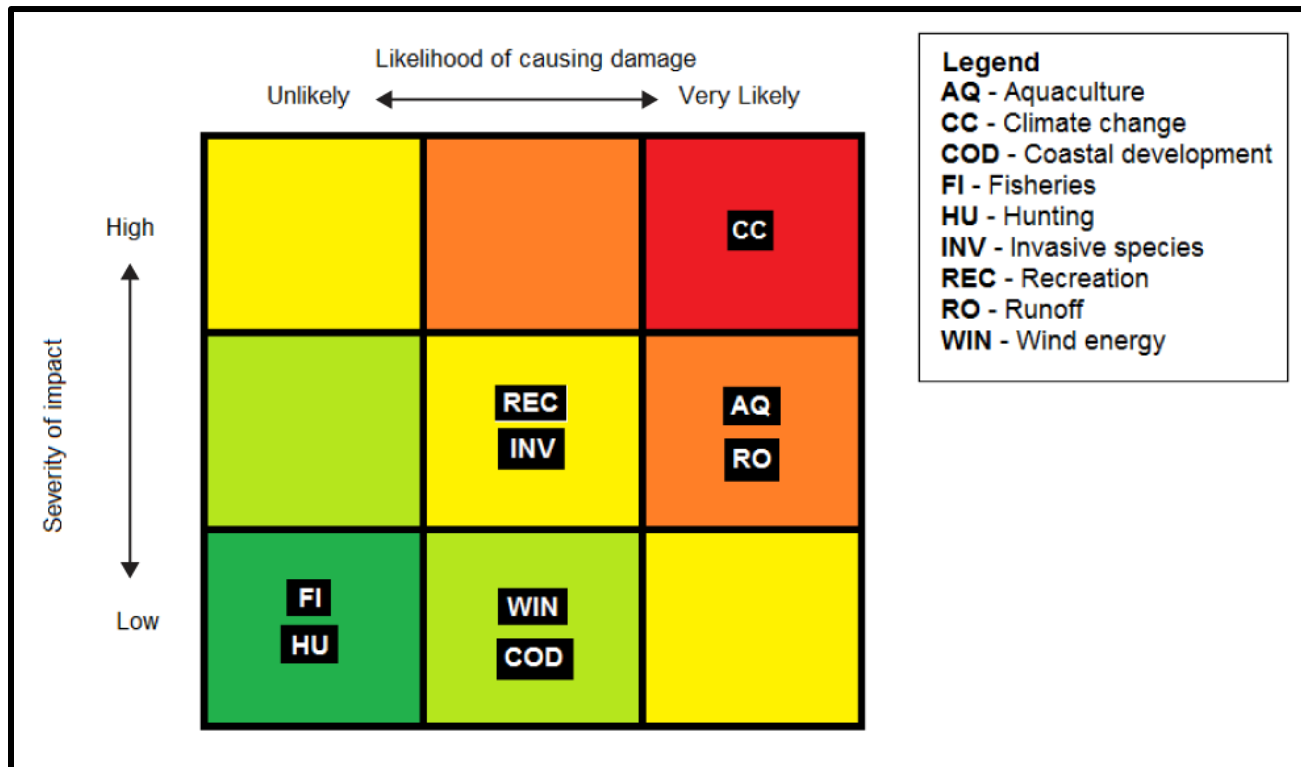


Figure 7. Risk matrix of existing threats to Malpeque Bay, judged by likelihood of causing damage and the severity of the resulting impacts.

Table 1. Threats to migratory birds and their habitat at Malpeque Bay, PEI, ranked based on their likelihood of occurrence and the apparent severity of their impact.

Ranking	Threat	Justification	
		Likelihood of causing damage	Severity of the impacts
1	Climate change	-Changes already occurring -Scientific consensus that SLR is irreversible	-Cumulative effects of sea-level rise, erosion, and greater storm intensities could be severe -Bird habitats will be flooded permanently or temporarily -Major changes to the Bay if Hog Island disappears
2	Runoff	-Inevitable with industries adjacent to waterways	-If not regulated sufficiently, cumulative effects could be severe -Contributes to already prevalent erosion problem -Toxins can directly kill birds or their food source
3	Aquaculture	-Province and DFO interested in expanding in the Bay -Bay not yet saturated with farming	-If not regulated sufficiently, cumulative effects could be severe
4	Invasive species	-Consistent problem on PEI -Likely to continue as aquaculture industry grows	-Major impacts have been on aquaculture industry -Effects on birds most likely indirect but potential shifts in ecosystem could bring in toxins or limit food sources
5	Recreation	-Tourism industry prevalent throughout PEI and has been expanding -Promotion of region as an ecotourism and cultural destination	-Some areas particularly sensitive to human presence (e.g. dunes) -Can cause direct damage to habitats
6	Cottage development	-Land currently for sale for this purpose but demand not existent	-Possible contribution for land clearance, which could disturb bird habitat -Increase human presence in the area -Contribute to loading of human wastes and associated chemicals into the ecosystem
7	Wind energy	-Already interest in developing wind technologies in this region	-Environmental Impact Assessments unlikely to allow development adjacent to important bird sites -Some bird deaths and disturbances still likely to occur
8	Fisheries	-Limited fishing in the Bay -Province could buy back lobster licenses to lessen fishing pressure	-Some minor disturbances likely to occur but overall low impact -Unlikely to compete with bird food source
9	Hunting	-Viewed as a problem of the past -Rates unlikely to increase	-Only certain species are allowed to be killed at certain times of year (highly regulated)

This Chapter will explore the existing international, federal, and provincial policies and legislation that are in place with the objective of protecting migratory birds, as well as their coastal habitats. Both policies and acts that directly protect these natural assets will be discussed, as well as those that indirectly do. For example, Canada's *Migratory Bird Act* directly protects migratory birds, while PEI's *Pesticides Control Act* sets pesticide use standards, which indirectly protects birds from harmful airborne sprays and waterborne runoff. It must be noted that there are likely more policies and acts that apply to these circumstances but only the most relevant or commonly cited will be discussed.

4.1 International commitments

Canada has been an active participant in negotiating and committing to international environmental conventions and agreements. In recognizing that the environment is fluid, Canada has identified that collaboration among nations is required to ensure that the environment is protected. The Ramsar Convention and the Convention on Biological Diversity (CBD) are two examples of agreements to which Canada is a signatory.

4.1.1 Ramsar convention, 1971

The Convention on Wetlands, officially termed the "Convention on Wetlands of International Importance especially as Waterfowl Habitat", is an intergovernmental treaty that was signed in Ramsar, Iran, in 1971. The mission of this treaty is to promote "the conservation and wise use of all wetlands through local and national actions and

international cooperation, as a contribution towards achieving sustainable development throughout the world“(p. 7). Once focusing on wetlands that were used prominently by waterbirds, the mission has since expanded to one of general wetland conservation (Ramsar Convention Secretariat, 2011). Since signing on to the convention in 1981, Canada has designated 37 Ramsar sites, covering 8% of all wetlands in Canada, including the site at Malpeque Bay (Lynch-Stewart, 2008).

Contracting parties have four main responsibilities:

- i) To designate at least one wetland as a “wetland of international importance” and to promote the site’s conservation;
- ii) Use land-use planning to promote the “wise use” of wetland sites;
- iii) Establish nature reserves that include wetlands and support wetland research and management, while ensuring to compensate for any wetland loss; and to
- iv) Cooperate with other countries, especially where wetlands and water bodies are trans-boundary.

In addition to these main obligations, parties are expected to comply with the commitments they’ve made. However, this particular treaty does not have any sanctions or penalties for failing to meet Ramsar Convention standards. Technically, there are no legal commitments that go along with the convention. In order to keep a level of accountability, countries are expected to submit a report to the Conference of the Contracting Parties every three years. This report should document any changes to the Ramsar sites, including any existing threats (Ramsar Convention Secretariat, 2011).

4.1.2 Convention on Biological Diversity (CBD), 1992

In 1992, the CBD was signed at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. The main goals of the convention are to conserve biodiversity, promote sustainable use of biodiversity components, and to encourage equitable sharing of the benefits acquired from utilizing the Earth's resources. The convention aims to give protection to all existing ecosystems, species, and genetic resources. The agreement recognizes the need to manage ecosystems in their entirety – not just specific species and habitats. It also promotes the use of the precautionary principle by which measures should be taken to minimize threats even in light of scientific uncertainty (Secretariat of the Convention on Biological Diversity, 2000).

Canada signed and ratified the CBD in 1992 and, in obligation to the convention, developed a national Biodiversity Strategy. This document established five goals:

- i) To conserve biodiversity and to use resources sustainably;
- ii) Increase ecological knowledge and resource management capacity;
- iii) Increase understanding about why biodiversity and sustainable resource use are important;
- iv) Create legislation and incentives for biodiversity conservation and sustainable resource use; and to
- v) Cooperate with other countries to meet the CBD objectives (Biodiversity Convention Office, 1995).

While this convention is not specific to the protection and management of migratory birds and their habitat, it has pushed Canada to establish general objectives in terms of

conservation, and has set a precedent for the establishment of conservation legislation, such as the Species at Risk Act.

4.1.3 North American Waterfowl Management Plan (NAWMP), 1986

Under NAWMP, Canada cooperates with the United States and Mexico to conserve waterfowl and migratory bird populations. The agreement has a purpose to “sustain abundant waterfowl populations by conserving landscapes, through partnerships that are guided by sound science” (p. 5). The plan aims to sustain populations throughout the continent through collaboration with local management units. Through the creation of joint ventures, individuals, companies, NGOs, and government bodies work together to put local plans in place that focus on the conservation of waterfowl habitat, particularly wetlands (NAWMP Committee, 2004).

4.2 Federal policies and legislation

At the federal level, the policies and legislation which can be applied to the management and protection of migratory birds and their habitat tend to be quite broad. However, these broad policies and laws allow specific issues to be dealt with on a local level. For example, the *Environmental Protection Act* and the *Fisheries Act* require that land-based pollutants not be released into the marine environment unless permitted. These broad regulations apply to specific instances. For example, prosecutions related to fish kills in PEI rivers caused by runoff of farm pesticides, or limits set for releases of nutrients from potato processing plants into the Malpeque Bay watershed.

