Photo: Matthew Conlin

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Carters Beach Dune Restoration Project

A Case Study of Nature-based Coastal Adaptation in Nova Scotia

Natural Resources Canada
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Making Room for Movement
Saint Mary's University
DALHOUSIE UNIVERSITY

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Carters Beach Dune Stabilization Project: A Case Study of Nature-based Coastal Adaptation in Nova Scotia is one of six case studies of nature-based coastal adaptation projects in Nova Scotia prepared as part of the Natural Resources Canada-funded project *Making Room or Movement: A Framework for Implementing Nature-based Coastal Adaptation in Nova Scotia*, lead by TransCoastal Adaptations Centre for Nature-based Solutions, Saint Mary's University.

Team members from the School of Planning at Dalhousie University compiled the case studies. Other members of the Making Room for Movement Team provided content and insight to one or more of the studies, including Kirsten Ellis, CBWES, Inc.; Nancy Anningson, Ecology Action Centre; Dr. Kate Sherren, Dalhousie University; Dr. Danika van Proosdij, Saint Mary's University; Dr. Tuihedur Rahman, McGill University; and Tony Bowron, CBWES, Inc.; and team members with CBCL Limited.

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This project was undertaken in Mi'kma'ki, the unceded ancestral territory of the Mi'kmaq. We acknowledge and pay respect to the traditional stewards of the land on which we live and have conducted this work.

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Case Study Context and Purpose

Concerned about the declining health of the sensitive dunes at Carters Beach in the Region of Queens Municipality on Nova Scotia's South Shore, area residents together with local education and research centres, scientists, and support from provincial government agencies, organized the Carters Beach Dune Restoration Project. Dune health is an important part of the coastal ecosystem. Dunes provide protection from coastal hazards such as erosion, coastal flooding, and storm surge and are critical habitat for coastal wildlife. This case study illustrates how a community-based initiative uses citizen science and brings together diverse stakeholders to create a simple, effective, nature-based approach.

This case study draws on scientific reports, technical reports, fact sheets, municipal planning documents, organization websites and social media, media reports, and input from project organizers and participants to describe Carters beach and dunes, the land use impacts and environmental changes affecting dune health, the planning and regulatory context, and the project to restore dune health. The case study illustrates how a small-scale community-based initiative uses local knowledge, citizen science, and partnerships for implementing nature-based coastal adaptation.

Background

Carters Beach is 1.5 kilometres of white sand beach located on the southwestern shore of Port Mouton Bay in the Region of Queens Municipality on Nova Scotia's South Shore (Figure 1). Queens Municipality is approximately 2760 square kilometres, encompassing 220 kilometers of coastal bays and estuaries, and extensive watersheds of rivers, lakes, wetlands, forests and is home to 10,960 people in villages and small towns located mostly long the coast or rivers (Region of Queens Municipality, 2017). Port Mouton is a fishing village within the municipality and abuts Carters Beach. Port Mouton was originally named *Wologumk* by the Mi'kmaq, which means "deep gully" or "hole in the river" (Region of Queens Municipality, 2020b). Port Mouton is known for advocating for environmental stewardship and protection and sustainable use of the marine ecosystem.

Port Mouton Bay is a fairly wide bay in the context of the narrow inlets that are characteristic of this part of the coast. There are other well-known beaches, a provincial beach park, and iconic Nova Scotia sea-side resorts on across the Bay from Carters Beach. Port Mouton Island shelters the western side of Port Mouton Bay and Carters Beach from the open ocean. Other smaller islands sit between Port Mouton Island and Port Mouton. The islands also shelter an open-pen fin-fish farm which set up in the bay in 1994/1995. In 2006, a second fish farm was proposed in the bay. The proposal inspired community-based science research to understand the effects of fish farms in the bay. In 2009, an indefinite fish-farm moratorium in the bay was announced but in 2020, the province approved the lease and license renewal for the open-pen site in Port Mouton Bay. The community group, Friends of Port Mouton conducts research and advocates for environmental stewardship and protection of the marine ecology of Port Mouton Bay.

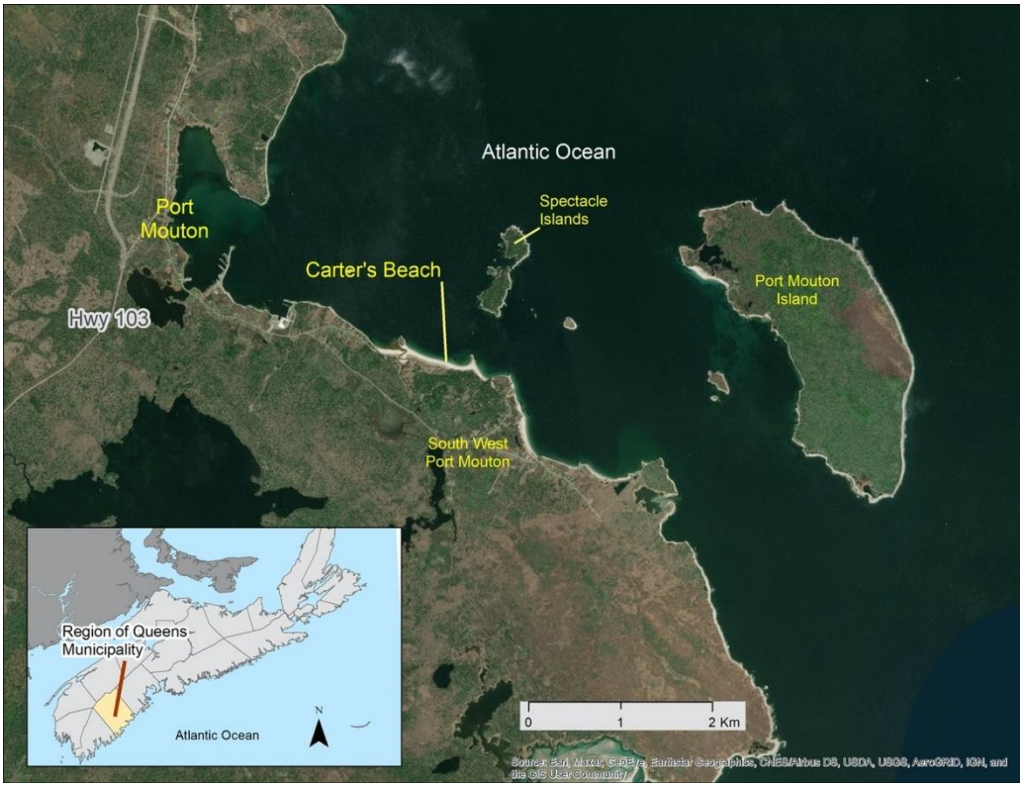

Figure 1: Carters Beach on Port Mouton Bay, Region of Queens Municipality, Nova Scotia (adapted from Google Images)

Figure 2: White sand and micro-terrain at Carters Beach (Photo by Loucks in Smith *et al*., 2019)

Carters Beach is a popular destination in Nova Scotia and is commonly referred to as Nova Scotia's Caribbean for its white sand and dunes, crystal blue waters, pockets of rocky islets, and nearby islands. The dunes at Carter's beach are the highest on the Nova Scotia's Atlantic coast (Davis & Browne, 1996), comprise a full sequence of sand dune ecology and include rare lichens, mosses, and orchids. A study by R. Taylor (2017) describes the geography and geomorphology of the beach. The dunes have been classified into two main sections - coastal and inland. The coastal dunes comprise up to three regions - a foredune ridge, and one or two secondary dunes, parallel to the shoreline (Basquill et al., 2011). The foredunes, located closest to the beach, consist of fine white sand anchored by marram grass. They range from two to four metres in height, and the coastal system approximately 35 metres in width (Basquill et al., 2011). Inland dunes stretch approximately 30 metres from the coastal dunes, inland. Moving inland, Marram grass growth becomes thicker. It provides habitat, and protects inland areas from flooding and strong winds during storms. Basquill et al., (2011) describes that the beach has an abundant sediment supply and has remained relatively stable for 100s of years. Over time, the

dune system and associated vegetation have gone through periods of erosion and regrowth. However, the beach shows resilience and adaptability to changing conditions.

Carters Beach has three bays. From north to south, the bays are commonly referred to as First, Second, and Third Beaches. (Figure 3). First and Second Beach are separated by a stream draining from a bog in the upland southwest of the beach. The stream meanders across the sand and foreshore zone, altering sediment patterns between the two beaches. Second Beach is the longest of the three beaches, and includes the largest dune system. Third Beach is separated from Second Beach by a rock islet.

