Making Room for Movement

A Framework for Implementing Nature-based Coastal Adaptation Strategies in Nova Scotia

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PHOTO: DANIKA VAN PROOSDIJ

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DEFINITIONS

Barrier for NbCA: A factor, obstacle or issue that impedes the path to implementing nature-based coastal adaptation.

Blue carbon: "Carbon captured by the world's ocean and coastal ecosystems" (NOAA, 2021). Tidal wetlands (such as salt marshes) capture carbon during photosynthesis and store it in the marsh soil via roots and buried sediments (Chmura et al., 2012). Carbon capture and storage makes blue carbon ecosystems effective carbon sinks.

Carbon sink: An area or ecosystem that absorbs more carbon dioxide than it releases.

Coastal practitioners: Professionals who work in coastal environments or settings.

Coastal processes: Dynamic environments under tidal influence, where land shifts and re-forms in response to the energy of wind and waves. Wind and water erode, transport, and re-deposit material within the coastal zone. Some coasts are more dynamic than others, allowing for more material to be transported. Coastal processes such as waves, currents, tides and storm surges are natural and only become a hazard when they impact coastal infrastructure, such as buildings, roads, or wharfs that coastal communities depend on.

Coastal squeeze: "The process by which coastal habitats and natural features are progressively lost or drowned, caught between coastal defences and rising sea levels" (Defra, 2003 as cited in Pontee, 2013, p.206).

Coastal zone: The geographic area of coastal land and water influencing each other through natural processes and sometimes intersecting resource management and jurisdictional interests. Geographic and jurisdictional definitions vary widely in spatial extent and precision. The American Coastal Zone Management Act, 1972 (Sec 304 [16 U.S.C. 1453]) defines the coastal zone as "The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches"

Driver or opportunity for NbCA: A factor, outcome or opportunity that makes NbCA more feasible in the eyes of decision-makers and those advising them.

Ecosystem: Organisms interacting with one another and their physical environment, through energy exchange and nutrient cycling, creating an interconnected and sustaining system. Ecosystems occupy geographic space and are influenced by local climate and physical setting. Coastal ecosystems include tidal wetlands (salt marshes and mangroves), lagoons, dunes, reefs, eelgrass meadows, tidal pools and rocky shores.

Ecosystem services: Conditions and processes through which natural ecosystems provide a flow of direct and indirect benefits to people. Services that ecosystems provide include flood protection, water filtration, air purification, and climate regulation, as well as sociocultural services such as places for recreation for physical and mental health, spiritual reflection, education, or aesthetic improvement.

Hard shoreline armouring: Coastal defense approaches that rely on inflexible structures (such as sea walls, rip rap, bulk heads, etc.) to protect the shoreline against erosion, which generally inhibit natural coastal processes and increase coastal squeeze.

Land use: The arrangement and activities of human use of land, including settlement type and pattern, economic development, and cultural activities (e.g., urban to rural, residential, commercial, industrial, recreational, and natural resource development such as agriculture, forestry, mining, or hydropower development activities, among others)

Making Room for Movement: The concept of allowing the space for dynamic coastal processes to take place and for coastal systems to respond.

Marsh body: Dykeland owners who are incorporated as a governing body for an area of marshland according to the Nova Scotia Agricultural Marshland Conservation Act, 2000.

Natural assets: Ecosystems or ecosystem components (e.g., wetlands, floodplains, forests) that provide services valued by society (e.g., recreation, stormwater management, flood mitigation, carbon capture).

DEFINITIONS

Nature-based coastal adaptation: Nature-based coastal adaptation (NbCA) reimagines the human relationship with the natural environment. Nature-based coastal adaptation involves keeping and restoring natural coastal environments and making room for coastal processes and ecosystem migration. Keeping natural coastal environments may require controlling the type of development and coastal alterations along a shoreline and reserving the space for natural processes. Restoring natural coastal environments uses native materials and harnesses natural processes. In some cases, hybrid approaches (which integrate elements of hard engineering and natural materials) may be necessary to allow time for natural systems to establish, or to provide additional protection where vegetation alone may not provide enough protection in areas exposed to high wave energy.

Sea level rise: An increase in the global mean sea level (GMSL) due to contributions of meltwater from mountain glaciers and land-based ice sheets and thermal expansion of the ocean. Some coastlines experience greater or less change in sea level from the global mean due to regional land subsidence or uplift as the earth's crust adjusts to the loss of weight of the glaciers, following deglaciation. Extraction of groundwater, especially in deltas, can also lead to land subsidence and an increase in relative sea level locally.

Soft shoreline protection: Approaches that rely on sustaining natural processes while enhancing coastal resilience with the help of engineering techniques. Such tools include beach nourishment, dune rehabilitation, artificial reefs, wetland (re)creation and other living shoreline techniques. Non-structural protection allows coastal processes to continue, and if designed and implemented well, can help stabilize erosion as well. (van Proosdij, MacIsaac, Christian & Poirier, 2016, p. 14)

Two-Eyed Seeing / Etuaptmumk: "learn[ing] to see from your one eye with the best or the strengths in the Indigenous knowledges and ways of knowing…and learn[ing] to see from your other eye with the best or the strengths in the mainstream (Western or Eurocentric) knowledges and ways of knowing…but most importantly, learn[ing] to see with both these eyes together, for the benefit of all." — Mi'kmaw Elder Albert Marshall (Institute for Integrative Science and Health, 2021).

ABBREVIATIONS

AM - Adaptive management
ARIA - Archeological resource impact assessment
CRM - Cultural resource management
EBM - Ecosystem-based management
ESA - Ecosystem service assessment
ICZM - Integrated coastal zone management
INRM - Integrated natural resource management
MCCAP - Municipal Climate Change Action Plan
MPS - Municipal Planning Strategy
NbCA - Nature-based coastal adaptation
NGO - Nongovernmental organization
NRCan - Natural Resources Canada
NSDA - Nova Scotia Department of Agriculture
NSE - Nova Scotia Environment
NSTAT - Nova Scotia Department of Transportation and Active Transit (now Department of Public Works)
NSTIR - Nova Scotia Department of Transportation and Infrastructure Renewal (now Department of Public Works)
SPPA - Special Places Protection Act
SVI - Social Vulnerability Index

INTRODUCTION

COASTAL AREAS WORLDWIDE ARE experiencing the impacts of climate change. Exposure to sea level rise, tidal and storm surge flooding, and erosion increases the risk of damage to or loss of infrastructure close to the shore (e.g., houses, roads, commercial developments, etc.). Hard engineering solutions such as sea walls or dykes protect built infrastructure from flooding and erosion; however, these structures are temporary fixes that require maintenance over time and can lead to the problem of coastal squeeze. Coastal squeeze is "the process by which coastal habitats and natural features are progressively lost or drowned, caught between coastal defences and rising sea levels" (Defra, 2003 as cited in Pontee, 2013, p.206).

Coastal ecosystems in Nova Scotia are threatened by coastal squeeze. Modern coastal development has intensified in the province through decisions that are either uninformed about or have ignored the inherent risks of coastal locations. Some land and resource development and coastal management practices such as dyking, tidal barrier construction, or infilling, among others, have degraded coastal ecosystems, making them less resilient to climate change and less able to protect the land behind them. Traditional approaches of building hard and inflexible structures (such as seawalls and dykes) to protect property, infrastructure, and land use from coastal flooding and erosion are not sustainable long-term solutions to adapt to climate change. These structures require maintenance or replacement, may break down over time, are static, and can exacerbate the problems they were built to solve. Coasts are dynamic environments where erosion and deposition are normal and sometimes rapid; climate change accelerates and accentuates these coastal processes.

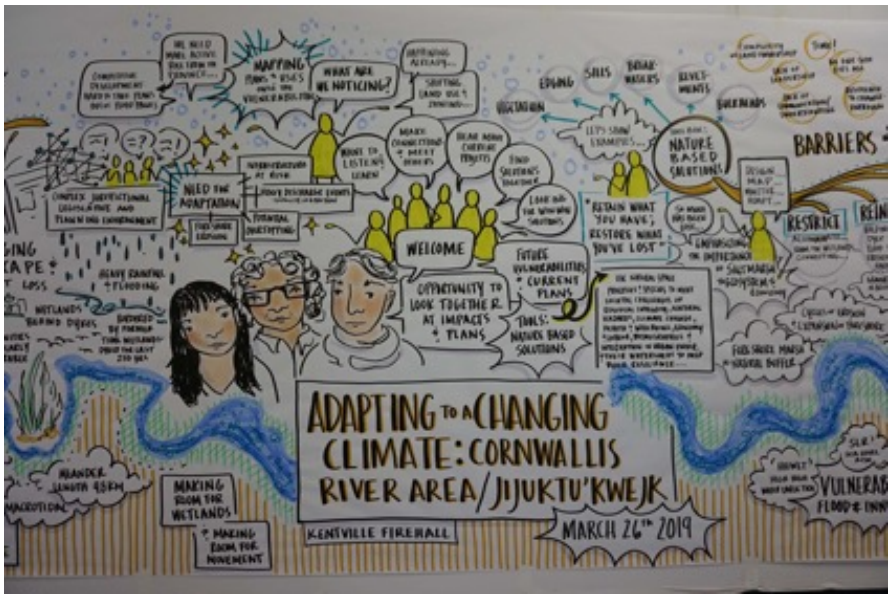

FIGURE 1: Graphic recording of a workshop for Jijuktu'kwejk (Cornwallis River area) showing the complexities of adaptation decision-making in coastal areas.

Nova Scotians are naturally attracted to the coast, but climate change is driving the need to re-imagine a new relationship with this landscape – one where healthy coastal environments protect against the impacts of climate change and where development respects dynamic coastal processes. Decision-makers need tools to help foster this new relationship, tools that work with nature for long-term resilience of coastal regions.

An alternative to managing the coastal impacts of climate change is Making Room for Movement, the concept of allowing space for dynamic coastal systems to sustain themselves through a variety of methods including policy and legislation or soft or hybrid shore protection. These options reduce the impacts of coastal squeeze because they restore or enhance natural features and/or set-back infrastructure to allow more space for coastal processes to take place. By reducing or eliminating the hard barrier on the landward side, there is more space for natural habitats to re-establish, often resulting in increased natural coastal protection.

Allowing for dynamic shoreline movement is an internationally recognized best management strategy to increase the resilience of coastal systems and enhance their protective function. Successfully designed and implemented, nature-based adaptation strategies can provide environmentally and economically sustainable protection against the impacts of coastal flooding and erosion. Using these approaches requires a change in how we understand and use our coastline and coastal environments.

This document presents a framework for Making Room for Movement as an alternative to hard coastal engineering for climate change adaptation in Nova Scotia.

The Making Room for Movement Project and Framework Development

Funded by Natural Resources Canada's Climate Adaptation Program in 2018, the Making Room for Movement framework supports decision-makers and coastal practitioners in selecting NbCA options, over hard engineering solutions, as the first or preferred response to coastal impacts of climate change. A multidisciplinary, multisectoral team of researchers and practitioners studied geomorphic, socio-demographic, cultural, jurisdictional, governance, planning, and regulatory barriers and drivers for using nature-based coastal adaptation and identified strategies for implementation. This evidence-based framework is not a step-by-step guide to designing and implementing NbCA projects; rather, it provides guidance for better aligning planning and decision-making regarding coastal development and resource use with natural systems and processes.

Nova Scotia's geology, climate, tidal range, and settlement history create a diverse coastal landscape. This diversity of coastal places supports exploring a variety of NbCA options within the same planning and governance context. Although developed in the Nova Scotia context, the framework can be adapted for other coastal jurisdictions, particularly in Atlantic Canada given the similarities in coastal environments, settlement patterns, jurisdiction, and governance across the four Atlantic provinces. The guiding principles are universal and therefore widely applicable: working with nature increases resilience to climate change impacts along Canada's Atlantic coast.

Framework development

The framework evolved primarily within the context of Nova Scotia governance, environment, and natural resource management, and community planning systems and through Western and positivist practices for gathering and interpreting knowledge. In developing the framework, the Making Room for Movement research team reviewed scholarly and professional practice literature; conducted focus groups with coastal residents, and workshops, surveys, and interviews with decision-makers and coastal practitioners; conducted policy and plan analysis; and documented case studies of local nature-based coastal adaptation initiatives.

The following sections describe the details of this work and how the findings of each contributed to the framework.

Literature review

In-depth analysis of literature, including scholarly articles and technical reports, and interviews with local practitioners experienced with using NbCA formed the basis for the project-specific investigation of drivers and barriers to NbCA. These investigations also led to peer reviewed publications authored by members of the research team.[1,2,3] Independent peer-review ensures that the framework foundations fit within current international scholarship, best practices, and regional on-the-ground expertise.

Workshops

Research team members conducted workshops at conferences, including Coastal Zone Canada and the Atlantic Planners Institute conferences in 2018, to gain insight into practitioners' perceptions and experiences with NbCA. Participants in these workshops included resource and environmental managers, engineers, planners, landscape architects, and policy makers. The findings from these workshops helped direct the literature reviews and contributed to identifying the barriers and drivers covered in this framework.

Coastal resident focus groups

In early summer of 2019, team members with the School for Resource and Environmental Studies at Dalhousie University collaborated with Narrative Research Inc. to run 14 online focus groups with coastal residents around Nova Scotia. The facilitated focus groups included discussions of climate impacts, approaches and attitudes to NbCA options, and an experimental treatment to determine the most effective way of communicating with residents in promoting an adaptive mindset. Details of this research are available in Krysta Sutton's Master of Environmental Studies thesis (2020)[4].