4.2.1 Federal Policy on Wetland Conservation (FPWC), 1991

The FPWC was developed by Environment Canada in 1991 to “promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future” (p. 5). The policy set forth several national goals, including the need to maintain wetland function, utilize wetlands sustainably, enhance and rehabilitate wetlands, and to establish sustainable management practices in industries that may harm wetlands (e.g. agriculture or peat moss mining). This policy also commits to no net loss of wetlands on federal lands, leaving other wetlands to be managed by provinces or private owners. In addition to these goals, the policy states that if wetlands of significance to Canadians are found to be unprotected then they should be given priority to become protected by either acquisition, legal means, or through a management agreement (Canadian Wildlife Service, 1991).

4.2.2 Migratory Birds Convention Act, 1994

This particular act outlines the rules and regulations that pertain to the protection of migratory bird populations, individuals, and nests. This legislation allows for the creation of Migratory Bird Sanctuaries. For the most part, the act discusses restrictions on hunting and trafficking and allows for legislation regarding these matters to be created. Important to Malpeque Bay is that the act prohibits the deposition of any harmful substances into waters or areas frequented by migratory birds (Government of Canada, 2010c).

4.2.3 Species at Risk Act, 2002 (SARA)

This piece of legislation gives legal protection to endangered and threatened species to prevent them from becoming extinct and to provide for their recovery. The act also works to prevent other species from becoming at risk by encouraging good management practices. SARA is meant to complement Canada's commitment to the CBD. The act outlines how species become listed and how these species can be managed. Once a species is listed, a recovery strategy must be developed. One component of this is identifying the species' critical habitat so that the habitat can become legally protected. Additionally, the Act established the COSEWIC, an independent organization that assesses the status of wildlife in Canada and then reports its findings to the government (Government of Canada, 2012c). In relation to the birds at Malpeque Bay, the Piping Plover is listed as endangered, meaning that it is facing extinction, while Barrow's Goldeneye is listed as a species of special concern, meaning that it may become threatened (Government of Canada, 2012c).

4.2.4 Wildlife Act, 1985

This act allows the federal government to acquire and designate lands or marine areas as national wildlife reserves. These areas may be designated for research and investigation or conservation and interpretation purposes. Actions for the conservation of wildlife within these designated areas may then be conducted (Government of Canada, 2010b).

4.2.5 Canadian Environmental Protection Act, 1999

The Environmental Protection Act largely deals with preventing pollution in order to protect the environment and humans from toxic substances. It recognizes that pollution is a threat to ecosystems and biodiversity. The act gives the federal government authority to manage pollution, to prohibit or limit the release of toxic substances, and outlines the governance in place for emergencies. In relation to the marine environment, this act gives protection, to a prescribed set limit, from land-based sources of pollution and from disposal of deleterious substances at sea (Government of Canada, 2012a).

4.2.6 Canadian Environmental Assessment Act, 1992

It is under this act that the federal environmental assessment (EA) process is legislated. This process is intended to promote sustainable development by conserving environmental quality through the avoidance of adverse effects on the environment. EAs must be conducted before federal agencies and departments conduct a project, fund a project, transfer land for a project to be undertaken, and before projects are authorized to proceed (Government of Canada, 2010a). With the passing of Bill C-38 in June of 2012, federal EA requirements were relaxed. For projects not listed as being required to complete EAs, discretion is left up to the Minister of the Environment to determine whether an EA is required (Doelle, 2012). For example, while the construction of facilities that process petroleum are required to go through an EA (Government of Canada, 2012b), exploration for petroleum is not listed. This could have implications for exploration in water bodies, such as the Gulf of St. Lawrence.

4.2.7 Oceans Act, 1996

This legislation promotes sustainable development, the use of integrated and ecosystem-based management, and the application of the precautionary principle in Canada's oceans. The Act pushes for intergovernmental collaboration in relation to ocean management and encourages Canadian citizens to participate in decision making processes. Marine protected areas are named as a tool for integrated management, and the DFO is named as the managerial authority for the oceans (Government of Canada, 2005). Based on the principles of ecosystem-based and integrated management, five Large Ocean Management Areas (LOMAs) were established for planning and implementing ocean management strategies. This included an established LOMA in the Gulf of St Lawrence (DFO, 2011) that encompasses Malpeque Bay. An internal DFO memo leaked in October of 2011, however, suggests that LOMA projects will be coming to an end (DFO, 2011b).

4.2.8 Fisheries Act, 1985

This act sets forth rules and regulations pertaining to both coastal and inland fisheries. The act regulates fishing gear, equipment, vessels, fishing seasons, and quotas (Government of Canada, 2011). Until recently, the act required that all fish and their habitat be protected against any serious harm but major amendments were made to this act through Bill C-38. These changes have shifted the focus to protecting fish of commercial value, recreational value, or that are a part of an Aboriginal fishery. This allows for more leniencies towards permitting activities that may harm non-valued fish and their habitat (Powell, 2012). Under these changes, the fish and habitat of Malpeque Bay itself would still be protected due to the presence of commercially valued species (e.g. lobster and oyster)

and an aboriginal fishery but the waterways that connect to the Bay would no longer warrant protection.

4.2.9 Navigable Waters Protection Act, 1985

This act recognizes that citizens have the public right to be able to navigate in public waters. The laws put forward by this act limit interference with navigation by prohibiting construction in these waters, regulating wreckage or other obstacle removal, and limit disposal or dumping that may interfere with navigation. Exceptions made under this act must be granted by the Minister of Transport (Government of Canada, 2009). Amendments to this act in 2009 restricted the ways in which these waterways are federally protected. The changes allow for construction projects deemed “minor” or those taking place in “minor” waterways to be exempt from EAs (Transport Canada, 2010). It seems unlikely at this time that Malpeque Bay would undergo major works and many of the waterways that make up its watershed are relatively small. Thus, any waterway protection once offered under this act is likely limited or, perhaps even non-existent in some of the smaller streams.

4.2.10 Aquaculture Policy Framework

As the federal authority for aquaculture management, the DFO has developed a policy which works to promote aquaculture while “upholding the ecological and socio-economic values associated with Canada's oceans and inland waters” (para. 9). It states that aquaculture must be undertaken with consideration of integrated and ecosystem based management, as well as the precautionary principle. Any issues that develop are to

be dealt with the use of science and risk-management approaches and keeping the environment in a clean state is a priority (DFO, 2008).

4.3 Provincial policies and legislation

Policies and legislation that exist to specifically protect habitat and wildlife on PEI are put forward by the provincial government. These acts and policies allow for PEI to develop rules and regulations that are based on the specific needs and expectations of the province, and may be more stringent than federal regulations.

4.3.1 Wetland Conservation Policy, 2003

This policy works to “promote the conservation and protection of Prince Edward Island’s wetlands to sustain their ecological and socio-economic functions, now and in the future” (p. 4). In order to achieve this, the policy commits to no net loss of wetlands on the Island. In order to accomplish this, a hierarchical approach to protection is suggested. First, the avoidance of causing damage or destruction to wetlands is of highest priority. Secondly, if negative effects cannot be avoided then the effects must be minimized as much as possible and, thirdly, compensation or restoration efforts must occur for any lost or damaged wetlands. The policy also promotes making the public educated and aware of the importance of protecting wetlands, suggests promoting environmental stewardship in regards to these ecosystems, and suggests the acquisition of lands containing wetlands, where possible (Department of Fisheries, Aquaculture and Environment, 2003)

4.3.2 Wildlife Policy, 1995

It is within this policy that PEI recognizes the need to protect and enhance wildlife and their habitats. The policy aims to maintain and restore ecological processes as well as biological diversity, and to ensure that the use of ecosystems and species is being conducted in a sustainable manner. There is recognition of the need to work closely with other governments, including both federal agencies and First Nations, and to work with public and private organizations in order to increase wildlife knowledge and wildlife management capacity. The policy recognizes some difficulties in environmental protection in PEI linked to the high percentage of private land ownership. Some specific issues are also addressed, such as the need to protect wildlife from exotic invasive species (Department of Fisheries, Aquaculture and Environment, 1995).

4.3.3 Wildlife Conservation Act, 1988

This legislation lays out the foundation, rules, and regulations for protecting and conserving wildlife on PEI. Along with this, this act requires that there be an inventory and assessment of the state of wildlife in the province conducted every three years. It is under this act that lands may be designated as Wildlife Management Areas that work to protect, manage and conserve wildlife and their habitats. The act also allows private landowners to come into agreement with the province for purposes of protecting private land. Threatened and endangered species can be listed under this act and, in this case, the species and its habitat become protected under provincial law from being destroyed, disturbed, or interfered with. Along with federal legislation, specific hunting and trapping regulations are established under this act (Government of PEI, 2012e). It is under this act that Indian

River, which flows into Malpeque Bay, has been designated as a Wildlife Management Area (Canadian Wildlife Service, 2001).

4.3.4 Environmental Protection Act, 1988

This act provides legislation for the management, protection and enhancement of the environment. This includes the need to investigate threats to the environment and also provides the legal means to prosecute those who are causing harm. Standards and requirements for the conduct of provincial Environmental Impact Assessments are explained. Within this act specific regulations are outlined, such as standards for contaminant discharge and the prohibitions on causing damage to wetlands and dunes. It is also within this act that a buffer zone is established which limits the ground or soil from being disturbed or altered within 15 metres of a watercourse boundary or wetland (Government of PEI, 2012a).

4.3.5 Lands Protection Act, 1988

This act recognizes the unique challenges that PEI faces in being a small province which contains fragile ecological features. It puts forth regulations for property rights in PEI, particularly in regards to how much land a corporation or person may own, and limits to the amount of shoreline property a non-resident may purchase. Under this act, conditions may be imposed as to what acquired land may be used for, such as designating land to only be used for conservation purposes. Lands may also be identified for non-development (Government of PEI, 2003). Land identification agreements, however, are

only active for ten years and termination of the agreements can be granted once this time has passed (Commission on Land and Local Governance, 2009).

4.3.6 Natural Areas Protection Act, 1988

Natural Areas may be designated on crown or private land under this act for the purpose of providing legal environmental protection to the site. For an area to be designated it must contain unique or rare wildlife, have unusual features, exceptional scenery, act as a haven for wildlife, or must provide research or educational opportunities. Regulations that are imposed within designated areas include prohibiting the destruction of vegetation, the introduction of invasive species, and infrastructure development. If the area is found to have degraded in quality, its Natural Area status can be revoked (Government of PEI, 2012b). In Malpeque Bay, Courtin Island has been designated as a Natural Area (Canadian Wildlife Service, 2001).