Figure 3: The three bays and beaches at Carters Beach. Other features are the vegetated dune field extending from the beach and extending from the brook around the upland rising abruptly behind the dunes and reaching up to the Central Port Mouton Road. The brook drains from the bog on the south side of the road. The road is at 3 to 4 metres elevation at this location. (Adapted from Google Earth, 2020)

Healthy dunes and beach systems are maintained by continual sediment supply. The beach is a sand reservoir for the dunes (Taylor, 2017) (the mechanism is illustrated in Figure 4). The sand reserve in nearshore bars naturally replenish the beach after large storms. Dune sediment capture

is enhanced by vegetation growing on the dunes. At Carters beach, Marram grass is the most plentiful vegetation. Marram grass has an extensive root system that anchors the plant in unstable environments and thereby stabilizes the dune (Clean Coasts, 2015).

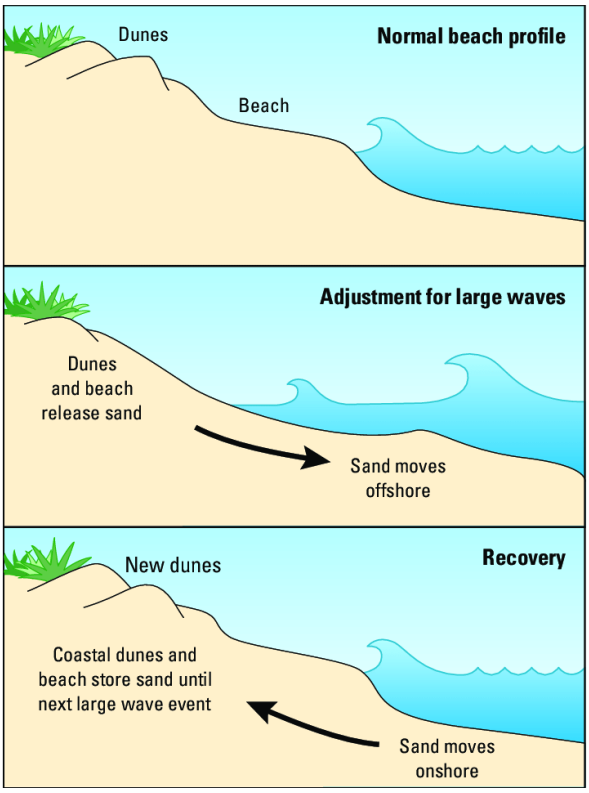

Figure 4: Coastal dune sediment exchange (University of Massachusetts, 2017)

Carters Beach has always attracted visitors, but more and more people are visiting the beach as tourism increases in Nova Scotia (Smith *et al*., 2019; Taylor, 2017). Beach-goers tend to access the beach at either the north or south end (Taylor, 2017). First Beach is closest to the main parking lot. Third Beach is accessible by the Southwest Port Mouton Path, and Second Beach is accessible by walking from either First or Second Beach. However, local stewards noticed that visitors were also accessing Second Beach at the southern end by an unofficial path (Taylor, 2017). Increased foot traffic on makeshift paths has caused significant damage to the dune system.

In 2013, the Nova Scotia Department of Environment (NSDE) released the *Parks and Protected Areas Plan*. The plan intends to incorporate approximately 13% of Nova Scotia's outstanding

landmass into Parks and Protected Areas by 2015 (NSDE, 2013a). NSDE suggested Carters become a Beach Nature Reserve (NSDE, 2013b) (Figure 5). Nature reserves are selected to preserve and protect ecologically important areas and natural processes that are considered significant as well as typical of Nova Scotia (NSDE, 2018). NSDE notes that the Carters Beach provides critical habitat, is an "outstanding example of dune development", and provides recreational opportunities (NSDE, 2013b). In April 2021, Carters Beach was named among 61 other provincially owned sites for eventual protection and designation as wilderness areas and nature reserves, following public consultation. The announcement came after concerns that Carters Beach would be delisted for protected status (McBain, 2021).

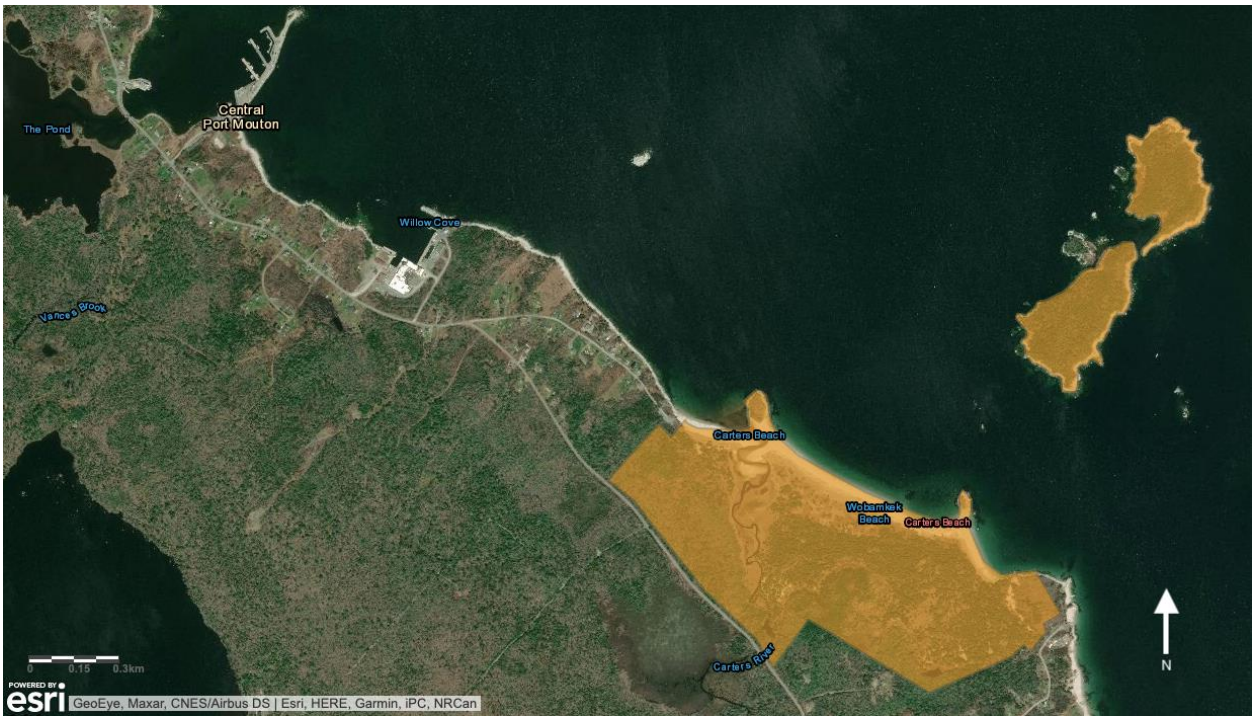

Figure 5: Proposed Beach Nature Reserve (NSDE, 2020)

HAZARDS AND RISKS AT PORT MOUTON-CARTERS BEACH

Climate change is creating warmer and wetter conditions in Nova Scotia, with more frequent and intense rainfall events (ECCC, 2019). As sea levels rise, coastal flooding and erosion are becoming more along the province's coast. Rising sea levels magnify high tides and storm surges (ECCC, 2019). As a result, coastal dune systems, such as Carters Beach, will be impacted by

more frequent and intense storms. During storm events waves attack higher on the dune system (ACASA, 2011). Higher and more intense wave attacks will likely result in shoreline erosion. Dune systems in Nova Scotia commonly move landward and steepen to adapt to rising seas (ACASA, 2011).