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[1] Rahman, H.M.T., Bowron, T., Pett, B., Sherren, K., Wilson, A., & van Proosdij, D. (2021). Navigating nature-based coastal adaptation through barriers: A synthesis of practitioners' narrative from Nova Scotia, Canada. Society and Natural Resources. DOI:10.1080/08941920.2021.1940405

[2] Rahman, H.M.T.; Sherren, K.; Manuel, P.; Rapaport, E., & van Proosdij, D. In Review. Characterizing barriers to nature-based coastal adaptation approaches. Wiley Interdisciplinary Reviews: Climate Change

[3] Rahman, H.M.T.; Sherren, K. and D. van Proosdij. (2019). Institutional innovation for nature-based coastal adaptation: lessons from salt marsh restoration in Nova Scotia, Canada. Sustainability 11, 6735. DOI:10.3390/su11236735

[4] Sutton, K. (2020). Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

Coastal practitioners and decision-maker survey and interviews

Coastal practitioners and decision-makers work in coastal environments or settings and address or manage coastal environmental protection or issues arising from coastal land use and development. They work in local, provincial, or federal government, Indigenous organizations, NGOs, academia, and private industry. Between summer 2019 and winter 2020, researchers at the School of Planning, Dalhousie University conducted a survey of decision-makers and coastal practitioners in Nova Scotia (73 respondents), followed by interviews (21 participants) to gauge knowledge, perceptions, and experience with NbCA, and to identify barriers to and drivers for, implementation. The survey and interviews informed the Nova Scotia-specific focus of the Making Room for Movement framework.

Case studies of NbCA in Nova Scotia

The research team developed case studies of NbCA in different coastal contexts around the province, covering wetland restoration, dyke realignment, living shorelines, dune stabilization, and letting nature take its course. These studies of small and large initiatives demonstrate partnerships and engagement, a willingness to experiment with new techniques and lead by example, and decisions that acknowledge the long-term costs of trying to immobilize a dynamic coast. The case studies informed the development of the framework and illustrate it. The case study reports are available as stand-alone documents accessible through online links, or as published articles in scholarly journals.

Framework organization

The framework is organized into four sections:

1) **Setting the Stage:** This section describes the spectrum of soft to hard shoreline protection approaches, outlines NbCA options that can be, and are, used within Nova Scotia, and describes how this framework fits within existing management strategies. This overview provides the necessary background for anyone beginning their journey into understanding alternative options for coastal management and adaptation to climate change impacts.
2) **Guiding Principles:** This section outlines the seven guiding principles for implementing NbCA, providing insight for ensuring sustainable and equitable development and protection of coastal processes and biodiversity.
3) **The Five R's:** This section provides an overview of climate change adaptation approaches which are aligned with NbCA: Reimagine, Reserve, Relocate, Realign, and Reinforce. The description of each approach includes identifying the NbCA options that work within the Nova Scotia context.
4) **Considerations and Strategies for Implementing NbCA:** This section describes place (e.g., geographical, historical, cultural, and political contexts) and governance contexts and strategies to consider when implementing NbCA.

Throughout the framework, descriptions of projects around the province highlight locally relevant examples of planning, designing, implementing, and managing nature-based coastal adaptation to climate change.

Setting the Stage

Introduction to the spectrum of soft to hard shoreline protection approaches

A variety of terms describe softer, more natural approaches to coastal management and engineering, including natural infrastructure, green infrastructure, and nature-based solutions. Each term has a specific definition; however, the general idea is that natural approaches (such as living shorelines, managed realignment, ecological restoration, etc.) work like, or in combination with, traditional hard or grey engineering solutions (such as dykes, sea walls, breakwaters, etc.).

This report focuses specifically on NbCA, which involves reimagining the human relationship with the natural environment and keeping and restoring natural coastal environments to make room for coastal processes and ecosystem development and migration. The crucial element of natural solutions is that they offer additional benefits of ecosystem services while maintaining built infrastructure and reducing coastal vulnerability.

Table 1: NbCA Options and Descriptions (page 5) presents nature-based coastal adaptation options suitable for, or already used in, Nova Scotia. This framework focuses on soft shoreline protection but as shown in Figure 2 (page 4), there are coastal protection options ranging from harder to soft approaches with hybrid solutions falling somewhere between these two.

Natural infrastructure solutions are founded in the best available science and engineering and can range from fully natural solutions (such as creation or restoration of wetland or flood plain) to hybrid or more engineered solutions (such as managed

realignment or retention ponds) (Bridges et al., 2015; Insurance Bureau of Canada, 2018). Examples of options along the spectrum used throughout Europe and North America provide evidence to support using similar options along the east coast of Canada.

Selecting a nature-based option or options for any given setting and situation requires consideration of the biophysical environment which includes physical exposure, coastal type, sediment supply, ecosystem sustainability, and time. Land use policies, planning, and regulation further influence the decision of which option to use; political and public values and perceptions of risk influence implementation (Manuel et al., 2016) (Figure 2).

Nature-based coastal adaptation

NbCA recognizes the dynamic nature of the coast and works with natural processes and ecosystems to balance human activities with the natural environment. The approach of working with nature rather than against has gained support and recognition nationally throughout Canada (Moudrak et al., N., 2018) and internationally (Cohen-Shacham et al., 2016). NbCA involves protecting and restoring coastal processes and habitats, and adjusting land uses and behaviours where necessary for the long-term benefits to society of healthy coastal ecosystems and a shoreline that can better adapt to climate change impacts.

There are many options for nature-based coastal adaptation. Some approaches involve reestablishing a natural coast while others involve measures to maintain the one already there. Some approaches integrate upland and coastal management. The approaches in Table 1 (page 5) are appropriate for Nova Scotia coastlines, some of which are already in use. Appendix A: *Additional Resources* provides more information on these and other NbCA approaches used internationally.

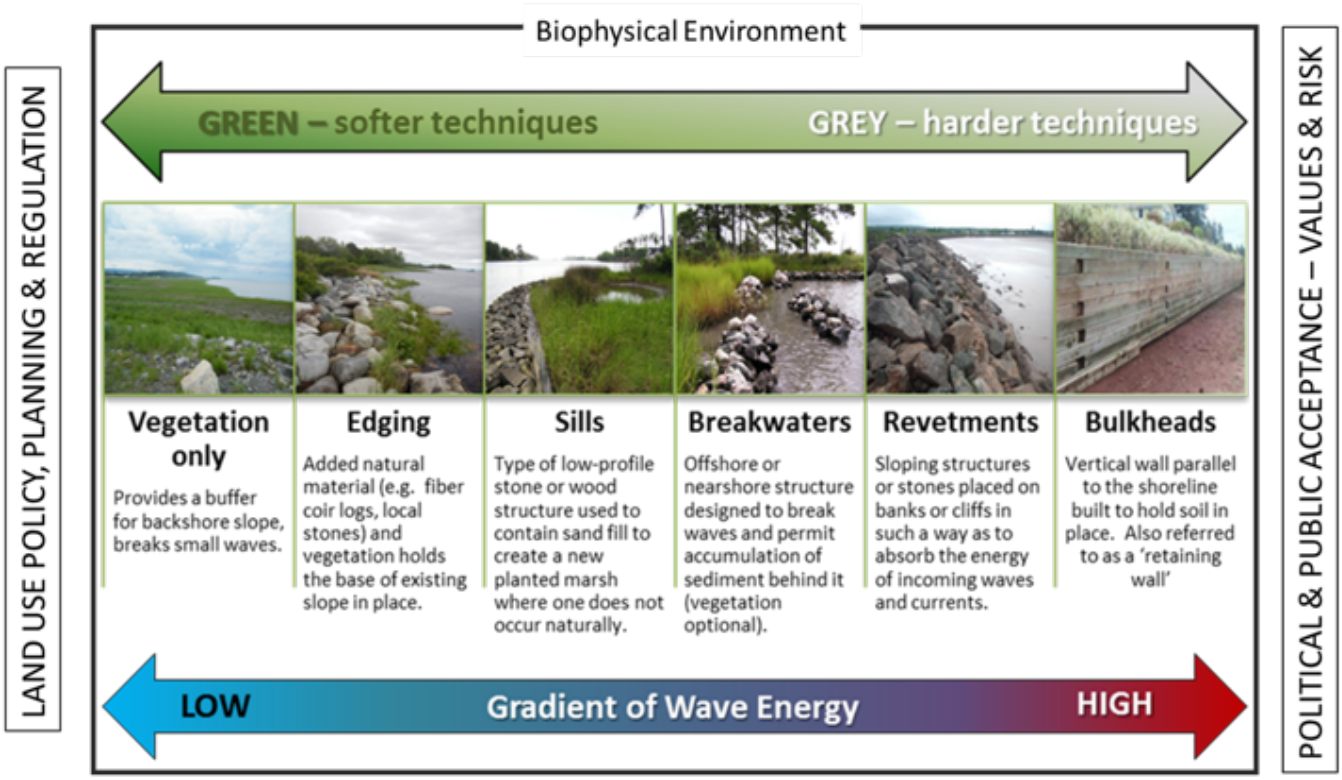

FIGURE 2: Continuum of green (soft) to grey (hard) shoreline protection techniques. Modified from Guidance for considering the use of living shorelines, NOAA (in van Proosdij et al., 2016)

TABLE 1: NbCA Options and Descriptions

NbCA options	Descriptions
Coastal upland and backshore approaches	
Stormwater management	An integrated approach to collecting, slowing down, absorbing, and controlling the flow of excess runoff. It uses a combination of site design (grading for proper drainage) and engineered and natural infrastructure. Natural elements include constructed and natural wetlands, bioswales, rain gardens, green roofs, and vegetated buffers, which reduce and/or slow down runoff toward the shore.
Bank stabilization	Treatments that increase the stability of coastal banks such as regrading or terracing combined with planting native vegetation.
Living dyke	A dyke with a long, shallow slope on the seaward side that allows space for a salt marsh to develop. The salt marsh absorbs wave energy before it can impact the dyke, thereby protecting the dyke. The salt marsh also provides additional ecosystem services (West Coast Environmental Law, 2018).
Foreshore and offshore approaches	
Living shoreline	A group of approaches that use natural materials, shellfish, and plants to mimic natural coastal ecosystems and allow naturally occurring processes while providing protection for property and land use. Hybrid living shorelines combine hard structures (e.g., rock sills, perhaps with oysters) with soft materials and plants to provide protection in higher energy environments.
Salt marsh restoration	Salt marsh restoration involves reintroducing or increasing tidal flow to areas where it has been blocked or restricted. Restoring tidal flow can involve removing dykes and aboiteaux (one way tide gates) or relocating and reshaping a dyke landward, thereby making space in front of the dyke for tidal flooding, or resizing culverts or replacing them with bridges. Allowing tides to return supports conditions for redevelopment of salt marsh morphology and vegetation.
Dune restoration	Building or restoring dunes by collecting blowing sand around sand traps. Traps can include planted dune vegetation (such as marram grass) or woody material like old Christmas trees (that will disappear beneath the accumulating sand and decompose). Erecting fences in certain areas can help to maintain the dunes and discourage trampling. (Leys and Bryce, 2016).
Beach nourishment	The deliberate placement of sand material (offshore source or dredge) on the beach or within the littoral zone, allowing natural coastal processes to re-distribute sediment within the littoral cell. A littoral cell is a natural coastal compartment within which sediment is transported from source (erosion) to sink (deposition).
Oyster reefs	A ridge or shoal made up of oysters. Oysters show a tendency to cluster on old oyster shells and rocky surfaces to form a 'living' or biological reef-like structure. Reefs reduce wave energy, which minimizes coastal erosion. They also provide habitat for many nearshore fish and other marine creatures. Oyster reefs support seagrass vegetation, and together they help protect coastal areas from erosion and flooding.
Eel grass restoration/ seagrass beds	Submerged coastal vegetation that reduces wave energy and protects coastal areas from erosion and flooding. Seagrasses trap sediments and settle the seafloor through their extensive root systems. Seagrass meadows are habitats for many marine species.
Managed realignment/ dyke realignment	Moving dykes inland or altering the existing dyke alignment to allow for regular tidal flooding and making space for natural habitats such as salt marshes. These habitats, in addition to supporting biodiversity, protect the dyke and the land uses behind it by absorbing wave energy and accommodating flood water.

Nonstructural approaches	
Land use regulation	A legal and policy tool that controls development in coastal areas vulnerable to flooding and erosion. By keeping development at a safe distance from the coastline, land use regulation reduces the risk of damage to property and loss of lives caused by coastal flooding and erosion. It also preserves natural coastal protection and habitat as well as biodiversity.
Managed retreat	A planned and pre-emptive withdrawal of people and infrastructure from flood-vulnerable coastal areas. Next to land use regulation, retreat is one of the lowest-risk techniques to reduce coastal damage, although it often faces community opposition for social, cultural, psychological, and economic reasons. Strategies such as land buyouts and land swaps may be employed to encourage property owners to relocate.
Flood mapping	An action that identifies and maps flood-vulnerable coastal areas. Flood mapping uses historical data to generate storm or coastal events of a specific magnitude (e.g. 1 in 100 year event) and models them on the site topography with flood mechanisms (e.g. tidal amplification, run-up, ice jams, impact of structures) to delineate potential flood extents in various conditions. With changing climate and sea level rise, new flood mapping incorporates projected future flooding based on the latest climate science. Flood mapping guides decisions about the placement of future infrastructure.
Coastal erosion hazard and risk assessment	An assessment of the susceptibility of a shoreline to erosion and the risk posed to infrastructure and land uses by the projected retreat of a section of coastline, over a specified period of time. Erosion is a natural coastal process that becomes a hazard only in the context of the risk it poses to exposed coastal land use. Assessment accounts for the materials composing the shore (e.g., geology, sediment, soil); the coastal geomorphology, including the slope and the shape of the coast affecting exposure to storms and waves; wave energy and natural or engineered coastal structures providing protection; historical and modern evidence of erosion patterns, including gradual erosion and episodic rapid erosion such as slope failures, and rates of erosion; and evidence of impacts on existing infrastructure and land use and response (e.g. exposed pipes or foundations, buildings abandoned or moved back from the shore, shoreline armouring). The assessment informs coastal management and regulations that control development in erosion-prone locations. For an overview of the steps and an example of coastal erosion hazard and risk assessment see Woolfe, 2017.