4.3.7 Planning Act, 1998

It is within this act that municipalities on PEI are given the power to develop municipal plans so that planning can take place at both a local and provincial level. The act also encourages planning that focuses on environmental protection. Essentially, this act provides the framework for land-use and development policies. When areas do not fall within municipal boundaries, they must comply with established provincial land planning and development regulations. Under this act, building restrictions are also imposed. For example, on off shore islands, land may not be subdivided into parcels, buildings cannot be constructed on dunes or in wildlife habitats, and no buildings that require sewage or a

water supply can be built. These restrictions are applied to Bird Island, Ram Island, Courtin Island, Conway Sand Hills, Hog Island, and George's Island in Malpeque Bay (Government of PEI, 2012d).

4.3.8 Pesticides Control Act, 1988

The *Pesticides Control Act* is one of many existing acts that encourage good agricultural practices on PEI. This act specifies pesticides that may or may not be used, requires applications for permits to use certain chemicals, and regulates pesticide disposal. Measures for best environmental practices include buffer zones within 25 metres of water bodies, where pesticides may not be used (Government of PEI, 2012c).

4.3.9 Aquaculture Leasing Policy, 2008

While PEI does not yet have an overall aquaculture policy, one is currently in the process of being established by DFO. However, only initial steps to identify stakeholders have been taken (personal communication, Randy Angus, June 2012). The province does have a leasing policy for this industry, however. This policy outlines the process for allocating new leases and managing those that are in existence. While DFO has jurisdiction over leasing, it is administered by the province of PEI. One aspect of the policy is ensuring that aquaculture proceeds while maintaining a commitment to the environment. It is also through this policy that coastal areas are zoned as to how appropriate they are for aquaculture development (PEI Aquaculture Leasing Management Board, 2008).

4.3.10 Climate change strategy, 2008

The policy document that exists in relation to climate change is PEI's *Strategy for Reducing the Impacts of Global Warming*. This document states that the province must adapt to climate change so that its infrastructure, natural habitats, resources and economy will be less vulnerable to the impacts. The role of the provincial government in this is essential to provide guidance through policy, support, and leadership. A great deal of focus is placed on reducing PEI's greenhouse gas emissions, particularly through greater use of renewable energy sources. However, the document also discusses the need to identify vulnerabilities, particularly along the coast; the need to consider climate change in land use and development planning; and the use of environmental assessments that also consider these changes. Recognizing the coastline's vulnerability to erosion and sea level rise, a focus on coastal areas, watercourses, and nearby infrastructure is seen as essential (Department of Environment, Energy and Forestry, 2008a).

By following the responsibilities set out by the Ramsar Convention, Canada will fulfill its international obligations in regards to conserving selected, globally important wetlands while also complementing existing policies and legislation at the federal and provincial levels. Although Canada has done well in actually designating Ramsar sites, there has not been comprehensive follow through in providing management that promotes sustainable use of these wetlands. This chapter will discuss the state of Canada's Ramsar sites and what the management expectations are for these sites, as set out by the Convention. A case study with similar features to Malpeque Bay will then be used as a comparison for the site on PEI, as a demonstration of an existing management plan that could be followed.

5.1 State of Ramsar site management in Canada

Canada submitted its most recent report outlining the status of implementing the Ramsar Convention on a national level at the 11th Conference of Parties, held in June of 2012. Within the submitted report it is evident that Canada has had several major successes in the implementation of this treaty, and has made an effort to ensure that wetlands are conserved in Canada. However, the country is still falling short in designing and implementing effective management strategies at these sites (Canadian Wildlife Service, 2012).

To date, 37 wetland sites have been assigned the Ramsar designation in Canada, including sites in each of the ten provinces and three territories (Canadian Wildlife Service,

2012). While this number of sites may seem to pale in comparison to the 169 sites in the UK, Canada's Ramsar sites encompass 13,066,675 hectares of space, accounting for the largest area designated by a nation under this convention (Ramsar Convention Secretariat, 2012). In relation to promoting conservation at these sites, most site managers (67.6%) agree that the Ramsar designation has helped maintain the ecological character of the sites, compared to if it they had not been nominated (Lynch-Stewart, 2008). It is without question that the responsibility to initially and continue to select Ramsar sites has been fulfilled. Canada has also kept its commitment to work cooperatively with other nations, particularly through the NAWMP in partnership with Mexico and the United States. Throughout this venture, over 4 million hectares of land and associated waterfowl habitat have been purchased across the country (Canadian Wildlife Service, 2012). These acquisitions are one example where the responsibility to designate nature reserves has been displayed. While these positive movements towards implementation are commendable, it is still questionable whether efforts have encouraged land-use planning that promotes "wise use" of the Ramsar sites, and whether research and management within these sites have been fully supported.

The treaty defines wise use as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development" (p.45). In order to achieve this, it is advised that policies, programs, and management action plans integrate this principle (Ramsar Convention Secretariat, 2011). Currently, 23 of the 37 Canadian Ramsar sites have management plans, with two others in the works. Of these plans, 11 date from before the year 2000, with some not having been updated since the early 1980s (e.g. Chignecto). While monitoring of

ecological health is ongoing at many of the Ramsar sites, only seven of the management plans have ever been reviewed, or are in the process of being reviewed, to assess their effectiveness (Canadian Wildlife Service, 2012). It can be inferred that many of the plans are out of date or are based on information that is no longer relevant.

The 2012 report names several challenges in implementing the convention. The greatest of these are a lack of human and financial resources, the need for better outreach and engagement strategies, and challenges related to jurisdiction. For example, while it is the national government that assigns the Ramsar designation, it is often the provincial government that must take on the managerial authority (Canadian Wildlife Service, 2012), for which they may not have the capacity or the resources. An independent survey revealed that managers themselves saw similar issues. Difficulties in or lack of management at sites was attributed to a lack of funding, lack of public education about the sites, and limited communications and information sharing among the Ramsar sites. The survey results also suggested that there was no consensus about how Ramsar sites should be managed, or how to attract greater support (Lynch-Stewart, 2008). More recently, the federal government has tried to ameliorate the lack of Ramsar site management by facing these criticisms. Environment Canada is working with site managers to develop a manager network which will aid in the dissemination of information and will encourage idea-sharing and collective problem solving. In 2009, the federal government offered a Ramsar site manager training course with the hope of improving management and meeting management needs at the existing sites (Canadian Wildlife Service, 2012). Regardless of such initiatives, some sites, like the one at Malpeque Bay, still exist with neither a management directive nor planning.

5.2 Management expectations for Ramsar sites

In order to provide direction to the Conference of Parties about how sites can be planned and managed for wise use, the Ramsar Convention Secretariat published a guidance document entitled *Guidelines for the implementation of the wise use concept*. These guidelines suggest three main courses of action:

- i) Adopt national wetland policies and legislation, including those that encompass environmental action planning and biodiversity strategies;
- ii) Facilitate the development of wetland inventory counts, monitoring and research programs, and training and education programs; and
- iii) Develop integrated management plans that encompass whole wetland ecosystems, including their catchments and surrounding activities (Ramsar Convention Secretariat, 2011).

While the first two courses of action are both important aspects that can be incorporated into a management plan, this section will draw particular attention to the third point as it is the intention of this study to provide guidance to developing management strategies for the site at Malpeque Bay.

In order to effectively manage a Ramsar site, an interdisciplinary approach should be taken which is suited to local political, social, economic, and ecological properties. It is essential that local needs and cultural considerations are taken into account in the planning process and that there is general agreement on planning and management actions to be taken amongst various stakeholders, from managers to resource users. In 2002, a document was developed by the Conference of Parties to the Ramsar Convention which sets standards and helps managers develop site-based management planning. The *New*

guidelines for the management planning for Ramsar sites and other wetlands document encourages the development of site-specific plans that can be integrated into broader scale ecosystem planning. Two important initial points that these guidelines make are that 1) management plans only have to be as complex as the site is and thus can be very concise with specific site management objectives and 2) a management plan does not necessarily have to be developed specifically for the site in order to guarantee wise use. For example, a plan could be developed for the whole watershed that would indirectly encompass the site's management. However, the types of broader planning with which a Ramsar site's management can be integrated will be dependent on the ecological characteristics of the site, as well as its management objectives (Ramsar Convention Secretariat, 2002).

In discussing the reasoning for developing wetland management plans, the document covers elements that a management plan must encompass. A management plan must:

- i) Establish objectives of the management site (i.e. what is it trying to achieve);
- ii) Determine factors that currently affect, or may affect, the site's features (i.e. existing threats and influences);
- iii) Recognize potential conflicts and ways to resolve them;
- iv) Determine monitoring needs;
- v) Determine management actions needed to achieve objectives;
- vi) Calculate resource requirements (i.e. budget planning);
- vii) Communicate with other site managers, organizations, government, and stakeholders;
- viii) Be able to demonstrate that management of the site is effective; and

- ix) Comply with local, national and international policies, strategies and legislation.

The guidelines suggest taking a management approach that is participatory in order to include the opinions of stakeholder groups while developing a management plan that fairly represents the community's needs. A precautionary approach should be taken in order to reasonably address serious threats, even with existing uncertainty. An adaptive approach should also be taken to adjust management actions if objectives are not being met, and to adapt to a changing environment (Ramsar Convention Secretariat, 2002).

Lastly, the document provides guidance on how a management plan could be structured. It suggests that planning should begin by making a policy statement that describes the existing policies and practices that have influenced the creation of a management plan, including the site's designation as a Ramsar site. The plan should then provide background information on the site, including relevant ecological, social, and economic information. Particular focus may want to be drawn to the features that have led to the site's designation as "important". These factors should then be evaluated in order to identify what aspects of them are important for management planning. For example, one key aspect of site ecology may be its biological diversity, or social importance of a site may be evaluated by exploring the archaeological history of the area. Following this, objectives for the site must be set. These objectives need to be measurable and achievable, and must describe desired conditions, not the actions required to get there. The next section of the management plan should rationalize the management required to maintain or restore the site to a desired status. This section should explore solutions to manage influences on the site. The last element to consider in a management strategy is the development of an action

plan. Building on the rationale, this section would set forth specific actions to be taken to implement the plan and to achieve the set objectives. The plan must identify when specific actions will occur, where they will occur, who will carry out the process, the action's priority, and how much it will cost (Ramsar Convention Secretariat, 2002).

5.3 Ramsar site management: a case study

In order to explore the applicability of these guidelines, a case study of a site with a development management plan in place will be discussed. Managers involved with Malpeque Bay can learn from the successes and can benefit by avoiding the weaknesses apparent in the case study site.