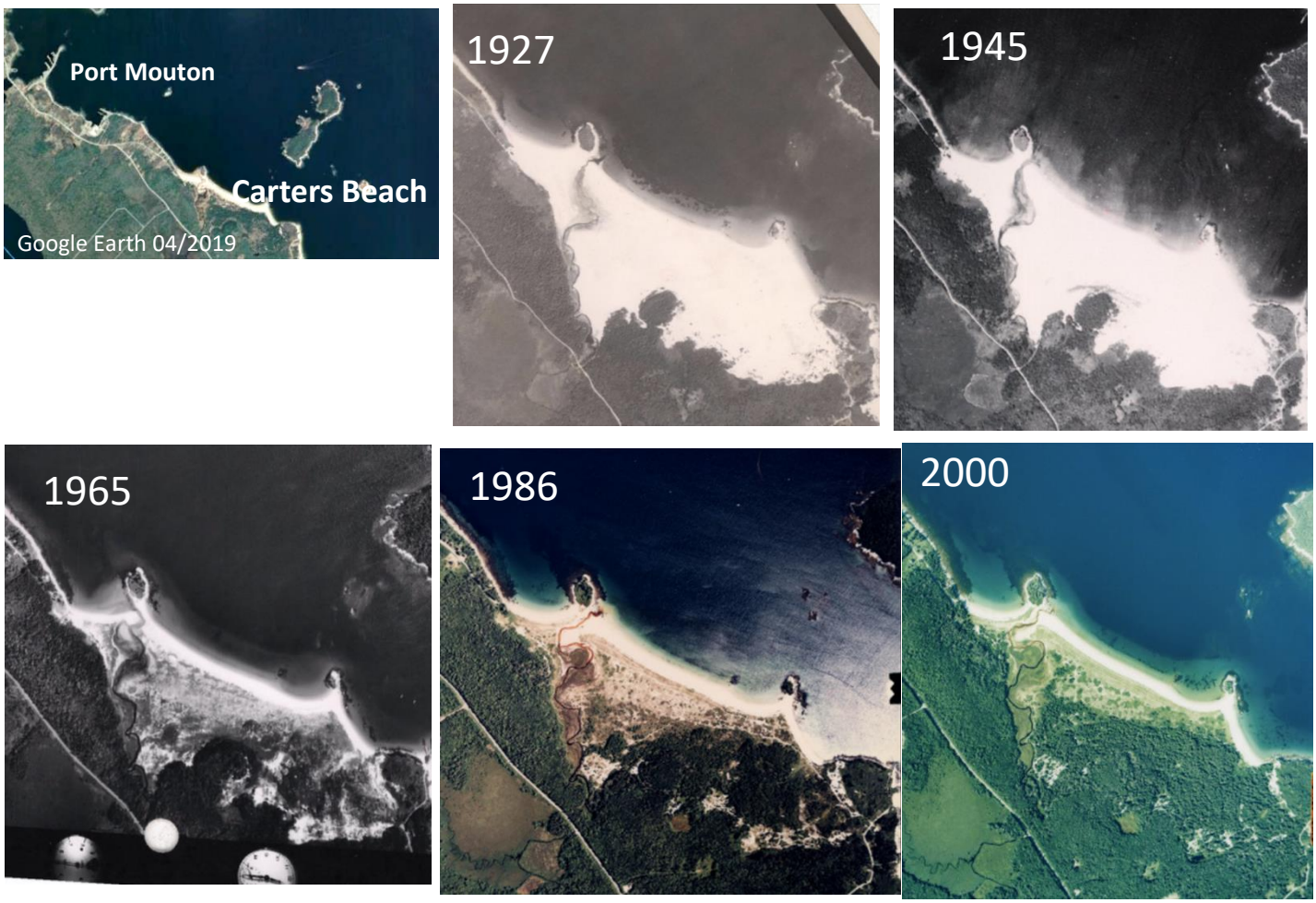

Figure 6: Adapted aerial photos sequence compiled by Basquill *et al*., 2011 showing dune stability and change and vegetation development of the dunes at Carters Beach (Note: The original sequence included years 1955, 1976, 1992)

Landward migration and steepening of dunes are necessary for the coastline to adapt to climate change (ACASA, 2011). In 2011 the (then) Department of Natural Resources (now Natural Resources and Renewables) undertook a detailed study of the coastal geomorphology and ecosystem diversity of Carters Beach (Basquill *et al*., 2011). Analysis of aerial photos beginning in the 1920s (Figure 6) indicated that Carters Beach and the dune system have been relatively adaptable to changing conditions (Basquill *et al*., 2011; Utting *et al*., 2010). The study identified

that First and Third Beach showed a healthy balance of erosion, replenishment, and vegetation growth. Second Beach was showing signs of imbalance. however. Close monitoring of Second Beach began in 2008, with regular beach inspections. The aerial photos in Figure 6 showed that dunes and vegetation became fragmented, and vegetation migrated landward, particularly along the south end of Second Beach (Taylor, 2017).

In 2017, coastal geomorphologist Dr. Robert Taylor conducted a study of the foredune stability and provided recommendations for reducing the impacts from beach visitors. In his report, he describes that spring storms in 2017 caused damage at Carters Beach. Marram grass, which was visible in 2016, was not visible in September 2017 (Taylor, 2017). The dunes migrated landward and showed signs of small cuts along the top of the foredune. He explains that these evolution patterns are a natural response to rising sea-levels and reduced sediment supply. However, in recent years, the dunes have experienced a significant loss in vegetation, blowouts (wind-eroded patches of beach), and dune migration (Figure 7) (Taylor, 2017).

Figure 7: Loss of vegetation and increased blowouts, August 2010 - June 2017 (Taylor, 2017)

The studies and recent visual observations indicate that dune health is deteriorating, in part due to climate change; however, the most detrimental impacts appear to be human-caused. Managing human activities to safeguard dune health and available space for dune migration are necessary considerations for ensuring dunes at Carters Beach can adapt to climate change. Increased human traffic and people attempting to access the beach by crossing the dunes at different locations is exacerbating climate change effects (Taylor, 2017). Pollution is also a significant threat to Carters Beach. Over recent years, there has been a notable increase in litter and human waste (Smith *et al*., 2019). Second Beach is experiencing the most significant damage. Summer 2020

was a particularly challenging year for managing the impacts at Carters Beach. Because of the coronavirus pandemic travel restrictions, record numbers of Nova Scotians were exploring their home province. Many of them found Carters Beach. In media interviews local residents and members of the stewardship groups described the impacts of dune trampling and litter that many hundreds of visitors a day left behind (Currie, 2020)

Climate change and human impacts stretch far beyond the dune system itself. Habitat damage has impacted the species dependant on these features. There are approximately 20 different ecosystems connected to Carters Beach (Steele in Saltwire, McKenna, 2017). There are several vegetation species at risk in the area including mosses, lichens, and a rare orchid species (Steele in Saltwire, McKenna, 2017). Carters Beach was once home to the endangered Piping Plover, which nest in dune grasses (Carters Beach Community Liaison Committee, 2018). The recent erosion and loss of dune grasses have damaged nesting habitat. As a result, Plovers have not been observed at the beach in recent years (NSDE, 2013a).

The Carters Beach area is also an important historical and cultural place. The Mi'kmaq have lived and stewarded the land since time immemorial. The surrounding region has two provincially registered archeological sites and three nature parks including Kejimkujik National Park, Port Joli Federal Migratory Bird Sanctuary, and Thomas Raddall Provincial Park (Region of Queens Municipality, 2020a).

Carters Beach is a vital component of the Port Mouton coast. The dune system provides habitat, reduces beach erosion, and is an iconic Nova Scotia landscape. In addition, Carters Beach dunes are an important natural defence against climate change risks and hazards that negatively impact humans. Coastline erosion poses particular challenges to human activities. Landward migration of the shoreline can create concerns for nearby roads, homes, and other coastal infrastructure (ACASA, 2011). Coastline erosion poses particular challenges to human activities. Landward migration of the shoreline can create concerns for nearby roads, homes, and other coastal infrastructure (ACASA, 2011). Carters Beach primarily borders on a vegetated knoll, although the dune field extends along the brook separating the First and Second Beach back to Central Port Mouton Road which lies at 3 m amslat this location. The road is the only access for residents

in South West Port Mouton The road is largely protected by knoll and upland between it and the shoreline, but the dune may provide some protection for the road from storm flooding at this vulnerable location where it is exposed to the coast via the brook channel. The primary dune value for climate change adaptation, however, is its significance for the preservation of coastal biodiversity in a provincially distinctive dune landform, structures that are at high risk to impacts of sea level rise, and for the scientific and cultural significance of beach-dune environments locally and provincially. Carters beach is valued greatly for recreational and environmental education.

The eastern border of the Queens Municipality is entirely coastal. The Region of Queens Municipality notes that much of their coast is vulnerable to climate change hazards and risks (Region of Queens Municipality, 2014) and is especially vulnerable to erosion. Figure 8 shows coastal areas in Queens at high-risk of erosion. The Queens' *Municipal Climate Change Action Plan* states that property loss, damage to buildings and structures, and infrastructure damage are all at "high risk" due to erosion.