Nature-based solutions are increasing the alignment between conservation and sustainable development objectives (Cohen-Shacham et al., 2019). However, there needs to be a clear understanding of how nature-based solutions are related to existing approaches. With its natural systems approach, the Making Room for Movement framework can operate within well-established planning and management strategies that are grounded in knowledge of environmental systems and responsive to environmental processes. Such approaches support human activity adapting to the local natural environment rather than attempting to control it. They include but are not limited to integrated natural resource management (INRM[5]), integrated coastal zone management (ICZM), ecosystem-based management (EBM), and adaptive management (AM[6]), as described on page 7.

[5] Also called integrated resource management (IRM)

[6] Also called adaptive co-management

Integrated natural resource management (INRM)

Integrated natural resource management is a process of coordinating and directing the many aspects of resource development and use, including biophysical, social, political, economic, and institutional factors to achieve the goals of specific users as well as wider societal objectives (Margerum et al., 1995). INRM builds a strategy by drawing from diverse knowledge sources of complex systems and monitors those systems in order to assess the performance of the management strategy (Council of Canadian Academies, 2019).

Integrated coastal zone management (ICZM)

Integrated coastal zone management is a process for planning and managing coastal resource development and use of coastal space among overlapping jurisdictions, competing interests, and the sensitive and dynamic coastal environments (Cicin-Sain et al., 1998; Salamons et al., 1999). The definition of ICZM provided by the European Commission (1999) is especially relevant to climate adaptation and implementing NbCA: "ICZM is a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones. ICZM seeks, over the long-term, to balance the benefits from economic development and human uses of the Coastal Zone, the benefits from protecting, preserving, and restoring Coastal Zones, the benefits from minimizing loss of human life and property, and the benefits from public access to and enjoyment of the Coastal Zone, all within the limits set by natural dynamics and carrying capacity."

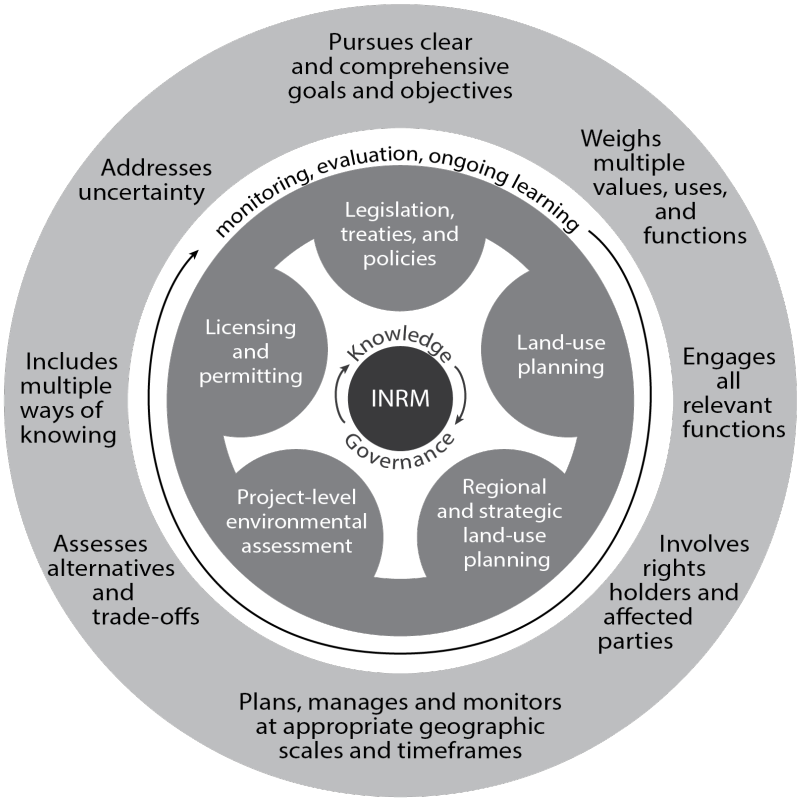

FIGURE 3: Continuum of Integrated natural resource management decision-making. Modified from Council of Canadian Academies, 2019

Ecosystem-based management (EBM)

Ecosystem-based management applies a whole-systems, place-based approach (O'Higgins et al., 2019; Olesen et al., 2011) to managing human uses of and interactions with natural environmental systems at scales that incorporate use impacts (Lackey, 1998). Ecological criteria (ecosystem complexity, ecosystem change across spatial and temporal scales) are considered with human economic, social, and governance criteria through management and decision-making frameworks that are adaptive, interdisciplinary, collaborative, and participatory (Frazão Santos et al., 2014; O'Higgins et al., 2019; Stephenson et al., 2021). The larger and more dynamic the management area of interest, the more complex are the system and management considerations. Coastal environments are complex because of the land-sea interface: coastal ecosystems are adapted to extreme environmental gradients with additional pressures from human development and jurisdictional overlap. Adaptation approaches must be responsive and adaptive to the dynamic coastal environment and also to the uncertainty in predicting coastal environmental response as climate change progresses.

Adaptive management (AM)

Due to the uncertain nature of sea level rise and ecosystem response to climate change, the management of coastlines needs to be adaptive. Adaptive management is a structured, repetitive process of decision-making, aiming to reduce uncertainty over time by monitoring systems through on-going observation and data collection, learning from system response, and adapting the man-

agement strategy to accommodate system change. In this way, decision-making simultaneously meets current objectives and accumulates information needed to improve future management. The knowledge gained through monitoring a project for the impact of policies and strategies is translated into improving future decision-making. In Nova Scotia, most tidal wetland restoration projects have been for habitat compensation (offsetting highway construction) which have formally included one-year pre- and five-year or post-restoration monitoring (Bowron et al., 2012). This monitoring has provided the opportunity to prevent potential maladaptive trajectories and evidence of positive effects of adaptive management in improving restoration outcomes. One example is the Belcher Street marsh dyke realignment and marsh restoration project (Figure 4).

FIGURE 4: Rill connecting ponded area to existing drainage network before (left) and after (right) adaptive management. Graham et al., 2020

Example of using adaptive management (AM) in Nova Scotia

In 2017 CBWES Inc. was commissioned by the Nova Scotia Department of Agriculture (NSDA) to develop a managed dyke realignment and floodplain (tidal wetland) restoration plan for the Belcher Street marsh, located in Kentville, Nova Scotia, along the Jijuktu'kwejk (Cornwallis) River. In 2018, after baseline monitoring and restoration designs were complete, the dyke at this managed realignment site was breached as a part of the Department of Fisheries and Oceans-funded Making Room for Wetlands project through TransCoastal Adaptations: Centre for Nature-Based Solutions at Saint Mary's University.

As a site adjusts to the reintroduction of tidal flooding and finds a new equilibrium, some areas may not respond as initially anticipated. Post-restoration site monitoring identified two areas that were not recovering in the desired way. In one area, water was ponding near the toe of the dyke; in a second area near the root wad living shoreline, the elevation was lower than the surrounding marsh surface resulting in rill formation and scour from the concentration of surface flow and preferential drainage across the living shoreline.

Both conditions posed a risk to the dyke's stability and to the recovery of the foreshore marsh. Assessments for each area led to adaptive management actions to alleviate risk. Adaptive management techniques for this site included:

- hand-digging a channel (runnel) to connect the pond to the larger drainage network at the back of the site. The runnel reduced the amount of trapped water, which should improve re-vegetation and soil stability (Figure 4).
- planting small coniferous trees to reduce the speed of water flowing across the living shoreline and to increase sediment buildup on the marsh surface. The trees filled gaps in the root wads, and wattle fencing and brush mats were combined with transplanted marsh vegetation. The adjustment should increase the elevation of the marsh surface behind the root wads to match the surrounding marsh surface thereby reducing preferential drainage and rill formation (Figure 5). (Graham et al., 2020) *Additional details are available here.*

FIGURE 5: Adaptive management at Belcher Street managed realignment site – scour around root wads (top left); adaptive management at root wads, 23 July 2019 (top right); sediment deposition behind root wads, 8 August 2019 (bottom left); adaptive management with wattle fences, transplants and brush matting (bottom right). Graham et al., 2020

GUIDING PRINCIPLES

THE IMPLEMENTATION OF NATURE-BASED solutions and NbCA are most effective when there are clear guiding principles and relationships with related approaches (Cohen-Shacham et al., 2019). The IUCN (International Union for Conservation of Nature and Natural Resources) recently released global standards for nature-based solutions (IUCN, 2020) which include a user-friendly framework for the verification, design, and scaling up of nature-based solutions. Their framework is built on the core principles outlined by Cohen-Shacham et al., 2019 of conservation; synergies; site specific context; transparency and broad participation; diversity and evolvement over time; landscape scale; trade-offs; and policy integration.

Guiding principles need to be locally relevant and resonate with decision-makers and practitioners who will use them. Key themes emerged out of the literature studies, decision-maker and practitioner surveys and interviews, coastal resident focus groups, and local case studies that became seven guiding principles for the Making Room for Movement framework (Figure 6). These principles support NbCA decision-making for long-term, sustainable and balanced development and protection of natural coastal systems along Nova Scotia's coastline:

1. Bridge knowledge systems
2. Preserve biodiversity and dynamic coastal processes
3. Restore coastlines using natural processes and materials
4. Seek ecosystem service co-benefits
5. Use a just transition approach
6. Foster shared interest and responsibility
7. Avoid maladaptation

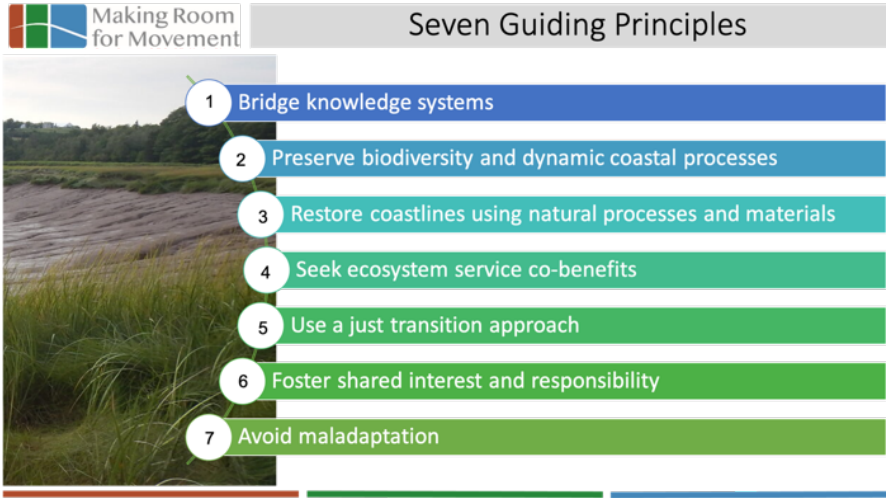

FIGURE 6: Seven principles of Making Room for Movement

1. Bridge Knowledge Systems

> *"...we learned from a traditional, community knowledge point of view... that tidal barriers were significant in this region because there was a lot of knowledge shared around how in the '60s and '70s...the province replaced a lot of bridges over existing estuarine waterways in the region and a lot of that was replaced...with culverts. And there was a very obvious decrease within the region, and apparent through Mi'kmaw community members' eyes, that there were changes to the coastal ecology just resulting from that... That had a huge impact on Mi'kmaw communities in the region and that had a direct effect on income for those families and traditional activities in the region."*
>
> — *Interview with NGO participant*

> *"Everybody was a source of information."*
>
> — *Interview with local government participant*

When we bridge knowledge systems about coastal processes and coastal adaptation through mutual learning, we build a more complete understanding of our environment and trust for implementing NbCA (Lebel, 2013; Rahman et al., 2019). Each of us has knowledge and experience we can contribute to the process. Local citizens have expertise from their lived experiences of the landscape and community history. They can share observations, records, journals, maps, stories, and photographs of landscape development, use, and change. Mi'kmaw ways of knowing offer critical relational understandings of human interactions with the natural world, largely seeing human–nature relationships as reciprocal. These knowledges have been developed through highly integrated relationships with the land and water over millennia. Mi'kmaw relational worldviews can be demonstrated by Netukulimk. As described by the Unama'ki Institute for Natural Resources (UINR) (Netukulimk | Unama'ki Institute of Natural Resources (uinr.ca)), Netukulimk binds the right to use

the resources of nature for self-support and community well-being with the responsibility to do so wisely, guided by Mi'kmaw knowledge and traditions, and to honour the creative force through which all things are linked. Sustainability is a shared principle between Mi'kmaw and Western approaches, but with different roots and traditions. Etuaptmumk – Two-Eyed Seeing – offers a framework and philosophy to connect the perspectives by leveraging the strengths of Indigenous and Western knowledge and ways of knowing for mutual benefit (Bartlett et al., 2012; Institute for Integrative Science & Health, 2021).

To increase the likelihood of sustainable and just management, practitioners and governments must respectfully and appropriately integrate the communities, cultures, and knowledge systems that may be affected by a shift in coastal management approaches. Trust and common understanding require early, meaningful, and on-going communication and engagement through partnerships, and many and diverse ways of knowledge sharing when designing the management approaches or transitions. Community trust of practitioners and governments may be strengthened by clearly and publicly outlining/stating how NbCA decisions and outcomes integrate the appropriate knowledge systems.