5.3.1 Case study selection criteria

For the case study to be comparable to Malpeque Bay, the site had to be chosen based on sharing similar characteristics, while having a developed management plan. The case study must exhibit the following criteria:

- i) Designated Ramsar site;
- ii) Site location on an island;
- iii) Location in the North Atlantic Ocean;
- iv) Important bird habitat;
- v) Shared ecological features with Malpeque Bay;
- vi) Public access to the management plan; and
- vii) Management capacity similar to that of Prince Edward Island.

Potential sites were explored by using the Ramsar Convention Google Earth plug-in (Downloaded from <http://ramsar.wetlands.org/GISMaps/RamsarSitesinGoogleEarth/tabid/944/Default.aspx>) in order to find a geographically suitable site. Potential case studies were then narrowed down by reading the Ramsar Information Sheets of these sites to seek out comparable ecological features. After gaining access to its management plan, the “Alderney West Coast and the Burhou Islands” (AWCBI) Ramsar site was chosen as the case study. As the site falls within an island territory of the United Kingdom, the management capacity is assumed to be similar to the PEI site. The site is significant as the home of close to 6000 pairs of Northern Gannets (*Morus bassana*), which accounts for roughly 2% of their global population. Other ecological features shared with Malpeque Bay include the permanent presence of shallow waters, vast expanses of eelgrass within its waters, sandy shore habitat areas and a present high diversity of shellfish (Soanes and Booker, 2007).

5.3.2 Alderney West Coast and the Burhou Islands Ramsar site management planning

The management strategy for the AWCBI Ramsar site sets a good example of how a site-specific wetland management plan that promotes wise use can be developed, while following an approach similar to that suggested by the Ramsar site management guidelines. While the management plan is missing some suggested aspects, it still demonstrates how a small island community is capable of generating management planning that has achievable goals.

The document opens by explaining the site’s designation under the Ramsar Convention. It also explains that the document is intended to provide a framework and

action plan to achieve long-term sustainability at the site and then defines the goals and objectives for the site (Soanes and Booker, 2007). Some criticism is warranted here, as not all of the defined objectives are obviously measurable; however, they do reflect what the management of this site is trying to accomplish and effectively express the reasons for having management activities at the site. The fourth objective, “to maintain the numbers and assemblages of seabirds within the Ramsar site to at least Seabird 2000 levels [a local seabird census]” (p. 5) is measurable. The second objective, however, is not obviously measurable. It states “to maximize the potential of the islands and marine environment to support vibrant marine life and seabird population, through appropriate management and protection measures” (p. 5; Soanes and Booker, 2007).

The document then provides descriptive information pertaining to the site, focusing on the location’s unique political situation as an island territory and describing in detail the ecological features of the site. Much importance is given to the bird populations. The document omits socio-economic information in this section, which represents a weakness. Continuing on, descriptive information about the seabirds and factors that could potentially affect the site are discussed. These last can generally be summed up as threats. Examples include coastal development, habitat loss, destructive recreational use, pollution, and climate change. The document states that management activities must directly address these identified threats (Soanes and Booker, 2007).

Perhaps the biggest strength of this document is that it breaks down specific management and monitoring actions, while describing where these actions are to take place, what is their level of importance for conservation, and what the priority of the actions are; finally, it identifies who will carry out the actions. While the document

describes how often these actions are to take place, it could benefit by providing more specific dates. Of high priority for both conservation and action are the plans for Burhou Island. The monitoring action plan at this location involves annual monitoring of puffin numbers, distribution, and productivity and also annual monitoring of storm petrel breeding success rates. Specific actions to be taken at this site are: to raise visitor awareness about puffin and petrel nest protection, and to establish artificial petrel nest sites for research purposes. These actions are to be carried out by the AWCBI Steering Group, the Channel Island Ringing Group, and the AWCBI Ringing Group. The document also estimates the costs of implementing the management strategy, exploring both overall yearly costs and a breakdown of costs per specific action. The document concludes by stating that the strategy and accomplished actions will be reviewed on an annual basis, with a full program review every five years (Soanes and Booker, 2007).

The most applicable aspect of the AWCBI strategy document to Malpeque Bay is that it exemplifies that the management expectations of the Ramsar Convention can be met in a simple and straightforward manner, involving specific steps to achieve site-based objectives. The compilation of a management planning document does not have to involve complex analyses or significant financial investment. Depending on what the site objectives are, PEI's Department of Agriculture and Forestry will have to decide whether it makes more sense to develop a specific document like the AWCBI strategy or, if it is more suitable to incorporate the site's management into a broader plan, as discussed in section 5.2. With many resource users in the vicinity of Malpeque Bay, and especially with the direct investment by fishers, the aquaculture industry and the Lennox Island First Nation, it will be essential for any management plan to do an exemplary job of including local

participation. This will be essential for determining practical objectives, and identifying existing threats and desired courses of actions.

CHAPTER 6 RECOMMENDATIONS FOR THE MANAGEMENT FRAMEWORK OF MALPEQUE BAY

The opening chapter hypothesized that increasing threats to Malpeque Bay will result in loss of wetland services and loss of migratory bird habitat. Threats found to have the greatest potential to cause these losses were named to be the impacts from climate change, runoff, aquaculture, and invasive species. The strong cultural link of Mi'kmaq people with the Bay, the importance of the estuary as a shellfish and finfish nursery, and the unique ecological features that attract thousands of migratory birds each year contribute to the significance of protecting the Bay against existing threats. Effective management practices are viewed as the primary method by which these threats can be controlled and will make an effort to ensure the protection of the ecological features of the Bay. Additionally, the use of planning practices will contribute to upholding the responsibilities associated with Malpeque Bay's designation by Canada under the Ramsar Convention by promoting wise use of the site. In this final chapter, it will be explained why focusing on developing a management strategy will protect the Bay more effectively than reliance on the current legal framework. Finally, recommendations will be made to the province of PEI in regards to where efforts could most fruitfully be focused in developing this plan.

6.1 Addressing the existing challenges and legal gaps

In recognizing that Malpeque Bay was designated as a Ramsar site in 1988 (Canadian Wildlife Service, 2001) and that no major steps have been taken to ensure that the site is protected against existing threats, it is clear that there have been ongoing

challenges. While private organizations have made efforts to support conservation, including the procurement of Courtin Island by the Island Nature Trust (MacQuarrie, 2000) and the current proposals by MCPEI to co-manage Hog Island (Jesse Francis, personal communication, May 18, 2012) as well as Piping Plover habitat on reserve land (Randy Angus, personal communication, May 2012), there has been no clear effort and directive provided by the provincial government, the elected managers of the site. While laws and policies exist that attempt to limit environmental harm done through human activities on the Island, they are not infallible, are not guaranteed to be followed, and are not sufficient to address rapid environmental change. Additionally, regulations do not provide guidance towards the actions that must take place to protect the Bay. PEI also faces its own unique challenges as an Island province. It relies heavily on its natural features for economic purposes, has a small population size, has limited monetary resources for environmental conservation expenditures, and has province-wide vulnerability to coastal impacts resulting from climate change.

The ability of the provinces of Canada to have self-governance, has advantages related to developing policies, regulations, and plans that reflect local interests, but the division created between federal and provincial jurisdiction also presents challenges. Related to the Ramsar Convention, there exists an incongruity with the fact that it is up to the Canadian government to take charge on the designation of Ramsar sites where it is generally the responsibility of provincial and territorial governments to manage wetlands, with the exception of on federal lands. This has more than likely contributed to the fact that 14 of Canada's 37 Ramsar sites do not have any management planning in place and 11 of the sites that do have such planning are dependent on documents that are one to two

decades old (Canadian Wildlife Service, 2012). Without a larger directive leadership role from Environment Canada, it has been difficult for sites, like the one at Malpeque Bay, which exist within provincial jurisdictions having limited resources, to attract investment for conservation. The national wetland policy does not provide a great deal of guidance, except for the commitment to no net loss of wetlands on crown lands. The policy remains vague and broad, without actually providing the means to protect the country's wetlands. On the one hand, policies that are broad and vague may initially save both human and financial resources and permit flexibility in development of site specific tools; but, if these broad policies are not found to be useful, then further investment to produce robust documents from the beginning is worth the time and effort.

Although the federal government has stated in its most recent report to the Conference of Parties of the Ramsar Convention that it is currently developing a manager network to facilitate communication amongst sites (Canadian Wildlife Service, 2012), the passing of Bill C-38 puts into question the role of the federal government in environmental management. Concerns related to this Bill are that it adopts less stringent environmental policies in favor of industry and promotes cuts in Canada's science and research fields ("Death of evidence", 2012). In relation to Malpeque Bay, this could mean that federal agencies, such as Environment Canada, may lose the capacity to act as policy advisors related to developing management plans, depending on where budget cuts are made. Within the past year, budget cuts have also affected NGOs that rely on federal funding. For example, the PEI Environmental Network, an NGO that works to improve environmental conditions on the Island, had its partnership with Environment Canada come to an end. This organization helped bridge communication between the federal government and

communities, helping citizens contribute to the development of environmental policy, legislation, and management (“Longstanding federal partnership”, 2011).

In describing the state of Canada’s wetland policy, Durigon, Hickey & Kosoy (2012) declare that although Canada was seen as an environmental leader 30 years ago, it is now in a position “of highly developed environmental regulation and weak environmental performance” (p. 45). This statement effectively describes the legal situation in regards to the protection of birds and bird habitat at Malpeque Bay. On paper, there are policies and an abundance of legislation that protect the habitat, for example federal restrictions on pollution, provincial level establishment of buffer zones, and legal protection of critical habitat of endangered species. While these existing bodies of control have undoubtedly contributed to habitat and species protection across the province, they still do not guarantee that the ecological state of the Bay will be maintained and do not offer direct protection to the Bay itself. In addition, the effectiveness of the specific designations that have been put in place in regards to environmental conservation, including the Wildlife Management Area at Indian River and the Natural Area designation at Courtin Island, are questionable. By the names of these sites, it seems as if they have been granted additional conservation measures. Upon closer inspection, additional protection at Indian River does little more than impose greater hunting restrictions (Government of PEI, 2004). Courtin Island, in having been entrusted to the Island Nature Trust, will remain in a natural state (MacQuarrie, 2000) but this does not make the location any less vulnerable to threats, except from direct development on the island itself. Neither one of these designations address the larger threats to the Bay.