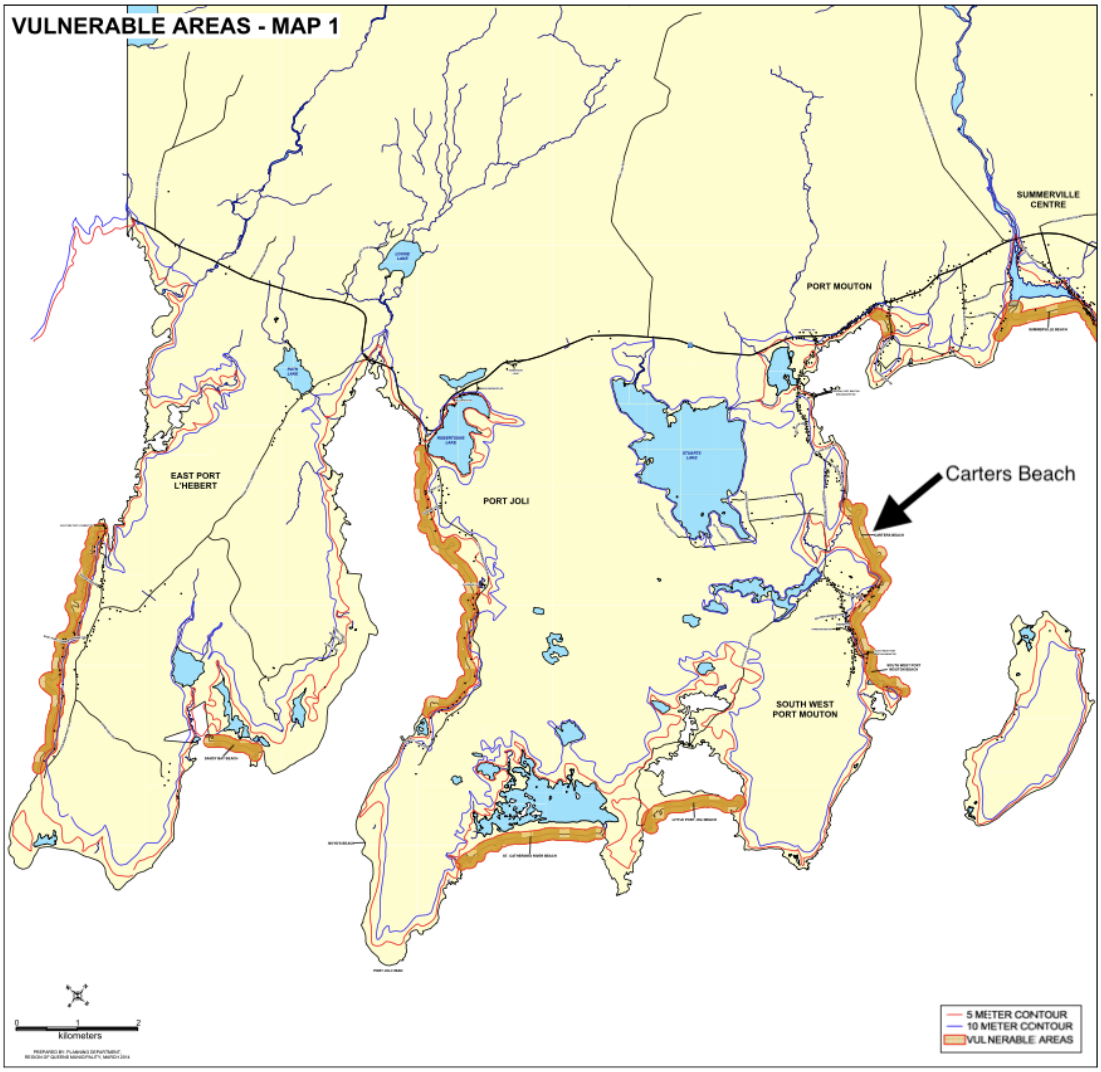

Figure 8. Vulnerable coastal areas map in Queens municipality (Region of Queens Municipality, 2014)

Dunes are a dominant coastal feature across Nova Scotia. There are 45 coastal dune systems greater than one kilometre in length (Hales, 1992). But they are also often squeezed between the coast and a road or a steep slope making them particularly vulnerable to climate change impacts of sea level rise and erosion. Understanding the risks at Carters Beach will provide important context for understanding dune adaptation, potential climate change risks, and mitigation options for Queens Municipality and Nova Scotia.

Social Vulnerability to hazard at Port Mouton-Carters Beach

Flooding and erosion are natural processes that become natural hazards when land development encroaches into flood prone areas and areas of active erosion, putting people, infrastructure, and land use activity at risk. Natural hazards affect populations differently. The impacts felt by a population, or a population's vulnerability to a hazard (such as flooding), is evident in the ability of the populations ability to respond to, cope with, and recover from the impact of the hazard. A variety of individual and social factors influence vulnerability of a population including income, employment, gender, age, race, education level, household composition, ability to speak the local language, among others. The greater the proportion of the population experiencing conditions that contribute to vulnerability (such as advanced age, unemployment, being a recent immigrant, for example), the more vulnerable is the population in that area. Vulnerability is described through indices such as the Social Vulnerability Index (Cutter, 2003), or a marginalization index (Matheson, *et al*., 2012) such as the Canada Index of Multiple Deprivation (CIMD) (Statistics Canada, 2019). The analysis for this case study uses the CIMD.

The CIMD is an area-based index created by Statistics Canada using variables from the 2016 Census of Population at the Dissemination Area (DA) level (Statistics Canada, 2019). A Dissemination Area is the smallest population unit for which Statistics Canada reports the full set of demographic and social statistics, about 400 to 700 people. DAs are relatively stable geographic areas. Statistics Canada developed CIMD datasets across three geographic scales: national, regional (two, including Atlantic), and provincial (three), referenced to 2106. This case study used the Atlantic Region CIMD data set.

The CIMD comprises four dimensions of deprivation and marginalization, with each dimension incorporating influencing indicators derived from the census data: residential instability; economic dependency; ethno-cultural composition; and situational vulnerability. The indicators for each dimension are listed in Figures 8 to 12. DA-level factor scores were calculated for each dimension using factor analysis. Scores were then ordered within each dimension into quintiles and the quintiles were assigned a value of 1 through 5, Quintiles represent fifths of a population; the first quintile is the lowest fifth of the data (1% to 20%) and receives the quintile

value ‘1’; the fifth quintile is the highest fifth of the data (81% to 100%) and receives the quintile value ‘5’. For the CIMD, ‘1’ represents the scores indicating the least deprived fifth of the population; and ‘5’ indicates the most deprived.

Figures 9, 10, 11, and 12 are maps developed from the Atlantic Region CIMD data set to show the deprivation levels for Port Mouton Bay and adjacent areas, the social context for Carters Beach. The shades of green on the maps represent lesser (light) to greater (darker) deprivation. The higher the deprivation the more vulnerable is the population to hazards. Table 1 compares marginalization/deprivation between 2006 and 2016. The 2006 data are from an earlier index, the Canadian Index of Marginalization (Matheson, *et al*., 2012). The CIMD and the marginalization indices consider the same factors and are compatible for comparisons to identify trends.