Questions to Consider when bridging knowledge systems

- *Have all those potentially affected come to a consensus on the problem or issue?*
- *Are we open to integrating knowledge that we may not have experience with? OR: How will we build our capacity to integrate knowledge that we may not have experience with?*
- *How can we ensure that any relevant local or Indigenous knowledge is integrated into the project in a meaningful way?*
- *Have we represented and integrated the appropriate knowledge systems through consultation or partnership with those who may be impacted?*
- *What are the opportunities in this work for local area residents and representatives of Indigenous communities to join our team, or form a committee to guide government decisions and coastal management practices?*
- *Do we have the resources within our team to engage with local and Indigenous peoples effectively and gain from their knowledge? If not, who could we partner with or hire to support engagement? OR: How can we manage our resources to engage in partnership when appropriate/necessary/important with local and Indigenous stakeholders?*

EXAMPLE

In 2017, The Confederacy of Mainland Mi'kmaq (CMM) Mi'kmaw Conservation Group set up the Artificial Reef Project to build capacity for coastal management within the CMM member communities. This nature-based approach aligns with traditional Mi'kmaw land and resource management principles. The project prepares communities to participate in and lead coastal restoration initiatives by enhancing marine habitat using reef balls along sections of the Northumberland Strait shoreline. In the coming years, the community will also monitor the reef balls through youth education and community training initiatives.

Combining knowledge systems was a key aspect of this project with partners that included Mi'kmaw communities (Pictou Landing First Nation), NGOs (the Clean Foundation, Restore America's Estuaries, Tampa Bay Watch, the Chesapeake Bay Foundation, and the Reef Ball Foundation), and industry (COJO Diving and CB Wetlands and Environmental Specialists).

Additional details are available here.

FIGURE 7: Mi'kmaw Conservation Group (MCG) Coastal Restoration Fund team at the construction site with their first reef ball. Photo: MCG

2. Preserve Biodiversity and Dynamic Coastal Processes

"...one of the things that really struck me after some of the big hurricanes that hit the eastern seaboard in, say, the last decade – Andrew and some of these – were these before-and-after air photos of headlands that were forested versus headlands that were cleared, and the huge difference between the level of impact and damage..."
— Interview with provincial government participant

"...currents in the ocean move perpendicular to the shore, and they move along the shore... The minute you put something structured in there, you stop that natural ebb and flow of sand..."
— Interview with NGO participant

Nature-based coastal adaptation adheres to the principle that healthy, diverse, functioning coastal ecosystems have the capacity to self-adjust and are resilient to natural disturbances such as storms. Making room for, and working with, coastal processes is the foundation of NbCA. Coastal systems are dynamic and need room to move in response to storms and rising sea levels.

Coastal systems range from slowly eroding rocky cliffs and headlands to lose, migrating coastal features, such as dunes, beaches, spits, and bars, that form because of current and wave forces. Sediments of varying size are carried to the sea by rivers or eroded from cliffs and bluffs. Tides, currents, waves, and wind move these sediments into adjacent areas. Dunes and sandy beaches, for example, go through cycles of losing and gaining sand depending on the season. Storm waves drag sediment off the beach into deeper water where it is stored in submerged bars near shore; the beach rebuilds when smaller waves return the sand during calmer weather. A continuous supply of sediment is essential for the creation and maintenance of beaches, dunes, and marshes. A wider beach facilitates sand transport by wind into the dune systems behind it. Vegetation within the dunes or tidal wetland help trap and build up sediment. Most of these systems also depend on the movement of sediment by water moving along the shore, a process called "longshore drift." The integrity and connectivity of coastal processes are key for maintaining heathy coastal ecosystems. Regular inputs of sediment to tidal wetlands helps these environments build elevation and keep up with rising sea level. Unobstructed movement of tidal waters over marsh grasses and within tidal creeks helps keep vegetation healthy and provides fish habitat. Biodiversity increases habitat value and the ability to recover from disturbance.

FIGURE 8: Salt marshes not only create habitat for fish, birds and other wildlife, they also act as a buffer from storm surge and wave action. Salt marshes are resilient if they are given the space to adapt to coastal changes. Photo: CBWES Inc.

Questions to Consider when planning adaptation

- *What is the character of the coast where we will work (natural or developed; low-lying or elevated; bluff or cliff; rocky, cobble, gravel, sandy shore or mudflats, or a combination of these materials; protected or exposed)?*
- *What are the coastal/riverine processes that maintain or degrade that character?*
- *What coastal adaptations are consistent/resilient with those processes?*
- *Is there a sediment supply available to support the natural system we are working within over 10, 50 or 100 years?*
- *Are structures like groynes, seawalls, or revetments (retaining walls) preventing sediment transport along the shore (longshore drift)?*
- *What are the coastal ecosystems common to this shoreline that can be preserved or provide examples (i.e., reference sites) for coastal restoration?*
- *What is the size and extent of the coastal ecosystem we are working within?*
- *How much room is available landward for the coastal ecosystems to migrate over time?*
- *What is the risk to land use of flooding or erosion (e.g., high/immediate or low/gradual?). What is the value of development at the coast (high, moderate, low)?*
- *How much time does the restoration need to take hold? What is the anticipated lifespan for our project?*
- *How will we know in future years if we made the right decision?*

EXAMPLE

The Cheverie Creek saltmarsh restoration project was the first planned saltmarsh restoration project implemented in Nova Scotia. Cheverie is located on the Kempt Shore of the Minas Basin. The restoration involved replacing a small wooden culvert under a causeway on Highway 215 with a larger sized aluminum culvert that allows tidal water to flood the saltmarsh behind the causeway. The project began in 1999 and involved a multi-year pre-restoration monitoring program, along with public engagement and education. The construction of the project took place in 2005, followed by seven years of post-restoration monitoring. The site has evolved to 43 hectares of wetland with low-to-high marsh habitat that is characteristic of Bay of Fundy saltmarshes (Bowron et al., 2012). Following restoration, volunteers of the Cheverie Crossway Salt Marsh Society built one kilometer of trail, which winds through the forest along the marsh edge. The society also uses the site for education purposes to teach about saltmarshes and promote the restoration project. (NS Trails, 2020)

Photo: Cheverie Salt Marsh Trail (cioc.ca)

3. Restore Coastlines Using Natural Processes and Materials

"... if we're looking at it on a larger scale, we have biodiversity loss, we have habitat disconnect between inland, marine, intertidal – all that. It's a whole system, so moving forward we have to highlight [what] that system creates... make sure that we are putting nature at the forefront of our planning along the coast."

— Interview with NGO participant

"...they're alive, they evolve... this is a bit of a shift in thinking from the hard engineering world."

— Interview with provincial government participant

Using native, natural materials including plants, woody debris, oysters, and sediments that are compatible with local geology (e.g., mud, sand, gravel, or cobble) and physical processes mimics natural habitats. Using natural processes such as currents to re-distribute sediment helps with the natural sorting of grain sizes and therefore faster establishment of a well-balanced coastal form. In some situations (e.g., high energy shorelines, shorelines with vulnerable infrastructure), a hybrid approach may be appropriate, combining hard and soft components to support the growth of a more natural coastal feature over time. Examples in higher energy conditions include using a concrete reef ball to create or restore marine habitat or planting native marsh grasses in specially designed grouted or block revetments for a living shoreline (Scheres & Schüttrumpf, 2019). Using natural materials and native species also provides benefits to physical and mental health and well-being that come from visiting and enjoying healthy, natural environments.

CASE STUDY

In August 2019, the town of Shelburne installed a living shoreline to reinforce an existing slope between low-lying armour shoreline and a parking lot. The Shelburne living shoreline project restored approximately 15 metres (93m^2) of shoreline (Stewardship Centre for BC, 2020) using logs, hay bales, and native vegetation to naturalize the area. A log border was placed around the parking lot to prevent cars from driving on the newly restored area. Hay bales were used to limit wave scouring, absorb highest high tide flows, deflect wave and wind energy, and provide nutrients. The restoration created four vegetation zones. The first zone closest to the parking lot consists of herbaceous perennials, flowering perennials, and small, fruit-bearing shrubs, primarily for visual appeal. A second zone consists of medium-sized shrubs to increase plant diversity and natural habitat. The third zone of large shrubs protects the vegetation behind it from wind and wave action. A transition zone next to the water consists of salt-tolerant grasses and perennials. The goal for the living shoreline is that it will become self-sustaining within about five years after installation; the only maintenance required will be pruning of the shrubs to maintain a desired size and for their health.

Additional details are available here.

FIGURE 9: Before (March 2019) and after (July 2020) implementation of a living shoreline in the town of Shelburne. Photos: CBWES Inc.

Questions to Consider when planning adaptation

- *What is the character of the coast where we will work (natural or developed; low-lying or elevated; bluff or cliff; rocky, cobble, gravel, sandy shore or mudflats, or a combination of these materials; protected or exposed)?*
- *What are the coastal/riverine processes that maintain or degrade that character?*
- *What coastal adaptations are consistent/resilient with those processes?*
- *How will our adaptation choices impact biodiversity and the natural environment in 10-, 50- or 100-years' time?*
- *Are there appropriate local materials (sediments, rocks, vegetation) that can be recovered from a site that is going to be destroyed within the same region? (e.g., from development activities where a natural habitat is already being disturbed)*
- *Are we selecting plant species that are resilient to climate change?*
- *What can we monitor to track the success of this adaptation?*

4. Seek Ecosystem Service Co-benefits

"...a nature-based approach really, to me, starts with a fundamental understanding of how a natural system works and having a good appreciation for what the limitations of that are and what the benefits of that are and how we interact with, really, the nature...and then from that understanding, building on that...to kind of capture and harness the benefits and some of the strengths of natural infrastructure."

— Interview with private industry consultant

Ecosystem services are the benefits that human society derives from ecosystems. These benefits are directly related to the quantity and quality of the ecosystem's natural assets[7] that are providing the services. Ecosystem services are the link between human well-being and the well-being of the environment. Ecosystem services are typically divided into four categories: provisioning[8], regulating[9], cultural[10], and supporting[11] (Millennium Ecosystem Assessment, 2005). Some jurisdictions recognize ecosystems as natural assets in their asset management plans.

As ecosystems are increasingly degraded or replaced by human infrastructure, the services they provide are also degraded or need to be replaced by technological solutions. Adaptation measures that use hard infrastructure tend to maintain only the ecosystem services that have direct market value and tangible uses and may compromise other ecosystem services; therefore, unintended negative economic and social impacts can result (Braat and de Groot, 2012). In addition to considering the risk of degradation, an important guiding principle in NbCA is to seek out and prioritize opportunities for ecosystem service co-benefits, i.e., projects that provide multiple services that benefit nature while meeting social and economic demands.

When compared to hard shoreline protection, such as armour stone, NbCA projects typically have numerous co-benefits for people and the environment beyond the primary purpose of the project. Soft or hybrid shoreline protection can provide additional economic co-benefits such as habitat for commercial and recreational fish, recreational opportunities, aesthetic improvements, carbon sequestration, and water purification. The ecosystem services concept is a tool to identify, communicate, and quantify the benefits of NbCA projects to people. This information supports public outreach and decision-making to encourage the implementation of NbCA.

Questions to Consider when planning adaptation

- *What are the opportunities to provide benefits beyond our immediate priorities?*
- *Do the options we are considering have negative impacts on the social and environmental systems that we aren't directly trying to influence? If so, what are the impacts and how do we control or remove them? What other options are available?*
- *Who are the stakeholders that are affected by this project and are they positively or negatively affected?*

FIGURE 10: Project rendering for a living shoreline concept in Mahone Bay (CBLC Limited, 2016)

CASE STUDY

The town of Mahone Bay has long faced threats of coastal flooding and erosion to the main road into the community along with the associated land uses and valued cultural assets. Rather than defaulting to the traditional hard armouring approach, the town recognized the co-benefits of using a living shorelines approach to address the issue. The town commissioned a study and subsequent design for a fringing marsh, supported by a low rock sill with small pocket beaches at the gaps in the sill. The adjacent site design includes a walking trail along the top of the marsh. The town was motivated to use this NbCA approach because of the array of co-benefits which include increased shoreline protection, habitat creation, aesthetic enhancements to the waterfront, improved public access, and recreational opportunities. In addition, the salt marsh vegetation dampens the waves coming into the shore; the lower wave heights then allow for a lower path elevation which preserves more of the waterfront views. The living shoreline installation began in 2021 along a section of the shore; if built to the full extent, it will run along 700 metres of the town's shoreline. *Additional details are available here.*

[7] Natural assets describe ecosystems or ecosystem components (e.g., shorelines, wetlands, green spaces) in terms of their value to society (e.g., nutrient cycling, rainwater drainage and flood mitigation).
[8] Such as food, fiber, fuel, etc.
[9] Such as mitigating erosion, flood regulation, etc.
[10] Such as recreation, aesthetic, educational, etc.
[11] Such as soil formation, nutrient cycling, etc.

5. Use a Just Transition Approach

"A lot of people can't afford 25K or 30K. That's what we've been quoted to if we wanted rock in front of our place. That's a lot of money too, and there's people on other sides that have done that and they're still doing it. They did it 10 years ago, they've done it five years ago. Maybe this year they won't have to but maybe in another five years they'll have to do it again. I'm retired, my husband's retired. We don't have big money like that to just sink into it. Like, we live in a community of a lot of cottages but we're permanent residents here and it's discouraging when you see some of the stuff people do and they don't even think about what it's doing."