On the other hand, there are severe gaps in regulation and policy, most obviously in the area of climate change. A great deal of effort on both the national and provincial levels has focused on the need to reduce greenhouse gas emissions in order to decrease the rate at which climate changes are occurring. Without downplaying the importance of these emission standards, it seems that not enough focus is being placed on developing adaptation policies and regulations that respond to the fact that changes are expected to significantly alter the environment and are going to occur regardless of mitigation. This is not to say that efforts are not being made. In partnership with Natural Resources Canada, research has been conducted through a *Regional Adaptation Collaborative* to increase the knowledge base surrounding the effects of climate change in PEI and determining the scope and degree of vulnerabilities (Department of the Environment, Labour and Justice, 2011). However, as it is already generally known what the effects of climate change will be, not making decisions in regards to how important ecosystems and habitats can be protected or how impacts may be mitigated demonstrates an approach that is neither proactive nor precautionary.

It is clear that greater action must be taken to provide sufficient protection to Malpeque Bay as the current legal framework cannot thoroughly deal with the existing threats. The reasons for developing a management plan for the Bay to augment existing policies, acts, and strategies is to solidify direct actions that must be taken in order to ensure that Malpeque Bay is truly protected to the best of PEI's abilities and in the interests of the stakeholders in the region. Establishing a management plan to ensure the wise use of the area, as required under our commitment to the Ramsar Convention, will help to overcome any legal gaps. For example, while an aquaculture policy is not yet in existence

for PEI, developing a management plan would allow the opportunity for public debate, through which aquaculture could be either integrated into the plan or explicitly ruled out, providing greater certainty for the industry, as well as for fisheries, aboriginal, conservation and tourism interests. Management objectives tailored specifically for Malpeque Bay will be able to directly target the issues in existence with actions that can be reasonably accomplished. Lastly, it would be expected that stakeholders would have a large involvement in contributing to the content and the motivations of an overall strategy that would form the basis of a management plan. Investment in the project by stakeholders ensures that their interests are taken into account, while attempting to reduce conflicts and creating an understanding of the benefits of managing the area.

6.2 Recommendations for the development of a management plan for Malpeque Bay

This study has provided the reasoning for developing a managing plan, suggesting that its development is pertinent in order to ensure that Malpeque Bay is sufficiently protected against existing threats. This document was also developed with the intention of providing a basis for this plan by compiling information that can be integrated into the plan itself. Chapter 5 outlines that a Ramsar site management plan should be able to describe the policies and practices that have influenced the creation of a management plan, examples of which are given in Chapter 4. Chapter 5 also points out the need to provide sufficient background information on the site, a thorough overview of which is given in Chapter 2. Based on this background information, factors that are important for management planning must be identified. In Chapter 3, factors which negatively impact the ecology of the Bay (i.e. the threats) were discussed. More work is required, however, to

actually develop a plan that puts forward set objectives and actions to protect Malpeque Bay. The following recommendations are submitted to encourage improved management practices by providing direction for the most immediate steps that must be taken in order to develop a plan.

i) A managerial authority must be identified

As it stands, the Department of Agriculture and Forestry has been recognized as the provincial agency responsible for the management of the Ramsar site. It must be decided if the Department has the resources to commit to developing this plan or if a more suitable agency exists, such as a non-profit group, tribal council, watershed group or consortium of agencies and organizations. It is not expected that the federal government will step in to provide much directive considering that such instruction has been lacking at the site for the past 24 years. This is especially the case in light of cuts to staff and budgets in federal departments such as Environment Canada, the related Canadian Wildlife Service, and consequently cuts to private initiatives that the Canadian government once funded (e.g. the PEI Environmental Network). As it is within their jurisdiction, the federal government still has a role in providing direction for fisheries and aquaculture, even with cuts to the DFO.

The lack of action on part of the provincial government is largely due to a lack of capacity in funding and trained staff available to be committed to such a project. With a current provincial deficit of over \$80 million (“Ghiz: Cuts on the way”, 2012), it seems imminent that outside organizations will have to step in to fulfill the management role. At the same time, some issues will still need to be dealt with on at a provincial level. These include the need for land-use policies to ensure that coastal development is properly

managed and that areas of known vulnerability remain undeveloped, as well as the need for a province-wide climate change adaptation strategy to limited impending coastal impacts.

While the interest groups of MCPEI and the Island Nature Trust have taken on a managerial role for some aspects of the Bay, an overarching coordinator is missing. Electing a watershed management group to act as the developer of a management plan seems to be one of the most realistic options. This is due to the fact that, even in light of the provincial deficit, these organizations are still receiving funding, with \$800,000 being provided to watershed groups in 2012 (Department of the Environment, Labour and Justice, 2012c). Three of the funded groups encompass the watershed of Malpeque Bay: the Kensington North Watersheds Association Ltd., the Lot 11 and Area Watershed Management Group, and the Richmond Bay Watershed Association Inc. (Department of the Environment, Labour and Justice, 2012a). Funding that goes toward the preparation of watershed management plans is given priority for approval (Department of the Environment, Labour and Justice, 2012b). Such a fund could help develop a watershed management plan for Malpeque Bay that could encompass protecting the migratory bird habitat as any threat to the birds and their habitat is also likely to impact the Bay's associated waterways, with perhaps the exception of wind energy development and hunting. Actions to protect the waterways against climate change impacts, aquaculture, invasive species, and development could reasonably be incorporated into a watershed management plan. It will be important for such a group to work in conjunction with the various interest groups, including the provincial government. A full stakeholder list of

those partners that should be engaged in the process was compiled by a study in 2009. The named stakeholder list can be viewed in Appendix B.

ii) Factors that influence the site must be determined

Chapter 3 has provided the basis for this step by identifying the most relevant risks to Malpeque Bay. However, with a lack of resources to prioritize these threats through quantitative means, the threats were ranked based off qualitative reasoning. If the data is available, it would be recommended that a quantitative method be undertaken to determine which threats pose the greatest risk in order to provide a scientific backing for actions that must occur most immediately. It must be recognized though, that in absence of such data or the resources to compile it, a qualitative method is perfectly valid if it is based on sound science and evidence from stakeholders. With the involvement of stakeholders, this method gains legitimacy by coming to a consensus about the existing threats and their relevance. Some complications exist in involving different interest groups in the process, however. It requires the adoption of a stakeholder engagement strategy, requires a time commitment by stakeholders, and due to conflicting interests, may not be able to generate a true consensus. For example, a mussel aquaculture industry representative may argue that invasive species pose the most immediate risk to the bay while an environmentalist may argue that it is the aquaculture industry that has promoted the proliferation of the most prevalent invasive species in the Bay (i.e. tunicates). The main managerial authority would need to coordinate and compile information gathered from stakeholders. In keeping with the last section, this authority could be a watershed management group.

iii) Specific objectives must be determined and specific courses of action must be established based on these set objectives

In order for a management plan to be practical and purposeful, it must have specific objectives that dictate what the plan is attempting to achieve. These objectives need to be both measurable and achievable and should be shaped by the managerial authority, with the help of stakeholders. The objectives must work toward the ultimate goal of providing greater protection to the Bay and, depending on where stakeholder interests lie, could also focus on repairing already existing damages. They must also work to face the specific threats that exist. Objectives that could be generated for Malpeque Bay could be very specific, such as proposing desirable numbers for bird population levels, ideal percent coverage of wetlands, acceptable water quality indicators limits (e.g. maximum levels of pesticides), or as specific as setting the desired limit on the number of aquaculture sites (or area covered). They could also be more general and pose objectives towards increasing public education and awareness, building management capacity, and reducing vulnerabilities to climate change. The specificity to which objectives can be made will again be reliant on sources of data, available resources, and the input from stakeholders.

In order to achieve the set objectives, plans of action must be created to direct the specific measures that must take place. While objectives will set out what the development of the plan intends to accomplish, the actions incrementally set out how the objectives are actually going to be reached. For example, if the set objective is to reduce the vulnerability of the Malpeque Bay coastline to the effects of sea-level rise and storm surge, specific actions would begin with determining the areas of the Bay that are most vulnerable. Actions which explore adaptation options would then follow and actions to implement the

most suitable of the research options would then be undertaken. Such options could relate to wetland restoration to absorb wave impact or could relate to barrier island restoration to ensure that the Bay remains sheltered.

Determined steps, must be nested within an implementation plan that details the timeline for action, the action's priority, the authority responsible for carrying out the action, and an approximation of the cost of the specific project (in both time and finances). A monitoring plan to determine whether objectives are being achieved should be established as part of the implementation plan. After which, a full assessment of the effectiveness of the management program implementation will have to be regularly conducted (i.e. every few years). Within this, it will be essential to have a capacity to develop adaptive management measures if the initial actions are not working. A major difficulty in taking on this type of action planning is, once again, related to money availability. Such planning requires long-term actions to be established but many organizations receive funding on a yearly basis. For that reason, best efforts should be put into developing low cost solutions and ensuring that tasks get disseminated to the appropriate authorities, as to not waste time and effort on duplicating actions.

iv) Communication standards must be established

Whether or not a Ramsar Convention managers' network is established by the Canadian government, the capability of effectively communicating with other Ramsar site managers, as well as the ability to gain guidance and advice from the Canadian Wildlife Service, is of utmost importance. It is suggested that the Malpeque Bay managers be in contact with other site managers in the country in order to receive advice on how a site management

plan can be developed, and what specific measures have been found to be effective in other sites. This provides both the opportunity to look at a variety of examples, as well as learn from the mistakes of others. Currently, the managers at the Musquodoboit Harbour Ramsar site are preparing a management plan, expected to be released in 2013 (Canadian Wildlife Service, 2012). It is recommended that Malpeque Bay managers remain in close communication with these managers as the Musquodoboit site shares many of the same ecological features as the Bay. It has salt marshes, barrier beaches, and is a habitat to large numbers of migratory birds, including the Piping Plover (Nature Conservancy of Canada, 2012). In addition, the plan in development will include socio-economic and cultural values (Canadian Wildlife Service, 2012), which will also be important considerations for incorporation into the Bay's plan. While the AWCBI management plan example from section 5.3 is useful as it proves that a small island jurisdiction is more than capable of developing a strategy to face existing threats, a local example will provide the right context.

6.3 Conclusion

The recommendations provided in this section are meant to offer a starting point from which the management plan for Malpeque Bay can develop. These recommendations are intended to provide guidance and are thought to be steps that are within the capacity that the provincial government, tribal council, NGOS, or watershed groups could undertake. A concrete management strategy and plan will be more effective in dealing with the existing threats to the Bay, providing specific protection measures rather than relying on existing, high-level policies and regulations. Implementing such a plan will encourage the

Canadian federal and provincial governments to fulfill the responsibilities set out by the Ramsar Convention and will provide direct benefits to the users of the Bay.