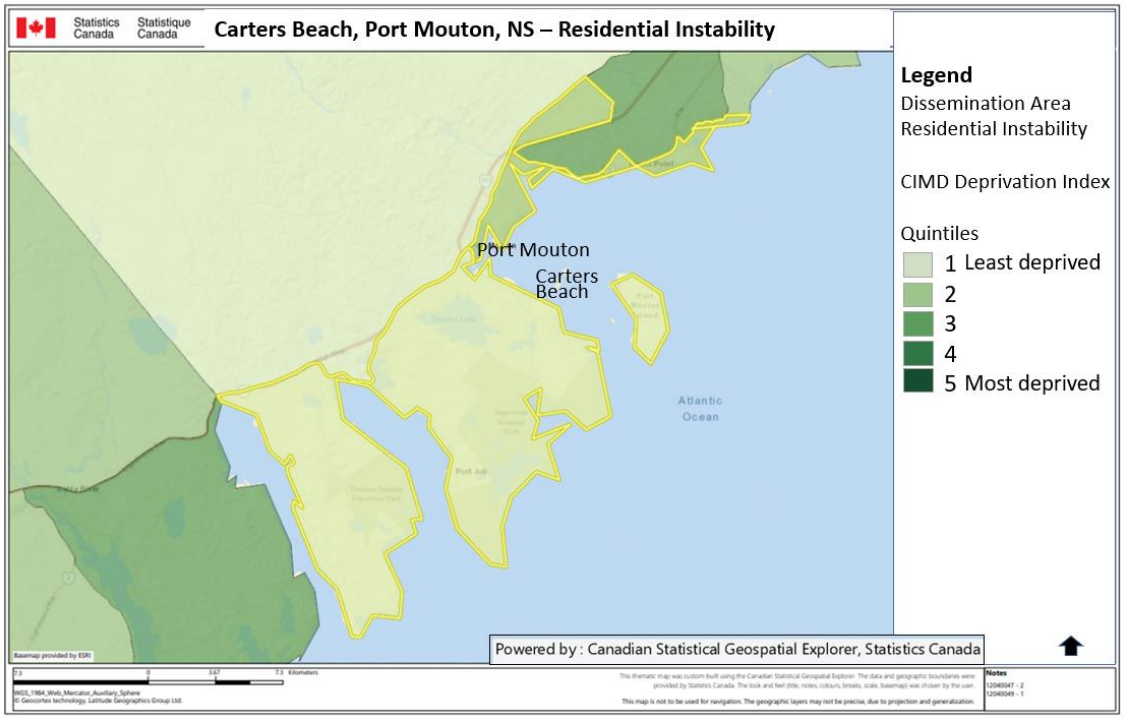

Figure 9. Port Mouton Bay and area - Residential Instability* at 2016
Canadian Index of Multiple Deprivation –(Statistics Canada, 2019)
*Proportion of persons living alone; proportion of dwellings that are owned, proportion of dwellings that are apartment buildings; proportion of the population that is married or common-law, proportion of the population that moved in the last five years.

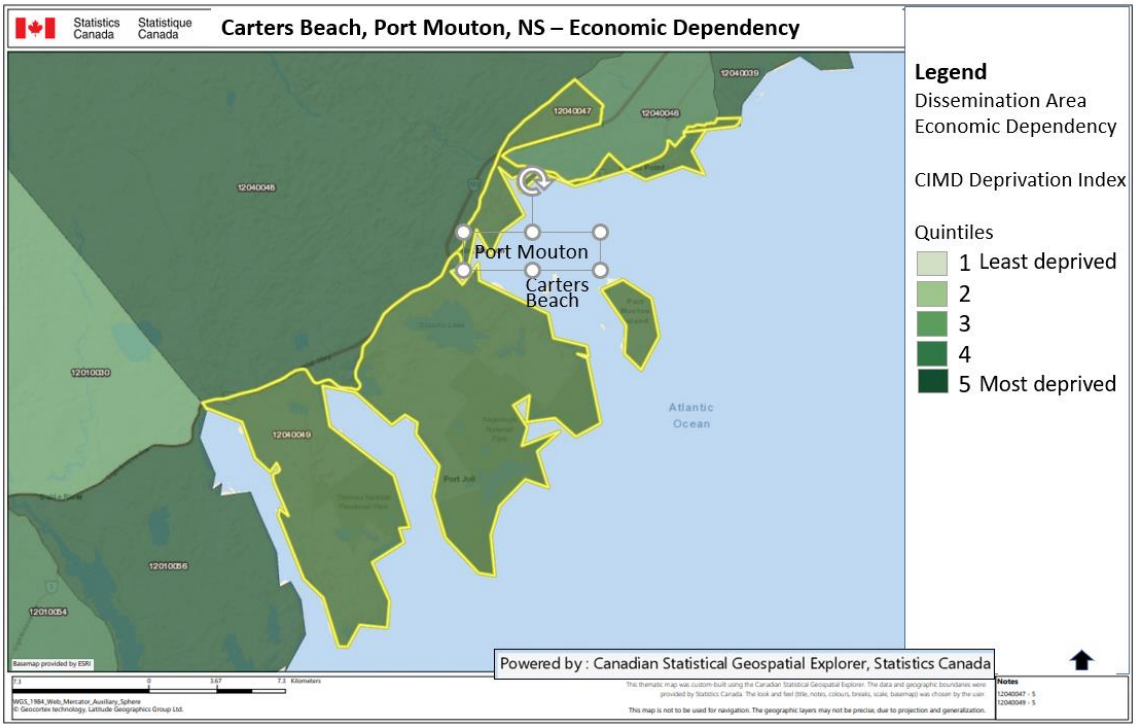

Figure 10. Port Mouton Bay and area - Economic Dependency* at 2016
Canadian Index of Multiple Deprivation - (Statistics Canada, 2019)
*Proportion of population aged 65 and older; proportion of population participating in the labour force -15 and over; dependency ratio (population 0-14 and 65 and over divided by population 15-64; ratio of employment population proportion of population receiving government transfer payments.

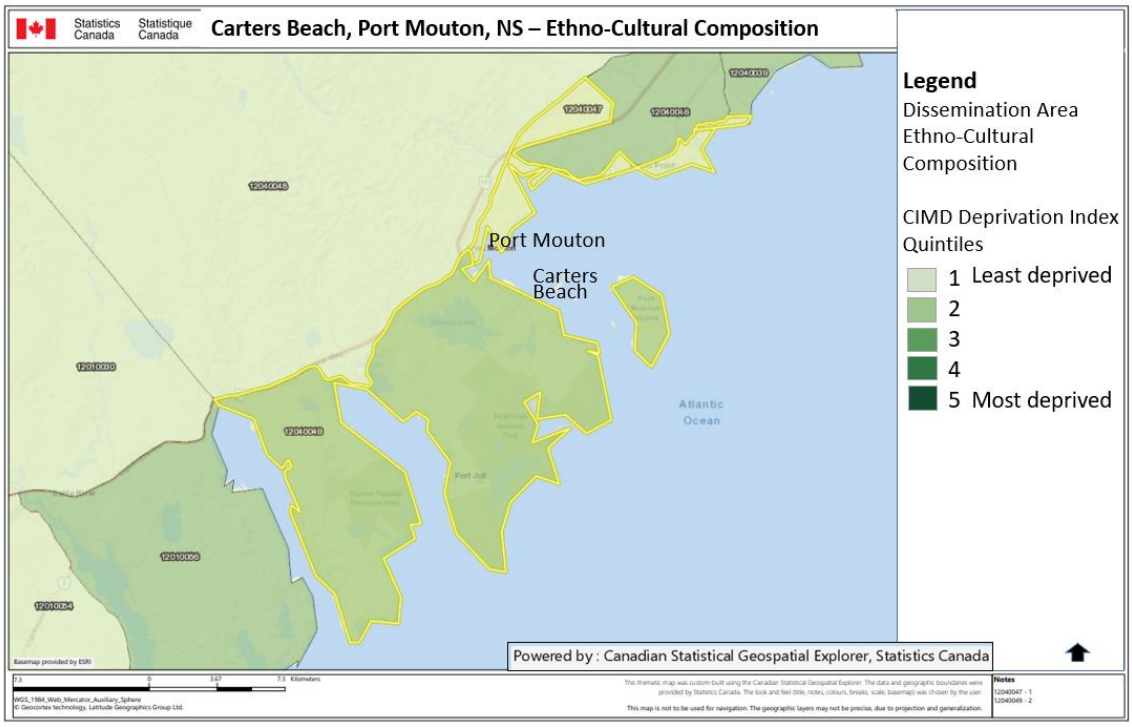

Figure 11. Port Mouton Bay and area - Ethno-Cultural Composition* at 2016 Canadian Index of Multiple Deprivation (Statistics Canada, 2019)

*Proportion of population that is recent immigrants; proportion of population that has no knowledge of either official language.