— Coastal resident in focus group

"You have your scientists, you have natural resources, you have infrastructure experts. Financially, is it going to be feasible? Are you going to give us a financial option to go somewhere else? Because a lot of people in my area can't do that. You just can't pick up and move somewhere else. It costs money."

— Coastal resident in focus group

A just transition is one that considers all the people who might be affected by the adaptation in question. We cannot avoid change from climate shifts, just as we cannot stop changes resulting from economic restructuring or technological advancements, but we can pay attention to equity in making decisions and designing related processes. Justice has many dimensions that are relevant when it comes to NbCA. We must pay attention to power relationships that exist in any given setting, whether these are related to income, race, gender, language, status (such as citizenship), age, ability, or any interaction of these (what is often called "intersectionality").

When we make decisions around coastal adaptation, we can make inequities worse unless we pay particular attention to them. For instance, real estate markets can drive less well-off homeowners to live in higher-risk places such as floodplains. The economic value of those homes, compared with more expensive homes also located in high-risk areas, may lead to a decision to relocate homeowners in poor areas but to defend rich areas with infrastructure (Siders & Keenan, 2020). Some NbCA options may actually cause what has been called "eco-gentrification," where the greening of residential landscapes leads to increases in real estate value that then excludes those who have traditionally lived there.

Similarly, we need to explore in detail the realities of power, identity, and livelihood when designing adaptation. For instance, land left vacant after home acquisition or relocation could become a safety risk and therefore should be purposefully converted to another use such as a coastal wetland or a maintained public space. A recent analysis of government coastal adaptation decisions in North Carolina (Siders & Keenan, 2020) showed that armouring decisions aligned with higher home values, high incomes, and low racial diversity, whereas home acquisitions for relocation aligned with low home values, low incomes and high racial diversity.

Research findings

Our focus groups with coastal residents illustrated that they are aware that not everyone is equally able to adapt, using any method, because of a lack of personal capacity or monetary resources. Government support is likely necessary to level the playing field in such situations[12].

Questions to Consider when planning adaptation

- *Who from our community is not at the decision-making table and could be impacted by the project?*
- *Who can we invite to the decision-making table that is not already here?*
- *How could those of varying identities experience this adaptation differently?*
- *How can we counteract the role of power and class in the political decisions that will surround this adaptation?*
- *What will the impact of this work be on the cross-section of people who live here in 10-, 50- or 100-years' time?*

[12] Sutton, K. (2020). Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

6. Foster Shared Interest and Responsibility

> *"...we work and talk in such siloes. We often put nature-based solutions as one thing and not necessarily connected to a broader way of how we re-envision our society in response to climate change."*
>
> *— Interview with provincial government participant*

> *"I think it depends on the situation. I think if an individual is doing something to purposefully and wilfully – that is affecting the coastline – I think people are going to be not hesitant in the time of his need. Like, if something does happen people are still going to pitch in and help and try to get him back on his feet. But they're going to expect him to make changes to what he's doing, not continue on the way that he is. I think they'll still pitch in."*
>
> *— Coastal resident in focus group*

Concern for our own homes and other assets is automatic when climate risks such as storms and floods threaten us. We often need some encouragement to consider our duty to our neighbours and those more distant. Armouring decisions that directly affect neighbouring shorelines by changing currents and starving them of sediment are evidence of this. Solnit wrote in 2010 about remarkable acts of altruism that emerge during disaster, including in Halifax after Hurricane Juan in 2003, and concluded that we have unmet desires for collective action (Solnit, 2010). While many of those giving advice about climate communication emphasize that we should focus on the benefits and downplay the need for sacrifice (Stocknes, 2015), there is evidence (including Canada's COVID-19 response) that a more collaborative approach to decision-making will be fruitful.

In the Maritime provinces, dykelands[14] operate under governance models that give the individuals whose land is protected by a given dyke structure a shared responsibility in making decisions about its future (Sherren et al., 2019). This is a holdover from a time when members of a marsh body[15] would share the cost of maintaining the protective dykes. Maintenance is now the responsibility of the provincial government; however, marsh bodies still have legislated rights to be consulted and to deliberate and vote on decisions such as dyke realignment. The shared responsibility is clearly delineated in the case of dykelands but it is less clear for other coastal areas that are just as linked, such as properties along a coastline that share a sediment source. Nevertheless, if residents are encouraged to think and deliberate on a given situation on a smaller scale, it can create a space for shared understanding about, and ownership of, the challenges, options, and implications.

EXAMPLE OF JUST TRANSITION

Clean Coasts is a program of the Nova Scotia Clean Foundation focused on restoring salt marsh habitat along the Northumberland Strait. Clean Coasts has collaborated with local communities and Mi'kmaq knowledge keepers and embraced a Two-Eyed Seeing/Etuaptmumk[13] approach throughout the program, including site selection, design, and implementation. Together, the partners involved in this project identified three salt marsh restoration opportunities: a tidal barrier removal at Marshalls Crossing; improved drainage runnels at Fergusons Cove; and oyster reef installation and planting at Sitmu'k, Pictou Landing First Nation (in collaboration with the Mi'kmaq Conservation Group). This inclusive process has increased awareness of the importance of salt marsh habitat and built trust between Indigenous and non-Indigenous partners and communities and increased cultural competency within the multidisciplinary and multi-sectoral project team. *Additional details are available here.*

[13] Elder Albert describes Two-Eyed Seeing/Etuaptmumk as "learn to see from your one eye with the best or the strengths in the Indigenous knowledges and ways of knowing...and learn to see from your other eye with the best or the strengths in the mainstream (Western or Eurocentric) knowledges and ways of knowing...but most importantly, learn to see with both these eyes together, for the benefit of all" – Elder Albert Marshall (Institute for Integrative Science and Health, 2021)

[14] Areas of drained marshes converted to agricultural land

[15] Marsh bodies are a collection of dykeland owners who are incorporated as governing body for a marshland section according to the Nova Scotia Agricultural Marshland Conservation Act, 2000

6. Foster Shared Interest and Responsibility *(continued)*

Research findings

Our focus groups with coastal residents demonstrated that moral communication devices such as asking people to consider their duty to future generations or to think about the achievements and sacrifice of wartime mobilization increased their willingness and sense of urgency to adapt to climate change. In addition, many focus group participants voiced a belief that their communities would act collaboratively to help those at higher risk as long as the people at risk were also committed to that collective ethos (i.e., not act for personal gain with the assumption that they would be rescued without personal cost).

Questions to Consider when planning adaptation

- *Can we outline areas of shared interest and responsibility for collaborative decision-making on this issue?*
- *How can the "winners" in this decision help support the "losers"?*
- *Whom do we need to take care of that may not have the ability to do it themselves?*
- *What are the impacts of our decisions on people who do not have the power to influence it?*

CASE STUDY

The Onslow-North River dyke realignment and saltmarsh restoration project required the consultation and majority agreement of all landholders within the marsh body, though not all of them knew they had this responsibility. The proponents of the project first had to "activate" the marsh body, which nominated a chair and engaged in careful engagement on and study of the issues before voting to proceed (Sherren et al., 2019). *Additional details are available here.*

FIGURE 11: Researchers and practitioners at the climate resilient coastal natural infrastructure workshop held at Saint Mary's University, May 2019.
Photo: Caytlyn McFadden

FIGURE 12: Participants at the Juuktu'kwejk/Cornwallis River workshop, March 2019.
Photo: Caytlyn McFadden

7. Avoid Maladaptation

"A lot of people are using the same approach because they saw their neighbours using armour stone, rip-rap – just other things that can ultimately be maladaptive."

— Interview with NGO participant

"I don't think you can underestimate the human desire to groom landscape – you've got an expensive property at the coast; you both want to show it off and you want a view. People like to groom and neat and tidy. They see nature as something to be overcome."

— Interview with provincial government participant

Unintended negative consequences of adaptation are commonly referred to as "maladaptation." In coastal areas, hardening the shoreline to prevent erosion or protect against flooding can have unintended consequences that impact natural physical processes and coastal ecosystems, which in turn can impact coastal communities and the people who live there. We can avoid such consequences through long-range thinking and planning. There are two categories of maladaptation: rebounding vulnerability and shifting vulnerability (Juhola et al., 2016).

Rebounding vulnerability

Rebounding vulnerability happens where hard infrastructure, such as rock walls, gives a misleading sense of protection in the face of sea level rise and storm surge (Sovacool, 2011). This overestimation of protection often results in increased development in vulnerable areas, which then requires more resources to protect these areas. Pressure mounts for decision-makers to make further investment in reinforcing the hard protection rather than requiring individuals to modify their behaviour (Abel et al., 2011; Barnett & O'Neill, 2010; Bulleri et al., 2010; Dugan et al., 2011; Kabisch et al., 2016).

Shifting vulnerability

Shifting vulnerability happens when adaptation methods move the problem from one area, sector, or community to another (Juhola et al., 2016). For example, installing infrastructure (such as groynes and breakwaters) to protect against erosion in one location can prevent the transport of sediment to another location. The loss of sediment supply means that build-up of sediment does not keep pace with erosion elsewhere, leading to diminished sandy beaches and other coastal ecosystems. Attempting to solve the problem for one section of the coast can create a problem elsewhere.

EXAMPLE

In 2019, TransCoastal Adaptations: Centre for Nature-Based Solutions at Saint Mary's University, as part of their Making Room for Wetlands Project, held a workshop (Figure 12, page 17) to discuss changing landscapes in Nova Scotia and how we can respond to the impacts of climate change in our coastal zones. Using the geographic area of the Cornwallis River/Jijuktu'kwejk as an example, the workshop brought together participants to discuss current and anticipated land uses, existing hazards and vulnerabilities, and the tools and opportunities for adaptation in the area. This meeting aimed to better understand climate change vulnerabilities in the area, what adaptation techniques might be appropriate, where they might be in use already, and how they could continue in the future. This participatory workshop involved presentations to set the stage, group discussions, and table-top mapping exercises. Participants included individuals from local government, provincial government, NGOs, industry, watershed groups, and wildlife associations. *Additional details are available here.*

Questions to Consider
when planning adaptation

- *Does this option hinder the natural processes that exist at the site? If so, which ones and how?*
- *Does this option reduce or increase our future options for adaptation? If so, how?*
- *Are we really clear on what problem we are trying to solve?*
- *Can we foresee unintended consequences of the option? For instance, ask decision-makers to "imagine it is five years after implementing this option, but it has gone badly; write a brief history of what happened."*
- *Does this option shift risk to ecosystems or people in other places? If so, which ecosystems or people could be at risk and why?*
- *How might the present and future residents of this area assess this decision?*
- *What flexibility have we built into the project to enable adjustment when faced with new information or an unanticipated negative consequence of this option?*

THE FIVE R's

ADAPTING TO THE IMPACTS of climate change typically involves selecting from or combining approaches presented in the PARA framework: protect, accommodate, retreat, or avoid (Doberstein et al., 2019). We make our choices by assessing the level and urgency of risk, the cost and benefit of options, the physical coastal environment, the tools at hand, and the political and social preparedness for accepting a particular adaptation approach. The Making Room for Movement framework involves the same assessments but considers them with the view of working with nature. Employing NbCA solutions requires a new interpretation of the PARA framework, as well as a fifth option related to the cognitive shifts that we need to make when using a nature-based approach– reimagine. Any given NbCA option comprises two or more of the resulting Five R's: Reimagine, Reinforce, Relocate, Realign, and Reserve (Rahman et al., in review). Each approach requires supporting elements from one of the others. A wide range of NbCA options are suitable for coastal Nova Scotia, are already in use, and align with the Five R's. All NbCA options address the need to reimagine the coast and at least one more of the other "R" approaches.

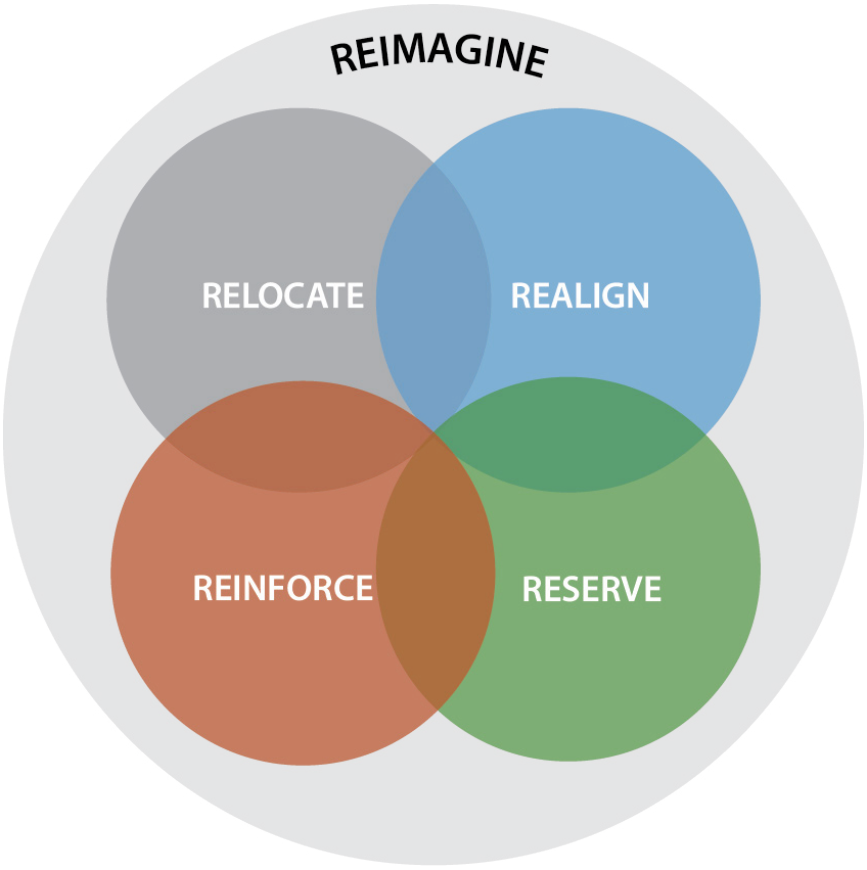

FIGURE 13: The Five R's of nature-based coastal adaptation

Reimagine

Reimagining encourages residents of coastal communities, decision-makers, and practitioners to change their understanding of how the coast works – from a fixed to a dynamic landscape; what it is for – from private property and amenity to environmental commons and public good; how we interact with it – from controlling to adaptive; and who are its custodians and stewards – from government responsibility to personal and community responsibility. Coastal communities and practitioners need to reimage and communicate alternatives for managing the impact of climate change at the coast with a shift to working with nature.