While there is an apparent lack of technical and financial capacity on PEI to support thorough resource management practices, it seems more realistic to integrate the management plan for Malpeque Bay into broader scale watershed planning. It appears that it would be beneficial to the watershed management groups that surround Malpeque Bay to take on a managerial role. While many limitations have been discussed in regards to PEI being an island province, its small size does confer some advantage. A small area and similar ecological features throughout the province contribute to the fact that environmental threats are generally province-wide issues. Thus, it is easier for broader-scale planning to be applicable to the Bay, in comparison to larger provinces. If a watershed management plan is developed for Malpeque Bay, it will certainly be a step toward supporting the wise use of the area. However, this plan will need to be backed by provincial and federal policies in order to ensure that issues that cannot be dealt with through watershed management practices are addressed. The provincial government must still work toward developing land-use and climate change adaptation policies and the federal government must work to promote sustainable use of the Gulf of St. Lawrence to limit negative impacts from inflowing into Malpeque Bay.

REFERENCES

- Arens, C., Paetzold, C., Ramsay, A. & Davidson, J. (2011). Pressurized seawater as an antifouling treatment against the colonial tunicates *Botrylloides violaceus* and *Botryllus schlosseri* in mussel aquaculture. *Aquatic Invasions*, 6(4), 465-476. doi:10.3391/ai.2011.6.4.12
- Baldwin, D. (1998). *Land of the red soil: A popular history of Prince Edward Island*. Charlottetown: Ragweed Press.
- Bardati, D. (2011). *Watershed voices in Prince Edward Island: Hearing from watershed groups*. PEI Watershed Alliance. Retrieved from http://peiwatershedalliance.org/Publications/Watershed_Voices_Bardati.pdf
- Basquill, S. (2012). *Hog Island and the Sandhills ecology, geology, and geomorphology* [Presentation slides]. Sackville, NB: Atlantic Canada Conservation Data Centre.
- Berneshawi, S. (1997). Resource management and the Mi'kmaq nation. *The Canadian Journal of Native Studies*, 17(1), 115-148.
- Biodiversity Convention Office. (1995). *Canadian Biodiversity Strategy: Canada's response to the Convention on Biological Diversity*. Hull, QC: Environment Canada. Retrieved from http://www.biodivcanada.ca/560ED58E-0A7A-43D8-8754-C7DD12761EFA/CBS_e.pdf
- Canadian Wildlife Service (1991). *The federal policy on wetland conservation*. Ottawa: Government of Canada. Retrieved from <http://www.ec.gc.ca/Publications/BBAAE735-EF0D-4F0B-87B7-768745600AE8%5CGOCFederalPolicyonWetlandConservation1992.pdf>
- Canadian Wildlife Service. (2001). *Canada 30: Malpeque Bay, Prince Edward Island. Information sheet on Ramsar wetlands*. Sackville, NB: Environment Canada. Retrieved from http://www.wetlands.org/RSIS/_COP9Directory/Directory/ris/4CA030en.pdf
- Canadian Wildlife Service. (2012). *National report on the implementation of the Ramsar Convention on Wetlands*. Submitted to the 11th Meeting of the Conference of the Contracting Parties, Romania, June 2012. Gatineau, QC: Government of Canada. Retrieved from <http://www.ramsar.org/pdf/cop11/nr/cop11-nr-canada-e.pdf>
- Catto, N. & Catto, G. (2009). *Geomorphology and sedimentology of the Hog Island (Pemamgiag) sandhills*. PEI: Mi'kmaq Confederacy of Prince Edward Island.
- Chiasson, N. (2004). *An investigation of coastal wetland loss and degradation due to*

- cumulative effects of federal projects*. (Unpublished Master's graduate project). Dalhousie University, Halifax.
- Cicin-Sain, B. and R. W. Knecht. 1998. *Integrated coastal and ocean management concepts and practices*. Washington, DC: Island Press.
- Claudi, R., Nantel, P. & Muckle-Jeffs, E. (Eds.) (2002). *Alien invaders in Canada's waters, wetlands, and forests*. Ottawa: Natural Resources Canada.
- Commission on Land and Local Governance (2009). *New Foundations: Report of the commission on land and local governance*. Charlottetown: Government of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/photos/original/ReportEng.pdf>
- Committee on the Status of Endangered Wildlife in Canada. (2012). *Guidance for completing the threats classification and assessment calculator and determining the number of 'locations'*. Gatineau: Government of Canada.
- Davies, M. (2011). *Geomorphic shoreline classification of Prince Edward Island*. Ottawa: Coldwater Consulting Ltd. Retrieved from http://www.gov.pe.ca/photos/original/shoreline_pei.pdf
- Death of evidence. (2012, July 19). *Nature*, 487, 271–272. doi:10.1038/487271b
- Dennison, M. & Berry, J. (1993). *Wetlands: Guide to science, law, and technology*. Park Ridge, New Jersey: Noyes Publications.
- Department of Agriculture and Forestry. (2012). *Prince Edward Island's forests*. Charlottetown: Government of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/forestry/foresthstory>
- Department of Environment, Energy and Forestry. (2008a). *Prince Edward Island and climate change: a strategy for reducing the impacts of global warming*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/env_globalstr.pdf
- Department of Environment, Energy and Forestry. (2008b). *Securing our future: The 10 point plan*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/wind_energy.pdf
- Department of Environment, Energy and Forestry. (2011). *State of the environment*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/eef_soe_2010.pdf
- Department of the Environment, Labour and Justice. (2011). *Regional adaptation*

- collaborative*. Government of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/environment/rac>
- Department of the Environment, Labour and Justice. (2012a). *2012-13 watershed management fund recipients and ACAP groups*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/elj_wtshed_map.pdf
- Department of the Environment, Labour and Justice. (2012b). *Watershed Management Fund*. Charlottetown: Government of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/environment/index.php3?number=1015820&lang=E>
- Department of the Environment, Labour and Justice. (2012c). *Watershed Management Fund Awards 2012*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/elj_awards.pdf
- Department of Finance and Municipal Affairs. (2011). *Province of Prince Edward Island 37th annual statistical review*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/fma_37asr2010.pdf
- Department of Finance, Energy and Municipal Affairs. (2012a). *Budget paper: Background on the economy*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/fema_bdgback1.pdf
- Department of Finance, Energy and Municipal Affairs. (2012b). *Estimates of revenue and expenditures*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/fema_bdgtestim.pdf
- Department of Fisheries and Oceans. (2005). *Aquaculture: Frequently asked questions*. Government of Canada. Retrieved from <http://www.dfo-mpo.gc.ca/aquaculture/faq-eng.htm#n1k>
- Department of Fisheries and Oceans. (2008). *Aquaculture Policy Framework*. Government of Canada. Retrieved from <http://www.dfo-mpo.gc.ca/aquaculture/ref/APF-PAM-eng.htm#note1>
- Department of Fisheries and Oceans. (2011a). *Prince Edward Island aquaculture leasing policy*. PEI: Fisheries and Oceans Canada and the Province of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/forms/pdf/1780.pdf>
- Department of Fisheries and Oceans. (2011b). *Transformation at Fisheries and Oceans Canada*. Unpublished. Retrieved from <http://www.cbc.ca/news/pdf/nl-dfo-memo-20111013.pdf>

- Department of Fisheries and Oceans. (2012). *Canadian aquaculture R&D Review 2011*. Government of Canada. Retrieved from <http://www.dfo-mpo.gc.ca/science/enviro/aquaculture/rd2011/rdshellfish-mollusques-eng.html>
- Department of Fisheries, Aquaculture and Environment. (1995). *Wildlife policy for Prince Edward Island*. Charlottetown: Government of Prince Edward Island. Retrieved from <http://www.gov.pe.ca/photos/original/95wildlfpolicy.pdf>
- Department of Fisheries, Aquaculture and Environment. (2003). *A wetland conservation policy for Prince Edward Island*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/fae_wetland_con.pdf
- Department of Fisheries, Aquaculture and Rural Development. (2011). *Rural action plan: A rural development strategy for Prince Edward Island*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/FARD_RAP_PR_2.pdf
- Department of Innovation and Advanced Learning. (2010). *Island prosperity: a focus for change*. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/IPS_2011_Report.pdf
- Doelle, M. (2012). CEEA 2012: *The end of federal EA as we know it?* Halifax, NS: Social Science Research Network. Retrieved from <http://ssrn.com/abstract=2104336>
- Dufour, R., Benoit, H., Castonguay, M., Chasse, J., Devine, L., Galbraith, P., ... Starr, M. (2010). *Ecosystem status and trends report: Estuary and Gulf of St. Lawrence ecozone*. Canadian Science Advisory Secretariat research document 2010/03. Mont-Joli/Moncton/Dartmouth: Department of Fisheries and Oceans. Retrieved from <http://www.dfo-mpo.gc.ca/csas-sccs/>
- Durigon, D., Hickey, G. M. & Kosoy, N. (2012). Assessing national wetland policies' portrayal of wetlands: Public resources or private goods? *Ocean & Coastal Management*, 58, 36-46. doi:10.1016/j.ocecoaman.2011.12.008
- Environment Canada. (2001). *Threats to sources of drinking water and aquatic ecosystem health in Canada*. NWRI scientific assessment report series No. 1. Burlington, ON: National Water Research Institute. Retrieved from <http://www.ec.gc.ca/inre-nwri/235D11EB-1442-4531-871F-A7BA6EC8C541/threats-eprint.pdf>
- Environment Canada. (2004a). *A guide to understanding the Canadian Environmental Protection Act, 1999*. Ottawa: Government of Canada. Retrieved from http://www.ec.gc.ca/lcpe-cepa/E00B5BD8-13BC-4FBF-9B74-1013AD5FFC05/Guide04_e.pdf