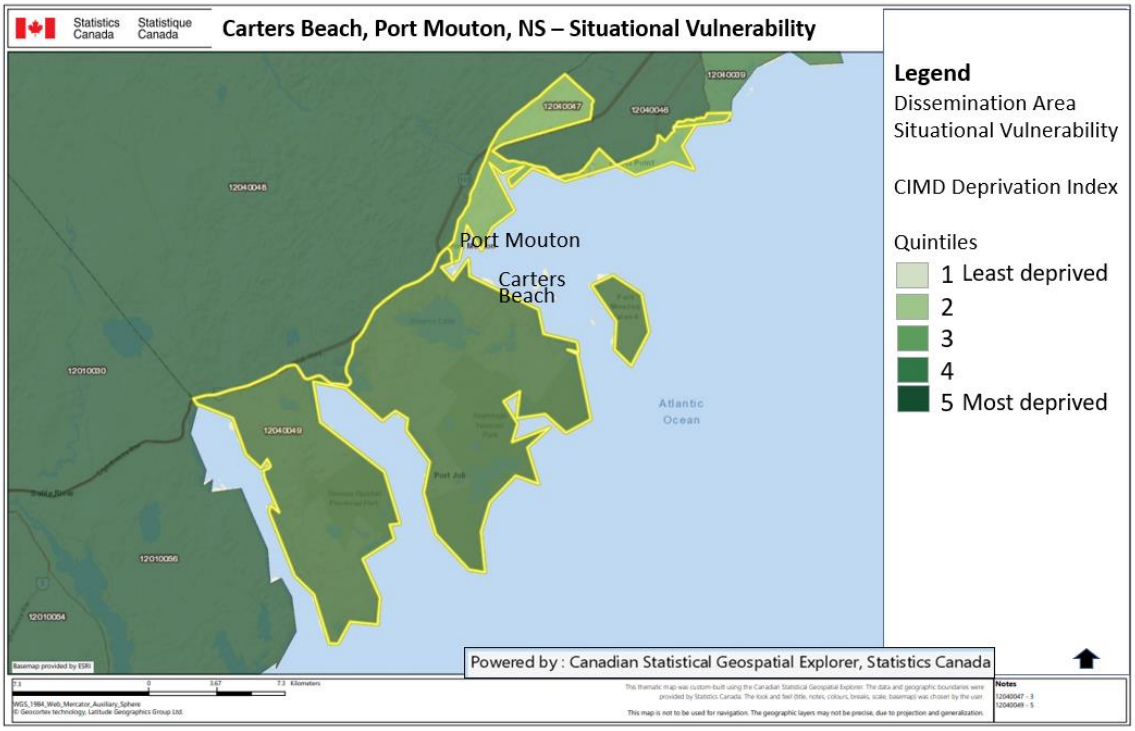

Figure 12. Port Mouton Bay and area - - Situational Vulnerability* at 2016
Canadian Index of Multiple Deprivation (Statistics Canada, 2019)
*Proportion of the population that identifies as Aboriginal; proportion of dwellings needing major repairs; proportion of population aged 25 to 64 without a high-school diploma.

For the population in the DAs closet to the Carters Beach area including Port Mouton and Central (closest) and Southwest Port Mouton, Situational Vulnerability and Economic Dependency have the biggest influence on social vulnerability measured through the multiple deprivation factors. Vulnerability in these areas is least influenced by Ethno-cultural Composition and Residential Instability. Situational Vulnerability reflects educational status or dwellings in need of repair; Economic Dependency reflects characteristics related to an older population, and a population receiving transfer payments, like pensions or employment insurance benefits. Proportion of seniors (age 65+) is a factor of Economic Dependency. Seniors are the fastest-growing demographic in Nova Scotia, and rural regions experience this more intensely than cities (CBCL, 2009). Seniors make up 15% of the population in Nova Scotia, and 25-30% in rural areas (CBCL, 2009) like the Port Mouton/Carters Beach area.

Table 1 compares marginalization and deprivation scores for 2006 and 2016 showing the eastern DA 12040047, which contains Port Mouton, and the western DA 12040049 which includes Central and Southwest Port Mouton. Indices for all factors decreased for DA 12040047 except

for Economic Dependency, which maintained a high deprivation index of five. The indices for the western DA 12040049, which includes Central and Southwest Port Mouton, remained stable, and high for Economic Dependency and Situational Vulnerability.

12040047 - 2006		**12040047 - 2016**	
Residential Instability	3	Residential Instability	2
Dependency	5	Economic Dependency	5
Material Deprivation	4	Situational Vulnerability	3
Ethnic Concentration	1	Ethno-cultural Composition	1
12040049 - 2006		**12040049 - 2016**	
Residential Instability	1	Residential Instability	1
Dependency	5	Economic Dependency	5
Material Deprivation	5	Situational Vulnerability	5
Ethnic Concentration	1	Ethno-Cultural Composition	1

Table 1. Comparison of vulnerability using Canadian Marginalization Index (2006) and the Canadian Index of Multiple Deprivation Indices 2016. (1= least marginalized/deprived; 5= most marginalized/deprived (Statistics Canada, 2019).

GOVERNANCE, POLICY, AND PLANNING

Carters Beach and adjacent upland, as well as some of the islands in Port Mouton are Crown land within the Region of Queens Municipality (Figure 13). The province purchased private land near Carters Beach in 2008 (EAC, 2008). Twenty-nine hectares of Crown land, encompassing Carters Beach and dunes falls under the *Beaches Act (1993)* (Utting et al., 2010). The purpose of the *Beaches Act* (Nova Scotia Legislature, n.d.) is to:

1. provide for the protection of beaches and associated dune systems as significant and sensitive environmental and recreational resources;
2. provide for the regulation and enforcement of the full range of land-use activities on beaches, including aggregate removal, so as to leave them unimpaired for the benefit and enjoyment of future generations;
3. control recreational and other uses of beaches that may cause undesirable impacts on the beach and associated dune systems

Figure 13. Crown Land Ownership (NSDE, 2020)

The protected beach area and adjacent upland, together comprising 95 hectares, are also candidates for protection as the Carters Beach Nature Reserve (Luck, 2021).

The Nova Scotia Department of Lands and Forestry (NSDLF), (now Natural Resources and Renewables DNRR) is responsible for enforcing the *Beaches Act*. Nova Scotia Department of Environment (NSDE) (now Environment and Climate Change ECC) will become responsible for the land when Carters Beach becomes a Nature Reserve. ECC will be responsible for enforcing any regulations regarding the Nature Reserve (NSDE, 2020). However, DNRR will remain responsible for the beach itself. The Province must approve any alteration to the beach/dune system.

The Region of Queens Municipality is responsible for regulating land use within the boundaries of the municipality, described and governed through the *Region of Queens Municipality Municipal Planning Strategy* (2009) and *Land Use Bylaw* (2009). Each municipality permits different types of land use along the coast, through policies and bylaws, which will ultimately affect the capacity to mitigate and address the impacts of coastal flooding and erosion in the

coastal zone. Municipalities also have the power to protect buildings, citizens, and the environment by establishing setbacks, elevation requirements at the shoreline, standard lot sizes, and site design requirements that consider a variety of constraints including climate change predictions.

The entire municipality has land use planning and zoning; however, land outside developed areas is generally zoned as rural residential and mixed use coastal residential in coastal areas which permits a diversity of uses. The following are the dominant land use zones on the western side of Port Mouton Bay around Carters Beach (Region of Queens Municipality, 2009a):

- Mixed-use Coastal Residential (R-6)
- Recreation and Open Space (P-1)
- Conservation (O-1)
- Fishing and Marine (M-3)

In the Carters Beach area, M-3, P-1, and O-1 are zones located on the waterfront to support marine industry and business operations. M-3 permits low intensity uses such as marinas, small scale wind turbines, and commercial marine uses, excluding processing plants. The zoning has a front yard setback requirement of 12.2 m. M-3 zones are located north of Carters Beach. P-1 zones make up a substantial portion of the coast in Queens Municipality. P-1 allows for low-intensity uses, including golf courses, athletic fields, boat launches, and trail systems. However, P-1 also allows for infrastructure such as skating rinks. Infrastructure within the P-1 must have a 6.1 m front yard setback. The Conservation Zone (O-1) is the dominant zone at Carters Beach. It encloses Carters Beach and dunes and the neighbouring beach along Burgess Road. The O-1 zone only allows for boardwalks, trail systems, and public and private parks. The majority of the coastal zone near Carters Beach, excluding the beach and part of Port Mouton Island, is R-6. This zone permits an extensive list of uses, including agriculture, small scale wind turbines, marine commercial uses, and various dwelling types, ranging from single-detached homes to apartment buildings. Coastal infrastructure must have a setback of 7.6 m in this zone.

Buildings that existed before new zoning regulations are permitted to change their use and structure if they comply with all other zoning regulations even though they do not meet lot requirements. Buildings can be enlarged, reconstructed, repaired or renovated if the construction does not further reduce lot requirements. Existing residential buildings can be rebuilt or repaired if destroyed by fire or "otherwise", if lot requirements are not further reduced (Region of Queens Municipality, 2009b). Allowing reconstruction of non-conforming buildings without enforcing the new bylaw provisions, such as stricter setbacks, is not a proactive approach to addressing climate change hazards and risks at the coast.