The economic, social, and cultural uses of landscapes, and our emotional and aesthetic responses to those uses, result in a unique way of life among coastal communities that is transmitted across generations. This shared memory of coastal life helps individuals construct their experience in a community, structures their interactions, and establishes a way of living together through a virtual tie identified as the "social imaginary" (Taylor, 2002), a collective sense of what is desirable and possible. Reimagining means creating a new social imaginary of the coast.

Reimagining landscapes is more difficult to achieve than other options because it requires communicating the risks of climate change and the potential NbCA solutions to address those risks with many individuals who are influenced by different values, knowledge, and perceptions (Corner et al., 2014; Guy et al., 2014; O'Brien & Wolf, 2010).

Engaging individuals and communities in identifying, developing, supporting, and implementing climate change solutions should be a necessity rather than an option (Wolf & Moser, 2011). New forms of climate risk communication are important for implementing NbCA even in societies with a high level of climate awareness (Guy et al., 2014; Pidgeon, 2012). For example, the arts are an important but underused means for transmitting new cultural narratives (Fischer et al., 2007).

Options for reimagining might be small initiatives, such as artwork, to memorialize the shift of land uses and occupation after retreat, or they might be large actions. For example, A.R. Siders' call for a National Seashore in the United States, where one could walk from Maine to Texas on public coastline, gives people something desirable to work towards rather than a loss to focus upon (Davison, 2020). Reimagining could also call on institutions, formal or informal, to consider ideas such as creating communities of shared responsibility to make coastal decisions based on natural geophysical boundaries rather than legal ones (Sherren et al., 2019).

Nature-based coastal adaptation approaches using *Reimagine*

Coastal upland and backshore approaches

- Buried revetment/living revetment
- Bank stabilization
- Living dyke
- Stormwater management

Foreshore and offshore approaches

- Salt marsh restoration
- Dune restoration
- Beach nourishment
- Reefs (e.g., oysters)
- Eel grass restoration/seagrass beds
- Managed realignment/dyke realignment

Nonstructural approaches

- Land use regulation
- Managed retreat (e.g., land buyout, land swap)
- Flood mapping
- Coastal erosion hazard and risk assessment

CASE STUDY

The Town of Mahone Bay and the community came together to advocate, research, and develop a plan for a living shoreline project to mitigate coastal erosion and flooding. Traditionally, the town has taken a hard infrastructure approach to managing coastal flooding and erosion. For example, the town thoroughfare and coastal road, Edgewater Street, is reinforced by a rock wall (CBCL Limited, 2016). Waterfront development has expanded with hardening the shoreline and infilling coastal areas. In 2014, the Mahone Bay Harbour Development Committee initiated conversations concerning development projects on the northern shore of the harbour. However, the conversations went in a different direction and centred on reimagining the coastal landscape by using natural approaches to address coastal hazards. The town council voted on the Shoreline Reconstruction Project, later titled the Flood Prevention and Shoreline Enhancement Project, as a priority initiative. The town of Mahone Bay is gaining recognition for green initiatives and for sustainability planning in cultural, economic, social, and environmental sectors.

Additional details are available here.

Reserve

Reserve uses policy and regulations to preserve the natural coast and ensure room for movement by discouraging, restricting, or prohibiting development in the shore zone. Because it imposes restrictions on land use, it requires public and political support (Aerts et al., 2014; Rosenzweig et al., 2011). Reserve requires reimagining and communicating a change in coastal land use practices that may result from implementing this option. Policy tools include land use planning to reserve coastal land as natural spaces. Regulatory tools, such as flood and coastal protection zones in the form of horizontal or vertical setbacks, enforce policy giving legal support to a reserve approach. For example, regulations can prohibit development in flood prone areas or near eroding slopes, or require allocation of land for public use including as conservation lands, in land subdivision. This approach relies on public awareness of risk and willingness to combine risk reduction with natural area protection, and on governance and market mechanisms which in turn require government action and market innovation (Brody et al., 2009).

Nature-based coastal adaptation approaches using *Reserve*

Backshore and coastal upland approaches

- Stormwater management

Foreshore and offshore approaches

- Managed realignment/dyke realignment

Nonstructural approaches

- Land use regulation
- Managed retreat (e.g., land buyout, land swap)
- Flood mapping
- Coastal erosion hazard and risk assessment

EXAMPLE

Nova Scotia's Coastal Protection Act, proclaimed in 2019, will establish a coastal protection zone (CPZ) to enforce horizontal and vertical setbacks prohibiting or restricting certain activities along the coast (https://novascotia.ca/coast/). The vertical setback is an elevation along the coast that incorporates historical flood information and sea level rise projections; the horizontal setback requires site-specific analysis of slope and geology to establish the right setback for erosion protection. By reserving coastal space, the legislation aims to protect the coast and sensitive environments from development impacts and to protect people from coastal processes that become hazards when development gets in the way. *Additional details are available here.*

Relocate

Relocate[16] is the planned transfer of infrastructure, houses, commercial and other buildings, cultural assets or other land uses away from coastal flooding and erosion to safe locations. It can involve relocating a single, fairly mobile asset such as power lines, as was done for the managed dyke realignment project along the Salmon River at Onslow (near Truro), Colchester Municipality (link), or moving an entire neighbourhood or community. The need to relocate, or even contemplate it, is potentially daunting and emotionally difficult for people who are facing it. People need support to understand the risks of not relocating, to prepare for moving, and to resettle in a new location. They need support to envision the transformation of their vulnerable landscape, and the potential of a new place.

When relocating public assets, governments must find land and financing. For personal assets, in addition to losing a familiar place, potentially one with complex social and familial relationships, home and business owners are also losing their most important investment. People in affected communities can strongly oppose moving if they are not willing to give up their ownership or location (Siders, 2019). The success of a relocate strategy depends on how and when incentives are designed and communicated with affected communities. Relocating individuals and property is complex and takes time; early communication and planning can avoid many of the social, financial, and physical burdens of relocating after a disaster (Saunders-Hastings et al., 2020).

[16] Also known as managed retreat.

Relocation can help make room for coastal habitat with additional benefits to a community such as improved public access to the coast. However, given the psycho-social and economic challenges for individuals and communities, relocation involving homes and businesses is suitable only where alternative options are not feasible in the long term (Dyckman et al., 2014; Greer & Binder, 2016; Neal et al., 2005). Furthermore, there must be space for equitable resettlement.

Nature-based coastal adaptation approaches using *Relocate*

Foreshore and offshore approaches

- Managed realignment/dyke realignment

Nonstructural approaches

- Land use regulation
- Managed retreat (e.g., land buyout, land swap)
- Flood mapping
- Coastal erosion hazard and risk assessment

Realign

Realign combines foreshore habitat development with hard engineering for coastal protection. This approach involves moving protective structures, such as dykes, inland to allow more space for coastal flood water, thereby restoring the natural tidal ecosystem, most commonly salt marshes (Doberstein et al., 2019; Esteves, 2014; Hanley et al., 2014; Hinkel et al., 2014; James et al., 2019). The restored habitat absorbs and reduces the impact of wave energy on the protective infrastructure. Realignment is more cost-effective over the long-term (i.e., more than 25 years) than reinforcing hard infrastructure (Turner et al., 2007). Realignment requires support from both the Reimagine and Reserve options by borrowing additional components to accommodate flood water and to build a new line of coastal defense. In some cases, it may also be necessary to relocate infrastructure. Realign does involve abandoning current land use in the new flood zone and possibly relocating it elsewhere. This approach is suitable where population density and dependence on land resources in the newly flooded area are relatively low (Sherren et al., 2019) and has been successfully implemented along several sections of dyke in Nova Scotia. Pairing restoration with protection requires expert analysis and design to ensure long-term success and to optimize the co-benefits of protection and ecosystem services.

Nature-based coastal adaptation approaches using *Realign*

Foreshore and offshore approaches

- Managed realignment/dyke realignment

CASE STUDY

The Nova Scotia Department of Agriculture (NSDA) is responsible for the dyke systems throughout the province and has recently developed the agriculture dykeland system design decision tree. Within the decision tree is a guidance document and Microsoft Excel-based decision tool that will be used to determine the most feasible design option for Nova Scotia's provincial dykeland system. The tool examines nature-based solutions, such as dyke realignment or tidal wetland restoration, alongside traditional engineering (e.g., dyke reinforcement, aboiteau construction/upgrade/rehabilitation, drainage improvement) and management approaches (Dykeland System Management Plan).
Additional details are available here.

Reinforce

Reinforce utilizes a NbCA approach to protect coastal structures and uses, and may require 'advancing' the placement of infrastructure seaward (for example by using oyster reefs) (Rahman et al., 2021). This strategy can be applied to built-up areas where existing property values are higher than the cost of defense (Aerts et al., 2014; Sherren et al., 2019; Temmerman & Kirwan, 2015; Temmerman et al., 2013) or in populated areas where many people depend on limited land resources for livelihoods and food security (Aerts et al., 2014; Irfanullah et al., 2008; Kabat et al., 2005; Spalding et al., 2014). Reinforcing the coast is often a short-term strategy (25–50 years) and should be accompanied by longer-term plans to avoid maladaptation and cost escalation (the increasing costs of maintenance, or for each time it becomes necessary to replace the structure). This strategy can also disproportionately benefit higher-income communities, particularly when decisions to reinforce are based on the value of assets at the coast (See *Just Transition* on page 15). Reinforcement aims to reduce the impacts of flooding and erosion to a tolerable level without much alteration to existing settlement and land use. Eventual property loss may be unavoidable with this approach and there is a reliance on emergency measures for managing risks (Doberstein et al., 2019; Kabat et al., 2005). Like other options, it also needs community (i.e., reimagine) and policy (i.e., reserve) support for public acceptance and resource allocation.

Nature-based coastal adaptation approaches using *Reinforce*

Backshore and coastal upland approaches

- Buried revetment/living revetment
- Bank stabilization
- Living dyke

Foreshore and offshore approaches

- Salt marsh restoration
- Dune restoration
- Beach nourishment
- Reefs (e.g., oysters)
- Eel grass restoration/seagrass beds

EXAMPLE

The Mi'kmaw Conservation Group undertook the artificial reef project to build capacity within communities to participate in and lead coastal restoration initiatives by enhancing marine habitat within the Northumberland Strait. The project involves deploying artificial reef structures called "reef balls" at two sites in the Strait. Community members from Pictou Landing First Nation built 200 reef balls over six weeks and deployed 160 of them at two sites recognized as having cultural and ecological benefits to the community. They later deployed the other 40 reef balls in collaboration with the Clean Foundation. *Additional details are available here.*

FIGURE 14a: Reef balls loaded into fishing boat for the November 2019 deployment. Photo: Anthony King.

FIGURE 14b: Crane loading up the pontoon boat for the August 2020 deployment. Photo: Seonaid MacDonell.

IMPLEMENTING NBCA REQUIRES CONSIDERATION of the local context in all its complexity. The Making Room for Movement framework describes three considerations for implementation: consideration of what contributes to "place"; consideration of place governance; and consideration of practical strategies for implementation. The framework poses questions to prompt coastal decision-makers and practitioners to consider the local context and specific coastal adaptation needs when identifying NbCA options. The implementation strategies consider barriers and drivers identified in the Making Room for Movement project. Quotes from research participants illustrate experiences and knowledge of Nova Scotians as they reflected on working with nature for climate change adaptation and reimagining the province's coastal landscapes.

Place Context

Putting NbCA into practice requires consideration of place. Place is the physical environment or landscape –natural or developed – which changes through human use and settlement. The landscape also shapes human use and settlement patterns, and people habitually attach meaning to place or landscape. Coastal place is where land and sea meet, creating a dynamic environment that both challenges and sustains human use and settlement. Implementing NbCA requires understanding the attributes of coastal place including geography, ecosystems, landscape histories, and modern coastal settlement.

> *"I think that declaring one option is the best and one option as the worst is, in a way, counterproductive. Because if we are just looking at our own property it almost seems like a – well, the word 'selfish' is an unkind word but that's what it seems like... So, I think that what I'm trying to say is that there's no such thing as one best or one worst because it depends on what part of the coastline you're living on and also whether you're at a higher elevation or a lower elevation, or whether you make your living farming or fishing or in commerce. ...there are too many variables to make a one answer fits all."*
>
> — Coastal resident in focus group

Coastal geography and ecosystems

> *"I think we need to realize and promote that more, the fact that we do have those examples, that just because we didn't build that thing, whether it was using nature-based or not, we have the natural examples already there."*
>
> — Interview with private industry consultant speaking about undeveloped areas

> *"...the coast varies significantly in our area..."*
>
> — Interview with local government participant

The Nova Scotia peninsula and Cape Breton Island present a complex geology and submerging glaciated landscape bordering three marine regions (Atlantic, Bay of Fundy, Northumberland Strait/Gulf of St. Lawrence) and enclosing an inland sea (Bras d'Or Lakes). Local landform, sediment supply, tidal range, and wave exposure, combined with urban and rural land use, create a diverse coastal zone along 13,300 kilometres of coastline (Province of Nova Scotia, 2017). In addition, these coastal landscapes have changed over time and will continue to do so. Understanding these complexities is essential for the appropriate selection, application, and success of NbCA options.