- Environment Canada. (2004b). *Cavendish farms pleads guilty to federal environmental charge*. Summerside: Government of Canada. Retrieved from http://www.ec.gc.ca/media_archive/press/2004/040517_n_e.htm
- Environment Canada. (2012). *Migratory birds hunting regulations, 2012–2013: Prince Edward Island*. Sackville, NB: Government of Canada. Retrieved from http://www.ec.gc.ca/rcom-mbhr/default.asp?lang=en&n=C54AE041-1#_002
- Fanning, L. & Burbridge, C. (2009). *Addressing sea level rise and storm events as a priority coastal issue in Nova Scotia*. Marine Affairs Policy Forum, Marine Affairs Program, Dalhousie University, Halifax.
- Fishermen oppose expansion of mussel farming. (2009, March 18). *CBC News*. Retrieved From <http://www.cbc.ca/news/canada/prince-edward-island/story/2009/03/18/pe-mussel-expansion.html>
- Forsey, E. (2012). *How Canadians govern themselves*. 8th edition. Ottawa: Library of Parliament. Retrieved from http://www.parl.gc.ca/about/parliament/senatoreugeneforsey/book/assets/pdf/How_Canadians_Govern_Themselves8.pdf
- Ghiz: cuts on their way as P.E.I. deficit doubles. (2012, April 11). *The Canadian Press*. Retrieved from <http://thechronicleherald.ca/canada/83492-ghiz-cuts-on-the-way-as-pei-deficit-doubles>
- Government of Canada. (2005). *Oceans Act (S.C. 1996, c. 31)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/O-2.4.pdf>
- Government of Canada. (2009). *Navigable Waters Protection Act (R.S.C. 1985, c. N-22)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/N-22.pdf>
- Government of Canada. (2010a). *Canadian environmental assessment act (S.C. 1992, c. 37)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/C-15.2.pdf>
- Government of Canada. (2010b). *Canada Wildlife Act (R.S.C., 1985, c. W-9)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/W-9.pdf>
- Government of Canada. (2010c). *Migratory Birds Convention Act (S.C. 1994, c. 22)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/M-7.01/>
- Government of Canada. (2011). *Fisheries Act (R.S.C., 1985, c. F-14)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/F-14.pdf>

- Government of Canada. (2012a). *Canadian Environmental Protection Act (S.C. 1999, c. 33)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/C-15.31.pdf>
- Government of Canada. (2012b). *Canadian Environmental Assessment Act, 2012. Regulations designating physical activities*. Canada Gazette. Retrieved from <http://www.gazette.gc.ca/rp-pr/p2/2012/2012-07-18/html/sor-dors147-eng.html>
- Government of Canada. (2012c). *Species at Risk Act (S.C. 2002, c. 29)*. Department of Justice. Retrieved from <http://laws-lois.justice.gc.ca/PDF/S-15.3.pdf>
- Government of Prince Edward Island. (2003). *Land Protection Act (R.S.P.E.I. 1988, c. L-5)*. Department of Justice. Retrieved from <http://www.gov.pe.ca/law/statutes/pdf/l-05.pdf>
- Government of Prince Edward Island. (2004). *Fish and Game Protection Act (R.S.P.E.I. 1988, Cap. F-12)*. Legislative Counsel Office. Retrieved from <http://www.gov.pe.ca/law/regulations/pdf/F&12-8.pdf>
- Government of Prince Edward Island. (2010a). *Economy*. Retrieved from <http://www.gov.pe.ca/infopei/index.php3?number=13090&lang=E>
- Government of Prince Edward Island. (2010b). *From prehistory to the arrival of the Europeans*. Retrieved from <http://www.gov.pe.ca/infopei/index.php3?number=13104&lang=E>
- Government of Prince Edward Island. (2010c). *Location and terrain*. Retrieved from <http://www.gov.pe.ca/infopei/index.php3?number=13104&lang=E>
- Government of Prince Edward Island. (2012a) *Environmental Protection Act (R.S.P.E.I. 1988, c. E-9)*. Legislative Counsel Office. <http://www.gov.pe.ca/law/statutes/pdf/e-09.pdf>
- Government of Prince Edward Island. (2012b). *Natural Areas Protection Act (R.S.P.E.I. 1988, c. N-2)*. Legislative Counsel Office. Retrieved from http://www.gov.pe.ca/law/statutes/pdf/w-04_1.pdf
- Government of Prince Edward Island. (2012c). *Pesticides Control Act (R.S.P.E.I. 1988, c. P-4)*. Legislative Counsel Office. Retrieved from <http://www.gov.pe.ca/law/statutes/pdf/p-04.pdf>

- Government of Prince Edward Island. (2012d). *Planning Act (R.S.P.E.I. 1998, c. P-8)*. Legislative Counsel Office. Retrieved from <http://www.gov.pe.ca/law/statutes/pdf/p-08.pdf>
- Government of Prince Edward Island. (2012e). *Wildlife Conservation Act (1998 c.107, R.S.P.E.I. 1988, W-4.1)*. Legislative Counsel Office. Retrieved from http://www.gov.pe.ca/law/statutes/pdf/w-04_1.pdf
- Grant, J., Hatcher, A., Scott, D. B., Pocklington, P., Schafer, C. T., & Winters, G. V. (1995). A multidisciplinary approach to evaluating impacts of shellfish aquaculture on benthic communities. *Estuaries*, 18(1), 124-144.
- Hanson, A. (2004). *Status and conservation of eelgrass (Zostera marina) in Eastern Canada*. Technical Report Series Number 412. Sackville, NB: Canadian Wildlife Service.
- Harvey, O. (2009). *Community-led coastal integrated coastal zone management: Case study from Malpeque Bay, Prince Country, Prince Edward Island* [Master's graduate project]. Halifax: Dalhousie University.
- Hutchings, J. & Reynolds, J. (2004). Marine fish population collapses: Consequences for recovery and extinction risk. *BioScience*, 54(4), 297-309.
- Important Bird Areas Canada. (2010). *Site: PE001, Malpeque Bay, Prince Edward Island*. Port Rowan, Ontario: Bird Studies Canada. Retrieved from <http://www.ibacanada.com/maps/sites/PE001.pdf>
- Important Bird Areas Canada. (2012). *Malpeque Bay, Eastern Prince County, Prince Edward Island*. Retrieved from <http://www.ibacanada.ca/site.jsp?siteID=PE001&seedet=Y#>
- Industry Canada. (2009). *Mobilizing science and technology to Canada's advantage*. Ottawa: Government of Canada. Retrieved from [http://www.ic.gc.ca/eic/site/ic1.nsf/vwapj/STProgressReport2009.pdf/\\$file/STProgressReport2009.pdf](http://www.ic.gc.ca/eic/site/ic1.nsf/vwapj/STProgressReport2009.pdf/$file/STProgressReport2009.pdf)
- Klassen, G. & Locke, A. (2007). *A biological synopsis of the European Green Crab, Carcinus maenas*. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2818. Moncton: Department of Fisheries and Oceans. Retrieved from <http://www.dfo-mpo.gc.ca/library/330845.pdf>
- Klein, R.J.T., Nicholls, R.J., Ragoonaden, S., Capobianco, M., Aston, J. & Buckley, E.N. (2001). Technological options for adaptation to climate change in coastal zones. *Journal of Coastal Research*, 17(3), 521-543.
- Lennox Island First Nation. (2010). *Lennox info*. Retrieved from <http://lennoxisland.com/>

lennoxcommunity/index.html

- Locke, A., Doe, K., Fairchild, W., Jackman, P. & Reese, E. (2009). Preliminary evaluation of effects of invasive tunicate management with acetic acid and calcium hydroxide on non-target marine organisms in Prince Edward Island, Canada. *Aquatic Invasions*, 4(1), 221-236. doi:10.3391/ai.2009.4.1.23
- Longstanding federal partnership with Canadian Environmental Network terminated. (2011, October 19). *Canadian Environmental Network*. Retrieved from http://www.peieconet.org/content/page/front_news/id/99
- Lynch-Stewart, P., Kessel-Taylor, I. & Rubec, C. (1999). *Wetlands and government: Policy and legislation for wetland conservation in Canada*. Ottawa: North American Wetlands Conservation Council. Retrieved from <http://www.wetlandscanada.org/1999-1%20Wetlands%20and%20Government.pdf>
- Lynch-Stewart, P. (2008). *Wetlands of international importance (Ramsar sites) in Canada*. Ottawa: Lynch-Stewart & Associates. Retrieved from www.ramsar.org/pdf/wurc/wurc_canada_survey_2007.pdf
- MacDonald, K. (2006). *Environmental assessment of the 30MW East Point wind plant*. Alberton, PEI: Frontier Power Systems. Retrieved from http://www.gov.pe.ca/photos/original/eef_epwf_jn1506.pdf
- MacEwen, D., Gaudet, S. & Scarth, H. (2008). *Malpeque Bay aquaculture - The way ahead*. Charlottetown: VisionQuest Inc. Retrieved from <http://www.dfo-mpo.gc.ca/aquaculture/lib-bib/malpeque/malpeque-2008-11-eng.htm>
- MacIntyre, C. (2011). *The environmental pre-history of Prince Edward Island 1769--1970: A Reconnaissance in Force*. (Unpublished Master's thesis). University of Prince Edward Island, Charlottetown.
- MacQuarrie, K. (2000). *Protecting Prince Edward Island*. PEI: Island Nature Trust. Retrieved from lin.ca/Files/11106/ps09.pdf
- Marleau, R. & Montpetit, C. (Eds.). (2000). *House of Commons procedure and practice*. Ottawa: Parliament of Canada. Retrieved from <http://www.parl.gc.ca/MarleauMontpetit/DocumentViewer.aspx?DocId=1001&Sec=Ch001&Seq=0&Language=E>
- Mi'kmaq Confederacy of Prince Edward Island. (n.d.). *About MCPEI*. Retrieved from <http://mcpei.ca/node/1>
- Mi'kmaq Resource Centre. (2012). *Mi'kmaq First Nations*. Sydney, NS: Cape Breton University. Retrieved from <http://www.cbu.ca/mrc/mikmaq-first-nations>