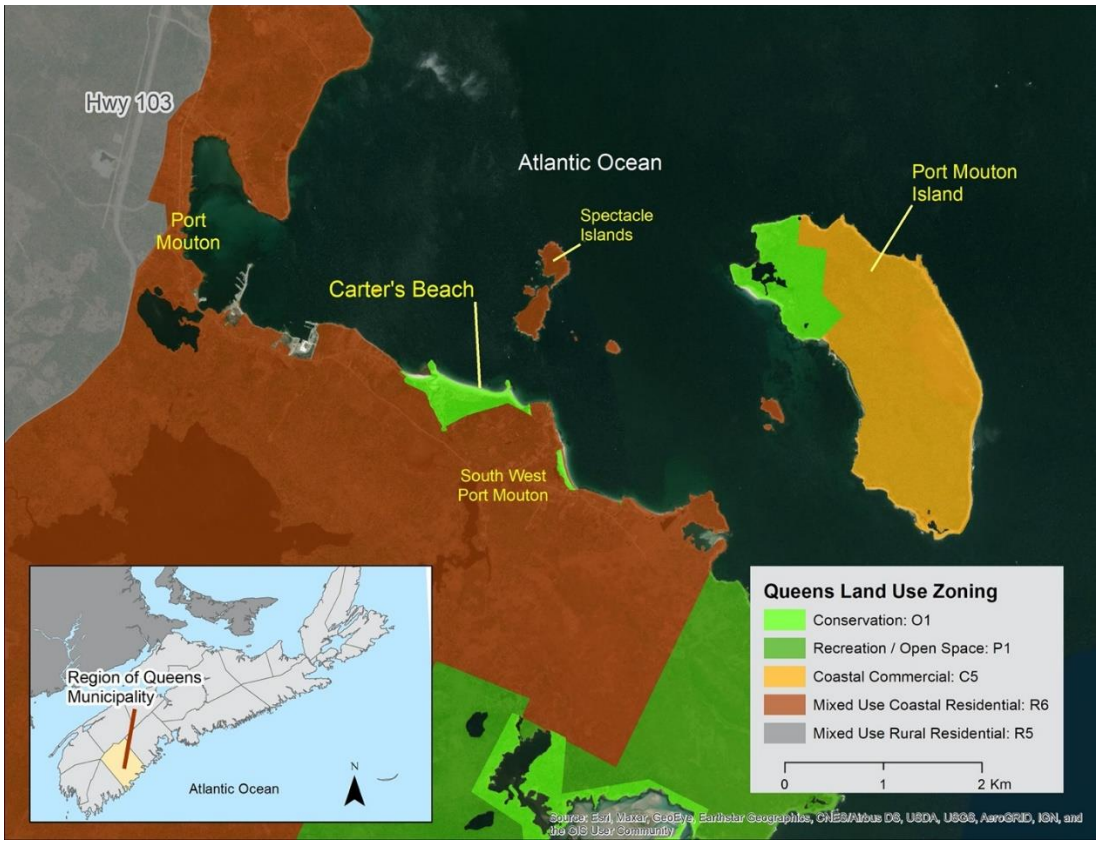

Figure 14: Region of Queens Municipality Land use Zoning for the west side of Port Mouton Bay

Land use conformity between provincial and municipal governments

The municipal CS zoning at Carters Beach convers the beach and dunes protected under the *Beaches Act.* The adjacent provincial land that will be added to the protected beach to form the Carter Beach Nature Reserve carries the most permissive municipal zone, R6. A possible explanation for the inconsistency is that when zoning was applied to the area, the property was still privately owned. The municipal plan and by law were approved in 2009, the province purchased the land in 2008 and the zone was not updated. It is rare for private land to carry restrictive zoning, except for limited areas like environmental buffers or specially protected lands such at wetlands. Furthermore, there was no indication of candidate protected status until 2015. The R6 zone permits many uses and would not constrain most other uses for the land that the province might have considered. Once the province confirms the nature reserve, the municipality should update the zoning.

Consideration of municipal policy and regulation with respect to nature-based approaches to adaptation

In general, the Regional Municipality of Queens recognizes that the natural environment is an asset and provides important ecosystem services (Warren, 2020). For example, Queens identifies the importance of wetlands to mitigate coastal and river flooding. The municipality recognizes that development too close to the waterfront can expose citizens to hazards and risks such as flooding and erosion (Warren, 2020). There are policies in the MPS that require the LUB to include provisions regarding the retention of vegetation along significant watercourses. Queens municipality recognizes the significance of natural features to protect residents. The MPS contains Natural Environment Policies, which include the creation of a Conservation zone. The policy intends to zone all dune systems, designated beaches, Provincial Wilderness Areas and lands owned by conservation organizations as Conservation. However, there are no policies that provide any recommendations on how to use nature to address the possible impacts of climate change (Warren, 2020).

The Carters Beach Dune Restoration Project

Process

Community members of Port Mouton Bay are advocates for the protection of their natural assets. In 2016, Friends of Port Mouton Bay collaborated with the Ocean Canada, Atlantic Canada Working Group. Ocean Canada is a six-year research initiative (2014-2020) funded by the Social Sciences and Humanities Research Council of Canada (Ocean Canada, 2020). Ocean Canada has 19 partners who collaborate to investigate threats facing oceans in Canada's Arctic, Pacific, and Atlantic (Ocean Canada, 2020). Ocean Canada and Friends of Port Mouton Bay held a community workshop in 2016. The workshop inspired the community to develop a Community Assets Map, which illustrates features that the community values. The participatory mapping project defines a community asset as "Anything community members find valuable: be it a place, a thing, a person, or a group of people." (Ross, n.d.). For example, assets in Port Mouton Bay include Carters Beach, surfing, and sailing. Community members also included observations of coastal climate change impacts (Ross, n.d.) noting flooding risks, erosion, dune damage, among other impacts. Project participants presented several options for addressing risks within their community ranging from hard infrastructure to protect economic assets to nature-based approaches to managed retreat. The project also highlighted the need to protect Carters Beach. Participants noted the importance of ecosystem restoration and the negative impacts of increased human traffic. The community chose to create an Esri Arc Story Map to illustrate the connection between climate change and risk to the community and environmental well-being. A student from Dalhousie University was hired to develop the story map. Though this project did not directly inspire the Carters Beach Restoration Project, it did inspire a broader conversation about climate change, what is at risk in Port Mouton, ways to address coastal issues, and the importance of collaborative projects. The mapping project illustrated Port Mouton's community commitment to protecting the Bay and generated public interest in conservation projects including the Carters Beach Restoration Project. To view the Friends of Port Mouton Bay and Ocean Canada project, visit this link: https://tinyurl.com/yxvw9plq

A group of Queens Municipality community members spearheaded restoration at Carters Beach. The Carters Beach Community Liaison Committee was organized by NSDE Protected Areas at a

large community meeting in 2015. The committee was comprised of community volunteers. The role of the Committee is to determine the management details required for Carters Beach to retain protected status. Following a request from the Committee and NSDE Protected Areas, a visual survey was conducted to assess if the dunes would require management due to the increased number of people visiting the area (Taylor, 2017). The assessment indicated that the natural environment should be sufficient to support Marram grass growth if impacts from human activity were mitigated (Taylor, 2017). The assessment provided seven recommendations for mitigation. Several were complete as of Fall 2020.

Provide well serviced toilets –visitors were going to the washroom behind the dunes causing damage	Implemented
Rope off and implement signage for sensitive areas	Implemented
Educative signage	Implemented
Provide wayfinding signage to inform and direct people from the parking lot to the beaches	Implemented
Study the carrying capacity of the beach by monitoring daily and seasonal visitation	Ongoing
Inform local community members on stewardship activities	Ongoing
Set up re and post-project monitoring and documentation to understand how the project progresses	Pre – implemented Post - ongoing

In 2017, NSDLF made a presentation about site management concerns for Carters Beach to the Municipality of Queens Council (McKenna, 2017). It was determined that action should be taken to address impacts at Carters Beach while waiting for protection as a nature reserve. That year, the Carters Beach Community Liaison Committee applied for a permit from NSDLF to carry out dune restoration activities following the site study and a restoration plan completed by Dr. R. Taylor (2017). Each year, the Committee has been granted permission to continue Marram grass restoration at Carters Beach. NSDLF and NSDE provided materials for project implementation, but the restoration activities have been organized and led by a student group from the Nova Scotia Community College (NSCC) Environmental Technology Program, supported by community volunteers and liaison committee members (Smith *et al*., 2018). Additional support came from the Harrison Lewis Coastal Discovery Centre, located in Port Joli, southwest of Port Mouton. In 2018, the centre collaborated with Clean Foundation and NSDE Protected Areas Branch to hire a public outreach summer intern to conduct research into beach usage, and build community relationships (Harrison Lewis Coastal Discovery Centre, n.d).