Research findings

Our focus group participants (coastal residents) felt strongly that their part of the coast was unlike others and that, as a result, all decisions about adaptation would need to consider these things at a very fine-grained scale[17].

Coastal landscape histories

> *"I've never gone to a community and done a recreation plan or anything like that, or anything else, without...basic research into what the community was, a bit of its history, fundamentally how it's made up, and because that becomes very much a part of who they are."*
>
> — Interview with local government participant

Since its emergence from under the glacier ice 16,000 to 12,000 years ago, nature and human activity have shaped Nova Scotia's diverse coastal landscapes. Evidence so far suggests Nova Scotia has been home to the Mi'kmaq and their ancestors for at least 13,000 years. A legacy of spirituality and experience over millennia shapes the collective traditions and knowledge that guide Mi'kmaw use, values, and relationships with the land and waters. Archaeological research of Mi'kmaw cultural periods

[17] Sutton, K. (2020). Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

is exploring this complex and ancient history. The first documented European explorers to Nova Scotian shores were seasonal fishermen who came to the "Bacalaos" or "cod land" (Deveau, 2018). Acadians arrived in Nova Scotia over 400 years ago, among the first European settlers (Government of Nova Scotia, 2021). Their landscape legacy is the expanse of dykes they built to convert fertile salt marshes into agricultural lands – dykelands – that are still in use today. Climate change and changing land use have challenged the sustainability of the dykelands and aboiteaux built at a time of lower sea levels. Redevelopment over the centuries replaced many of the original Acadian aboiteaux and dykes; however, the designs did not consider climate change, fish passage, or changing land use. As Nova Scotia's population, and therefore development, increased, the purpose of the dykes expanded to include the protection of infrastructure and people (van Proosdij & Page, 2012).

Modern coastal settlement

> *"...we have very many communities that are in areas that they technically shouldn't be..."*
> *— Interview with NGO participant*

Today, 70 per cent of Nova Scotians live in coastal communities, with most of the coastal land (86%) in private ownership (Province of Nova Scotia, 2017). The concentration of population near the coast reflects the historical and modern importance of the ocean for natural resources, trade, and travel (Gardner et al., 2005; Milne & Milne, 1953). The ocean sector contributed over a billion dollars in 2011 to the Nova Scotia economy, which is approximately 7 per cent of the province's GDP (We Choose Now, 2015).

FIGURE 15: Coastal practitioners and researchers learning about Acadian landscape history at Beaubassin near the Converse Marsh restoration site, May 2019. Photo: Lydia Ross.

Urban harbours such as Halifax Harbour and Sydney Harbour and those in coastal towns such as Digby, Yarmouth, Lockeport, Shelburne, and Lunenburg are intensively developed with large infrastructure investments. Coastal uses in these areas include marine industrial and commercial uses, as well as institutional, residential, and recreational development and public open space. There are approximately 80 wharves in Nova Scotia managed by local harbour authorities through the Small Craft Harbours program of DFO (Fisheries and Oceans Canada, 2020) that are crucial to fishing and aquaculture industries. There are also harbours supporting marine commerce and industries and recreational boating that are not managed by harbour authorities.

FIGURE 16: Coastal development along the Mahone Bay waterfront. Photo: Courtney Kowal.

Most of Nova Scotia's natural, undeveloped coastline is in rural areas and some sections of the coast (including small sections of urban coastline) are protected areas (such as federal, provincial, and municipal parks, nature reserves, or protected beaches) or managed by non-government organizations. The public, quasi-public, and private-ownership pattern is complex. Undeveloped coastlines are great examples of NbCA, as they demonstrate the adaptive capacity of intact ecosystems and undisturbed coastal processes.

Research findings

Approximately 67,000 properties[18] either touch or are located within 10 metres of the coast in Nova Scotia. The average assessment value for those coastal properties is $166,957, for a total worth of just over nine-billion dollars[19] and includes public property, private property, roads, and railways. There are nearly 40 kilometres of railways within 30 metres of Nova Scotia's coast and 624 kilometres of roads and driveways[20].

[18] Analysed using ArcGIS with May 2019 NS Property Parcel Data
[19] Analysed using 2019 NS Property Valuation Corporation Data
[20] Analysed using ArcGIS with May 2019 NS Property Parcel Data

Place Strategies

The following section describes strategies for understanding the coastal landscape and settlement history and patterns, the barriers and drivers of each strategy, questions to consider, and case studies to illustrate how these strategies have been used in Nova Scotia.

Coastal landscape analysis

> *"...we investigated climate controls from the perspective of 'What is the landscape directly adjacent to the shoreline? Is it hard? Is it soft?' And what kind of things may impact erosion and different things like that."*
>
> *— Interview with local government participant*

For NbCA to be successful, it is crucial to choose options that are compatible with the local topography, geology, and dominant coastal processes. A coastal landscape analysis involves identifying the coastal geomorphology, geology, vegetation cover, critical habitat, wave exposure, and identification of the littoral cell (sediment source, transport, and sink pathways). The analysis also includes identifying sources of materials and species of vegetation suitable for the selected area because they would be exposed to tide heights, currents, and wave action particular to that area. Some components of the shoreline assessment include patterns of sediment transport, exposure of the site to waves and currents, rates of coastal change, shoreline characterization, coastal processes, tides, dominant wind direction, etc. Protecting existing ecosystems such as wetlands, beaches, dunes, and intertidal flats is the easiest way benefit from their protective functions (Moudrak et al., 2018).

Guidance on identifying coastal types and adaptation options suited to each type is available in the Additional Resources section of this report.

EXAMPLE

The Coastal Community Adaptation Toolkit (CCAT) (https://atlanticadaptation.ca/en/CCAT), developed for the Atlantic Climate Adaptation Solutions Association in 2016, is an interactive online tool (decision tree) that guides users through questions about their community, the types of flooding or coastal erosion issues they are facing, and their coastal environment to identify land use planning and soft, hard, and hybrid engineering adaptation options suitable for their coastal context and their adaptation capacity. The questions reflect the criteria typically used to evaluate the "fit" of climate change adaptation options. The outputs are tables that present the suitable options, along with factors for successful implementation, and fact sheets explaining and illustrating an example of each option. The tables also include limitations to options that are not suitable under existing site conditions or institutional capacity. Implementing hard and hybrid engineering options (where vegetation alone will not provide the required level of protection) requires professional analysis by a coastal scientist or coastal engineer to account for the local geology, ocean dynamics, and ecosystems.

Barrier or constraint	Driver or opportunity
• People involved in decision-making may have limited knowledge of coastal types and coastal processes. • Lack of available information about areas at risk to flooding and erosion.	• The Coastal Protection Act regulations will provide information about areas at risk, the requirements for technical assessments, and engaging knowledgeable professionals. • Land use planning is now mandatory in Nova Scotia under the Municipal Government Act, Minimum Planning Requirements Regulations[21]. Local planning reflects local settlement patterns and environmental opportunities and constraints and engages residents in the planning process. • Local planning combined with the Coastal Protection Act promotes awareness and protection of sensitive coastal environments and adequate space in the coastal zone for flooding and erosion without impacting infrastructure and land use. • Resources and guidance around Nova Scotia's coastal types and adaptation options are available and included in the Additional Resources section of this framework document.

[21] Minimum Planning Requirements Regulations Section 214(4) of the Municipal Government Act S.N.S. 1998, c. 18 N.S. Reg. 140/2019 (effective December 3, 2019)

CASE STUDY

A community of homes sits on the shore of Big (Miseners) Lake, a barachois pond behind a cobble barrier beach in Lower East Chezzetcook on Nova Scotia's Eastern Shore. The community is at risk of coastal flooding because storm waves and storm surge have cut channels through the barrier beach, exposing it to flooding and erosion. The provincial government has filled in the breach in the past, but following successive storms in 2018, and requests from the community to fix the breach, the then Nova Scotia Department of Natural Resources[22] hired engineering firm CBCL Limited to complete a study of the barrier beach: Coastal Risk Assessment and Adaptation Options at Miseners Long Beach (CBCL Limited, 2018). CBCL Limited studied the historical conditions of the beach, water depth, sea-level rise and storm surge projections, erosion patterns, saltwater intrusion vulnerability, and options for coastal adaptation. CBCL Limited concluded that breaching and flooding concerns will persist in the Lower East Chezzetcook region. Recommendations included building a beach dyke or allowing the beach to evolve naturally and address coastal adaptation for the community at the property level. CBCL advised that reinforcing the beach would not resolve the long-term flood risk, however. The then Department of Lands and Forestry decided to allow nature to take its course and to stop repairing breaches of the barrier beach. Community adaptation remains unresolved. *Additional details are available here.*

FIGURE 17: The original breach at Miseners Lake in 2018. Photo: NSDNR within CBCL Limited, 2018.

Questions to consider when planning adaptation

- *What are the local geological and ocean processes that shape the coastal form?*
- *What habitats occupy this coastal place?*
- *Are there land use activities or built structures in adjacent areas that may interfere with natural coastal processes?*
- *What were/are the traditional uses of the land and are these still a relevant or important part of community needs and/or Treaty commitments?*

Social and cultural assessment

> *"...the project so far hasn't really accounted...for archaeology. Nobody really thought far enough ahead to realize this would be a significant piece of what we're doing."*
>
> *— Interview with NGO participant*

Before considering any coastline modification, it is important to understand the place history, including historical land uses and settlement patterns. An archaeological resource impact assessment (ARIA) will characterize the heritage value of an area in advance of adaptations and implement a strategy for avoiding and/or mitigating impacts to cultural heritage.

Archaeological research provides essential information that contributes to determining the heritage value of a site, landscape, or region. Canada's federal branch of heritage management, Parks Canada, defines heritage value as "[t]he aesthetic, historic, scientific, cultural, social or spiritual importance or significance for past, present or future generations. The heritage value of a historic place is embodied in its character-defining materials, forms, location, spatial configurations, uses and cultural associations or meanings."[23] As some fundamental legislation is present at the federal level, heritage value is legally weighed using this definition in locations of federal jurisdiction.

In Nova Scotia, there are no regulatory or legal guidelines for assessing heritage value. The Special Places Protection Act (SPPA) regulates the preservation and study of archaeological, historical, palaeontological, and ecological sites and remains important to the province. Special places are protected by the SPPA, but the Act falls short of providing any guidelines

[22] Now the Nova Scotia Department of Natural Resources and Renewables

[23] For heritage terminology definitions see: Parks Canada, *Federal Heritage Designations – Glossary of Terms*

for how to determine heritage value.

The heritage value of a site, landscape, or region is highly subjective, and the valuation of any resource must consider many perspectives. Two methods employed to provide and communicate information that will help to determine or assess heritage value are archaeological and ethnographic research.[24] Ideally, regulations provide a rigorous and versatile framework for researchers to refer to. Commercial work done to perform this kind of research is called cultural resource management (CRM).

Managed dyke realignment and salt marsh restoration will be among the larger NbCA undertakings in Nova Scotia. As the province implements this climate change adaptation measure along sections of dyked coastline in the upper Bay of Fundy, the work triggers an ARIA; a qualified archaeologist, often with a CRM firm is hired to ensure adherence to heritage regulations. Heritage regulations are ideally designed to protect all heritage, but the SPPA functions best in protecting known heritage. Many heritage resources encountered under an ARIA are previously unknown, and their heritage value must be determined before considering a course of action for moving forward.[25] If the project has the potential to impact Mi'kmaq cultural resources archaeologists are encouraged to engage the Mi'kmaq as part of project planning and implementation.

CASE STUDY

Converse Marsh is located within the Tantramar marshlands of the Chignecto Isthmus along the Missaguash River, the border between New Brunswick and Nova Scotia. The marsh sits next to Parks Canada land. The landscape is culturally, historically, and environmentally significant. The Converse Marsh managed dyke realignment project (Figure 18) is an undertaking of the Department of Fisheries and Oceans-funded Making Room for Wetlands project through TransCoastal Adaptations: Centre for Nature Based-Solutions (Saint Mary's University). Project planning and design involved consultation with private landowners, institutional stakeholders including Parks Canada (site adjacent to Beaubassin historical site), the Nova Scotia Department of Agriculture, Nova Scotia Lands and Forestry, the Nova Scotia Department of Communities, Culture and Heritage, and the Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO).

In addition to detailed pre-design analysis of vegetation, soils, hydrology, and elevation, project planning included an ARIA to determine the presence of culturally significant resources or areas within the project site. The assessment included examining historical maps and imagery through desktop GIS (geographic information systems) survey, searching archives, and digging soil test pits to check for archeological resources. The assessment findings, and the need to maintain access to the historically significant ship railway[26] property, led to moving the footprint of the new inner dyke and a raising and relocating a section of the roadbed. *Additional details are available here.*

FIGURE 18: Soil test pits at Converse Marsh to check for archaeological resources. Photos: Wesley Weatherbee (left), Caytlyn McFadden (right).

[24] For archaeological terminology definitions see: Parks Canada, Archaeological Glossary.

[25] ARIAs considering dyke re-alignment should also consider how jurisdictional changes will change the monitoring protocol at archaeological sites. A 2017 report on preserving Canada's heritage lists 17 recommendations that will allow sustainable development to happen on federal lands (Canada House of Commons, 2017). Recommendation 3 is "that the federal government introduce legislation to establish a process to protect, conserve, document and exhibit archaeological resources on federal land and under waters of federal responsibility".

[26] Ship railway information is available here.