- Municipal Affairs & Provincial Planning Office. (2011). Prince Edward Island municipal boundaries. Charlottetown: Government of Prince Edward Island. Retrieved from http://www.gov.pe.ca/photos/original/fma_municimap11.pdf
- Nature Conservancy of Canada. (2012). *Musquodoboit Harbour*. Retrieved from http://www.natureconservancy.ca/en/where-we-work/nova-scotia/featured-projects/musquodoboit_harbour.html
- Natural Resources Canada. (2001). *The atlas of Canada. Prince Edward Island*. Retrieved from http://atlas.nrcan.gc.ca/auth/english/maps/reference/outlineprov_terr/pei_outline/referencemap_image_view
- Nicholls, R. & Mimura, N. (1998). Regional issues raised by sea-level rise and their policy implications. *Climate Research, 11*, pp. 5-18.
- North American Waterfowl Management Plan. (n.d.). *Canadian habitat matters*. Hull, QC: Canadian Wildlife Service. Retrieved from <http://www.nawmp.ca/pdf/chm2003-e.pdf>
- North American Waterfowl Management Plan Committee. (2004). *North American waterfowl management plan: Implementation framework*. Canadian Wildlife Service, U.S. Fish and Wildlife Service, and Secretaria de Medio Ambiente y Recursos Naturales. Retrieved from www.nawmp.ca/pdf/impfr-en-k.pdf
- Novaczek, I., Angus, R. & Lewis, N. (2009). Evolution of post-colonial indigenous peoples' fisheries management systems: Fiji and Prince Edward Island. In: G. Baldacchino, R. Greenwood and L. Felt (Eds.), *Remote Control: Lessons in governance from small and remote locations*. St John's: ISER Press.
- Petition opposing wind turbines presented to P.E.I. government. (2003, April 25). *The Canadian Press*. Retrieved from Proquest Database.
- Powell, B.H. (2012). *Analysis of the 2012 federal budget (Bill C-38) and its changes to Canada's environmental laws*. Edmonton, AB: Environmental Law Centre. Retrieved from <http://www.elc.ab.ca/pages/InformationResources/BriefsSubmissions.aspx>
- Prince Edward Island Aquaculture Leasing Management Board. (2008). *Prince Edward Island aquaculture leasing policy*. Charlottetown: Government of Prince Edward Island and the Department of Fisheries and Oceans. Retrieved from http://www.gov.pe.ca/photos/original/FARD_ALP_2008.pdf
- Prince Edward Island BioAlliance. (2012). *Infrastructure*. Retrieved from

<http://www.peibioalliance.com/infrastructure.php>

Ramsar Convention Secretariat. (2002). *New Guidelines for the management planning for Ramsar sites and other wetlands*. Gland, Switzerland: Ramsar Convention Secretariat. Retrieved from <http://www.ramsar.org/pdf/new-mgt-guide.pdf>

Ramsar Convention Secretariat. (2008). *The introductory Ramsar brochure. 3rd Edition*. Gland, Switzerland: Ramsar Convention Secretariat. Retrieved from http://www.ramsar.org/cda/en/ramsar-about-introductory-ramsar/main/ramsar/1-36%5E16849_4000_0__

Ramsar Convention Secretariat. (2011). *The Ramsar Convention manual: A guide to the Convention on Wetlands (Ramsar, Iran, 1971), 5th ed.* Gland, Switzerland: Ramsar Convention Secretariat. Retrieved from <http://www.ramsar.org/pdf/lib/manual5-2011-e.pdf>

Ramsar Convention Secretariat. (2012). *The list of wetlands of international importance*. Gland, Switzerland: Ramsar Convention Secretariat. Retrieved from <http://www.ramsar.org/pdf/sitelist.pdf>

Sarukhan, J. & Whyte, A (Eds.). (2005). *Ecosystems and human well-being: wetlands and water*. Washington, DC: World Resources Institute.

Science, Technology and Innovation Council Secretariat. (2011). *State of the nation 2010 — Canada's science, technology and innovation system*. Ottawa: Government of Canada.

Secretariat of the Convention on Biological Diversity. (2000). *Sustaining life on Earth: How the Convention on Biological Diversity promotes nature and human well-being*. United Nations Environment Programme. Retrieved from <http://www.cbd.int/doc/publications/cbd-sustain-en.pdf>

Shaw, J., Taylor, R.B., Forbes, D.L., Ruz, M.H. & Solomon, S. (1998). *Sensitivity of the coasts of Canada to sea-level rise*. Geological Survey of Canada Bulletin 505. Ottawa: Government of Canada.

Shaw, R.W. (2001). *Coastal impacts of climate change and sea-level rise on Prince Edward Island*. Climate Change Action Fund project CCAF A041. Dartmouth, NS: Government of Canada. Retrieved from [http://www.coastalchange.ca/download_files/external_reports/Shaw_\(2001\)_CoastalImpactsOfClimateChangeandSLRonPEI.pdf](http://www.coastalchange.ca/download_files/external_reports/Shaw_(2001)_CoastalImpactsOfClimateChangeandSLRonPEI.pdf)

Singh, K., Walters, B. & Ollerhead, J. (2007). Climate change, sea-level rise and the case for salt marsh restoration in the Bay of Fundy, Canada. *Environments Journal*, 35(2), 71-84.

- Smardon, R. C. (2009). *Sustaining the world's wetlands: Setting policy and resolving conflicts*. London: Springer.
- Soanes, L. & Booker, H. (2007). *Alderney West Coast and the Burhou Islands Ramsar site management strategy*. Version 1. Alderney, UK: Alderney Wildlife Trust.
- Species at Risk Registry. (2012). *Species profile (Piping plover melodus subspecies)*. Government of Canada. Retrieved from http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=687
- Statistics Canada. (2007). *Prince County, Prince Edward Island. 2006 community profiles*. Government of Canada. Retrieved from <http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CD&Code1=1103&Geo2=PR&Code2=11&Data=Count&SearchText=Prince&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=1103>
- Statistics Canada. (2009). *Aboriginal identity population, by province and territory (2006 Census)*. Government of Canada. Retrieved from <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo60a-eng.htm>
- Statistics Canada. (2011). *Age groups (13) and sex (3) for the population of Canada, provinces and territories, 1921 to 2006 censuses*. Government of Canada. Retrieved from <http://www12.statcan.ca/census-recensement/2006/dp-pd/tbt/Rp-eng.cfm?TABID=1&LANG=E&APATH=3&DETAIL=0&DIM=0&FL=A&FREE=0&GC=0&GK=0&GRP=1&PID=88977&PRID=0&PTYPE=88971,97154&S=0&SHOWALL=0&UB=0&Temporal=2006&THEME=66&VID=0&VNAMEE=&VNAMEF=>
- Statistics Canada. (2012a). *Census of agriculture, farm and farm operator data. 2011 Farm and farm operator data*. Government of Canada. Retrieved from <http://www29.statcan.gc.ca/ceag-web/eng/community-agriculture-profile-profil-agricole?geoId=110000000&dataType=1>
- Statistics Canada. (2012b). *Economic indicators, by province and territory (monthly and quarterly)*. Government of Canada. Retrieved from <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/indi02a-eng.htm>
- Statistics Canada. (2012c). *Economic indicators, by province and territory (monthly and quarterly) (Prince Edward Island)*. Government of Canada. Retrieved from <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/indi02c-eng.htm>
- Statistics Canada. (2012d). *Prince Edward Island and Canada census profile*. Government of Canada. Retrieved from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=11&Geo2=PR&Code2=01&Data=Count&SearchText=Prince%20Edward%20Island&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=11>

Summerside wind farm paying dividends. (2010, April 5). *CBC News*. Retrieved from <http://www.cbc.ca/news/canada/prince-edward-island/story/2010/04/05/pei-summerside-wind-farm-update.html>

Transport Canada. (2010). *Minor works and waters order (Navigable Waters Protection Act)*. Government of Canada. Retrieved from <http://www.tc.gc.ca/eng/marinesafety/oep-nwpp-minorworks-menu-1743.htm>

Vasseur, L. & Catto, N. (2008). *Chapter 4: Atlantic Canada*. In: D.S. Lemmen, F.J. Warren and J. Lacroix (Eds.), *From impacts to adaptation: Canada in a changing climate 2007* (pp. 119-170). Ottawa: Government of Canada.

Warren, F.J. & Egginton, P.A. (2008). Chapter 2: Background information – Concepts, overview and approaches. In: D.S. Lemmen, F.J. Warren and J. Lacroix (Eds.), *From impacts to adaptation: Canada in a changing climate 2007* (pp. 27-56). Ottawa: Government of Canada.

Webster, T. (2012). *Coastline change in Prince Edward Island, 1968-2010 and 2000-2010*. Charlottetown: Atlantic Climate Adaptation Solutions Association. Retrieved from <http://atlanticadaptation.ca/sites/discoveryspace.upei.ca/acasa/files/ACASA%20PEI%20Coastal%20Change%20from%201968-2010%20and%202000-2010.pdf>

Weiler, M. (2008). *Cultural analysis of Mi'kmaq toponyms of Prince Edward Island*. PEI: Mi'kmaq Confederacy of Prince Edward Island.

Wells, J. (2007). *Birder's conservation handbook: 100 North American birds at risk*. Princeton, NJ: Princeton University Press.

APPENDIX A

Watersheds which drain into Malpeque Bay include:

1. Baltic River Watershed
2. Barbara Weit River Watershed
3. Bentick Cove Watershed
4. Bideford River Watershed
5. Browns Creek Watershed
6. Carrs Pond Watershed
7. Grand River Watershed
8. Indian River Watershed
9. Josephine Shore Watershed
10. Lennox Island Watershed
11. Little Trout River Watershed
12. Lower New Annan Watershed
13. Mill Creek Watershed
14. Mills Point Watershed
15. Nebraska Creek Watershed
16. Oyster Cove Watershed
17. Platte River Watershed
18. Princetown Point Watershed
19. Rayners Creek Watershed
20. Rochford Pond Watershed
21. Shipyard Creek Watershed
22. Shipyard River Watershed
23. Trout River Watershed
24. Waites Creek Watershed

APPENDIX B

Stakeholders list of Malpeque Bay, as identified by Harvey (2009):

Environment and conservation organizations:

- Bedeque Bay Environmental Management Association (BBEMA)
- O'Leary Wildlife Federation
- Malpeque Community Improvement Committee
- Malpeque Bay Historical Society

Academics institutions:

- Atlantic Veterinary College Lobster Science Center (UPEI)
- Canadian Aquaculture Institute (UPEI)
- Institute of Island Studies (UPEI)

Resource organizations:

- PEI Shellfish Association
- Ellerslie Shellfish museum
- Western Gulf Fishermen's Association
- Cabot Fishermen's Cooperative Association
- Prince County Shellfish Association
- Prince County Flyfishers Association
- PEI Aquaculture Alliance
- PEI Fishermen's Association

Harbour authorities:

- Alberton
- Darnley
- Malpeque
- Milligan's Warf

Towns and communities:

- Town of Alberton
- Town of Kensington
- Community of Lot 11 and area
- Community of Malpeque Bay
- Community of Miminégash
- Community of Miscouche
- Community of Northport
- Community of Sherbrooke
- Community of Tyne Valley

Socio-economic development organizations:

- O'Leary's Area Development Corporation
- West Prince Tourism Association

- Tyne Valley and Area Development Corporation
- Miminegash and Area Development Corporation
- Kensington and Area Tourist Association