Project participants have come from the community, education institutions, and research centres, supported by government and non-governmental agencies. The actor ad their roles are summarized in Table 1.

Carters Beach Community Liaison Committee	Established to provide community input and direction to the management of Carters Beach
Nova Scotia Community College (NSCC)	Project lead, research
Volunteers	Community members who participate in the work group
Harrison Lewis Coastal Discovery Centre	Student intern - Carters Beach public outreach and stewardship project

Supporting actors:

Friends of Port Mouton Bay	Community group organized in 2006, out of concern for the future of the Port Mouton Bay and committed to protecting the Bay from open net fish farming Citizen science
NS Department of Lands and Forestry	Materials for site management; education
NS Department of Environment	Summer intern funding (to Harrison Lewis Centre)
Clean Foundation	Summer intern funding (to Harrison Lewis Centre)

Table 1. Carters Beach dune restoration project actors and roles

Carters Beach dune restoration

The goals of dune restoration are to preserve biodiversity and increase shoreline mobility to encourage natural adaptation. The purpose of dune restoration at Carters Beach is to enhance Marram grass growth and coverage in areas damaged by human activity and increase awareness and education about human impacts on the dune system. Restoration at Carters Beach involved Marram grass planting, installing physical barriers to limit human access, signage, and education.

Restoration activities began in 2017, with rope fencing, fencing, and educational signage (Smith *et al*. 2018). Signage and physical separation of human traffic were essential to ensure that

restored areas has the best chance of survival. Beach-goers needed to understand the restoration project, why it was necessary, and how their behaviour could influence dune restoration. The intent is that education will foster cooperation and responsible use of Carters Beach.

In April 2018, participants transplanted Marram grass from healthy plant communities located elsewhere on Carters Beach to six locations at the southern end of Second Beach, where most of the human impacts occur (Smith *et al*. 2018). The grass was selectively harvested to ensure that the original population remained healthy. April is an ideal planting time because it is generally free of major storms, frost, and drought (Smith *et al*., 2019).

The first round of planting was carried out as small pilot projects to gauge the effectiveness of transplanting Marram grass to increase dune health (Smith et al., 2019). Planting begins at the top of a blowout and continues down to the foot of the dune to avoid trampling while planting. Marram grass must be planted in a particular way to ensure grasses have the highest chance of success (Figure 15). The root and 2/3rds of the grassy plant must be covered with sand. Tall plants are folded to bury the top of the plant in the sand. The technique tricks the plant into behaving as if it was underground causing it to grow faster (Clean Coasts, 2015). Transplants are planted approximately 30 cm apart in line with blowouts (Smith *et al*., 2019). Marram grass shoots grow upwards and back into the dunes, increasing stability. Marram grasses have extensive root systems, which allows them to grow in unstable environments and thereby stabilize the sand.

2019 was the third year of restoration work at Carters beach with more transplanting at the three locations most heavily impacted by visitors.

Figure 15: Example of Marram grass planting from the Clean Coasts Marram Grass Planting Guide used for Carters Beach Restoration (Clean Coasts, 2015)

The project workers also conducted a survey to understand better how people view dune health and solutions (Smith et al., 2019). The survey showed that 40% of the 609 participants cannot recognize dune problems and more than half of the participants do not understand solutions (Smith et al., 2019).

Project Funding

The scale and design of this project meant that the project could be implemented with limited funding coming through material contributions and in-kind support. In 2018 and 2019, restoration was carried out by students from the NSCC fulfilling students' fieldwork assignment requirements, and supported by community volunteers; hence, there were no labour costs. The NSCC covered costs for students' transport to the site. The NSDE (Protected Areas) and NSDLF provided signage and materials for fencing that were reused each year, keeping costs low. Plant materials were acquired from the beach itself. Therefore, there was no cost for plant material.

Project outcomes to 2020

Monitoring is an important part of habitat restoration. Overall, educational signage and fencing have been effective in deterring human activity on the sensitive dunes. These measures were most effective on the southern end of Second Beach, and at Burgess Rd., at Third Beach (Smith et al., 2018; Smith et al., 2019). Where fencing was erected, grasses migrated over 3m (Smith et al., 2018). Unfortunately, in the mid-section of Second Beach, measures were much less successful. Several signs were missing, and Marram grass regrowth was less extensive than other fenced areas (Smith *et al*., 2018). Signage was noted as an essential feature of restoration. In the future, NSCC and NSDLF would like to increase the amount and types of signage.

Several ground surveys were completed to monitor the success of Marram grass planting. In 2017, multiple storms resulted in more than 20 dune breaches (Smith *et al*., 2018). Marram grasses were able to recover from all but five breaching events. Another survey was conducted in September 2018, following planting in April. The survey indicated that the success of replanting efforts ranged from 65 to 100% (Smith et al., 2018). Participants conducting the survey noted that grasses developed several shoots; therefore, accounting for individual plants was difficult. The survey also noted that where Marram grass was planted, there was significant sediment retention.

In June 2019, transplanted Marram grass showed a 91-98% survival rate (Smith et al., 2019). In September 2019, Hurricane Dorian rolled through Nova Scotia. It resulted in significant erosion and loss of roped fencing at Second Beach. Overall, transplanted Marram grass was resilient to the intense conditions. At four of the six locations, 81% to 100% of the transplanted grasses survived (Figure 16) while survival was 37% at a fifth site, and almost none of the transplants survived at the sixth site (2%). Human impacts were also monitored. Signage at Burgess Rd. appeared to remain effective while signage at the southern end of Second Beach proved to be less effective. Marram grass in the area showed signs of human trampling.

Figure 16. Marram grass growth at one of the restoration sites (left to right – April, 2018, September, 2019, September, 2019) (photos by Coolen in Smith *et al*., 2019)

In the summer of 2020 Nova Scotians were confined mostly to home due to the coronavirus pandemic public health travel restrictions. Many of them discovered Carters Beach. Residents and beach stewards expressed dismay about the impact of so man people on the beach and the apparent disregard for the dunes (Currie, 2020). Visitors who are coming to the beach, perhaps for the first time, and in great numbers, and who are not familiar with the sensitive habitat and the significance of dunes generally, or at Carters Beach in particular, may not value the place in the same way as local area residents do who have worked to protect and restore the dunes and who understand their significance for habitat and for coastal resilience. The experience underscores the importance of taking advantage of every opportunity to educate people about the importance of coastal habitats, their vulnerability to impacts, the services they provide to people, and their significance in ensuring habitat and structural resilience of the coast to climate change impacts.

Lessons, Barriers, Drivers

Dune restoration at Carters Beach, provides a great example of a community-led nature-based adaptation initiative. The community, along with project leads and collaborators, were able to initiate, implement, and monitor the project. The relatively small scale of this project made it manageable for the people involved. Connecting the NSCC diploma program, the community liaison committee, community volunteers, a local environmental research centre, non-

governmental and government agencies built a network with internal supports and legitimacy across the groups. The project has been an educational opportunity for students and community members. But, the project has really been motivated by the concern of the community for protecting the integrity of Carters Beach's dune system to ensure its physical and biologic resilience to climate change impacts. Ensuring its ecological health would maintain its eligibility for protected area status. The community is also protecting a valued community asset, one that has been identified by the community through community asset mapping and confirmed by the community in their actions to build is adaptive capacity to respond to climate change.

The beach restoration project has been successful but not without its challenges because of the increase in visitors to the beach in 2020 and 2021 (McBain, 2021). There is a need for improving infrastructure to manage parking along the road that leads to the beach entrance, and then directing people from there along the path of least disturbance to the beach. Once there, the challenge is managing visitor behaviour.

It is here that public education becomes fundamental to successful dune restoration at Carters Beach. Beaches and dunes can adapt to climate change impacts if human disturbance does not damage their delicate structures and development does not block their path of retreat. Carters Beach is opportunity to educate the public on the importance of protecting and preserving beaches not only for enjoyment but also for preserving coastal biodiversity as climate changes.

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