Barrier or constraint	Driver or opportunity
• Uncertainty about when archaeological assessments are required for NbCA projects. • Uncertainty about when consultation or partnership with communities, stakeholders, and rights-holders is required, or appropriate, for NbCA projects. • Not involving or uncertainty about how to involve Mi'kmaw communities in projects or decisions that could impact them. • Lack of awareness about the duty to consult contained in the Terms of Reference (TOR) established by the Assembly of Mi'kmaw Chiefs, the Province of Nova Scotia, and the Government of Canada. • Lack of experience with community asset assessments. • Lack of previous or longstanding relationships with potentially relevant stakeholders and rights-holders.	• Local historians, community archivists, members of local culture and heritage organizations, local residents, and Mi'kmaw knowledge holders may have knowledge of past land uses and the location of past houses, homesteads, industries, traditional activities, and culturally and spiritually important areas. • Facilitated community asset mapping using local planners or engagement specialists with NGOs to identify culturally valued structures and sites. • Mi'kmaw participants in public consultation for infrastructure projects have previously expressed support for NbCA approaches, stating the approaches align with their values, which potentially indicates future support and opportunities for partnership. • Building on successful experiences and established connections to engage Mi'kmaw communities in partnerships for NbCA. • The Terms of Reference (TOR) established by the Assembly of Mi'kmaw Chiefs, the Province of Nova Scotia, and the Government of Canada outlines the duty to consult with the Mi'kmaq on projects that may pose an impact to rights and title, including Crown land, water, and other natural resources.

Questions to Consider when planning adaptation

- *Does an Archaeological Resource Impact Assessment (ARIA) already exist for this area? If you are unsure, contact Communities, Culture, Tourism and Heritage to find out. If so, what are the findings?*
- *What were the historical land uses at this location?*
- *Is the site located within a known historical or culturally significant area?*
- *Is the site within an area that is designated for special protection?*
- *What are the potential impacts to archaeological evidence, or the opportunity to recover it, from the potential NbCA options?*
- *How does each option support the Mi'kmaq's use of the land?*
- *How does each option align with Mi'kmaw values, relationships, and use of the land and waters?*
- *Does the project have potential to impact Mi'kmaq cultural resources?*
- *Have the appropriate representatives of any affected Mi'kmaw communities been meaningfully informed of, consulted on, or involved in the choice of approach?*

Demographic assessment

> *"...year by year, the shoreline has eroded significantly and they're getting pretty close and I don't know what the alternative is other than moving out of their homes soon. But these are seniors that are a little limited in terms of what their options are."*
>
> *— Interview with elected official participant*

It is important to understand the characteristics of the people who live in and use the places where NbCA is being considered because they could experience and be affected by NbCA decisions in a variety of ways.

Information about the local population is available from Statistics Canada census data, including gender, age, income, education, occupation, status, and language group. The data can help identify adaptive capacity within a population.

The more diverse the age structure, for example, the more likely is the opportunity for intergenerational supports. Aging communities complicate resilience in many rural areas. Communities with aging populations may have fewer resources for adaptation because of lower incomes or because younger people area moving out of the community, which in turn affects tax bases that municipalities rely on.

Communities that are highly dependent on one sector (e.g., tourism, fishing) may struggle to adapt to coastal change.

Statistical data may not be available at the scale needed for small area considerations. Local area councillors (local government) and planning or community development staff, as well as staff in service organizations, know their communities and have local knowledge of factors contributing to site-specific vulnerabilities. They may know of individuals or households that could be disproportionally impacted by adaptation actions.

Dedicated surveys can establish the level of social vulnerability in a population. The timing and design of surveys, or any public engagement, should also consider patterns of seasonal ownership (e.g., cottage owners). Permanent and seasonal residents' experiences and willingness to accept nature-based adaptation approaches may differ, depending on their interests in the coast or their actual or perceived risks of coastal impacts of climate change. Both perspectives are important (Saunders-Hastings et al., 2020).

Questions to Consider when planning adaptation

- *What are the population characteristics of the area?*
- *Who lives in and near the project area?*
- *What is the social vulnerability of the area?*
- *Are there vulnerable populations in or adjacent to the area in question?*
- *What is the proportion of year-round and seasonal residents?*
- *Who will be affected by the selected adaptation option(s) and how?*

Barrier or constraint	Driver or opportunity
• Vulnerable populations (low income, seniors, narrow resource dependency) have less capacity for adapting to climate change and exploring NbCA options. • Lack of information about local social vulnerability. • Lack of strategies to lower social vulnerability in a community.	• Funding streams to help vulnerable populations (e.g., Nova Scotia Health's Wellness Fund) improve quality of life alongside risk-reducing adaptation options for those populations. • Vulnerability assessments and mapping to identify contributors to vulnerability and areas of higher social vulnerability support targeted responses for addressing vulnerability.

CASE STUDY

As part of the case studies of NbCA in Nova Scotia, the research team at the School of Planning, Dalhousie University conducted a spatial analysis of social vulnerability of the communities hosting the adaptation projects. Social vulnerability is an expression of the vulnerability of a population to the impacts of a stressor such as a natural hazard like flooding (Cutter, 2003).

Natural hazards affect populations differently. A population's vulnerability is evident in the ability of the populations to respond to, cope with, and recover from the impact of the hazard. A variety of individual and social factors influence the vulnerability of a population including income, employment, gender, age, ethnicity, 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, etc.), the more vulnerable is the population in that area.

Social vulnerability is described by indices such as the Social Vulnerability Index (Cutter, 2003), the Canadian Marginalization Index (Matheson et al., 2012), or the Canada Index of Material Deprivation (CIMD) (Statistics Canada, 2019). The indices are calculated using demographic and socio-economic data collected through a census and organized for mappable units like a census tract or a dissemination area. They are also context-specific, meaning they are calculated in relation to a statistical standard (such as an average) defined for a given geographic area, from national to regional, provincial, or local scales.

The protect team used the Atlantic Region CIMD data, prepared by Statistics Canada from the 2016 Census at the dissemination area[27] level, to map the social vulnerability for the case study locations. The CIMD uses four dimensions of deprivation and marginalization, with each dimension incorporating indicators derived from the Census data: residential instability; economic dependency; ethno-cultural composition; and situational vulnerability.

Mapping the indices shows the geographic pattern of social vulnerability and the location of socially vulnerable people in relation to a potential hazard. It also shows the level of vulnerability in a population that might be impacted by coastal management decisions, including policy or regulation changes, or adding or changing infrastructure to address coastal hazards. For example, moving from hard engineering flood protection to nature-based approaches requires evaluation of the services and infrastructure in the flood prone areas and who could be affected by the change if the same level of protection is not available, even if only in the short term while a natural system becomes established. Relocation must also consider impacts to the social fabric that could be particularly important for vulnerable populations.

Additional details about social vulnerability and the CIMD within six case studies can be found here.

[27] A dissemination area (DA) 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 which allows for location-specific comparison of demographic characteristics from one census period to another.

Putting NbCA into practice requires consideration of governance. Tools and strategies of governance greatly influence the evolution of place. Implementing NbCA requires understanding the coastal governance context and the use of governance tools and strategies. Governance is the over-arching system of rules, procedures, and protocols and the institutions that support them, whereby society functions. It is necessary to consider and work within all governance contexts when implementing NbCA. Federal and provincial governance contexts will apply province-wide; local context will vary among municipalities according to local political culture, community conventions, local economy, and land use and development patterns, all within the capacity of local plans and bylaws to encourage and support working with nature.

In the context of this framework, governance includes (a) government jurisdictions and respective policies, laws, regulations, plans, and protocols relevant to managing coastal environmental protection and development; (b) intersectoral relationships among government (including Mi'kmaq, Canadian federal, and Nova Scotia provincial governments), industry, and non-governmental and civil society organizations contributing to coastal management and decision-making; and (c) the general public – in particular, coastal residents and landowners.

Jurisdiction

> *"...you have lots of jurisdictions involved – in some cases you have three levels of government. It's a dynamic area so it's hard to define and delineate in some cases where does private property end? And people don't know that, the way that the...high tide works."*
>
> *— Interview with provincial government participant*

All three levels of government in Canada (municipal, provincial and federal) have the authority to implement NbCA approaches in coastal areas, according to their respective jurisdictions. The Constitution Act, 1867, provides the framework for the distribution of federal and provincial powers; however, when the Act was written, "the environment" was not specifically mentioned and so the division is based on other elements of the Constitution. For example, federal environmental jurisdiction can fall under Peace Order and Good Government, criminal law, and treaty making, whereas provincial environmental jurisdiction can fall under natural resources, property, and civil rights (East Coast Environmental Law Association, 2007).

Based on this division, modern environmental law and governance is often a shared jurisdiction with some clear distinctions and some overlap. For example, the Oceans Act, 1996 is the federal law that gives provinces jurisdiction for coastal lands landward of the normal low-water mark. Provincial statutes give municipalities jurisdiction over land use, which includes coastal land above the normal high-water mark. The relevant statute in Nova Scotia is the Municipal Government Act.

Figure 19 illustrates the normal coastal jurisdiction of federal, provincial, and municipal governments.

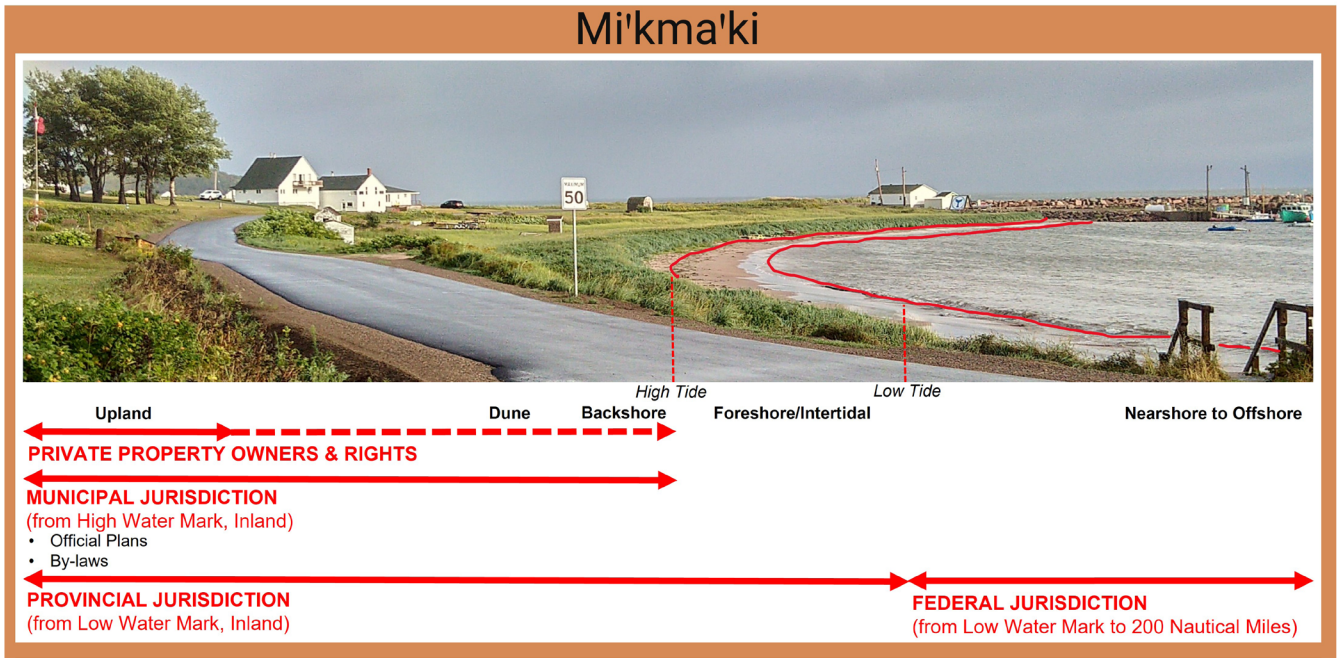

FIGURE 19: Jurisdiction at the coast in Nova Scotia. Photo: Dirk Werle.

As part of Mi'kma'ki, the province of Nova Scotia is the unceded territory of the Mi'kmaq. The Mi'kmaq have full rights to the lands, waters, and resources, as described in the Treaties of Peace and Friendship.

In 2010, the Assembly of Mi'kmaw Chiefs, the Province of Nova Scotia, and the Government of Canada jointly established and officially signed the Terms of Reference (TOR). The TOR recognizes that the Mi'kmaq never surrendered title to their land and still possess rights over the area known as the Province of Nova Scotia. Further, the document outlines how the province must consult with the Mi'kmaq on projects that may pose an impact to rights and title, including Crown land, water, and other natural resources (Mi'kmaq–Nova Scotia–Canada, 2010).

While Figure 19 suggests that federal government jurisdiction starts at the low-water mark, it also has jurisdiction over federal crown lands, and certain coastal activities (navigation and shipping); similarly a provincial government may have jurisdiction over the seabed where its territory extends beyond the low-water mark (East Coast Environmental Law Association, 2007). Jurisdictional overlap between Canadian Constitution government structures and their governance position within Mi'kma'ki means that collaboration across all governments of coastal areas is often necessary to implement NbCA options. It is important to note that consultation should be prioritized over informing and partnering should be prioritized over consultation. Strategies for navigating jurisdictional barriers and drivers are described in Governance Strategies.

More information about the roles, laws, regulations and programs that pertain to NbCA within Nova Scotia can be found in Appendix B. Additional key resources explaining jurisdictional roles at the coast are also available in Appendix A.

Land tenure

> *"...a lot of our lands are privately owned. We don't have a lot of municipal, or provincially or federally owned land."*
> *— Interview with local government participant*

> *"...how do you upscale from the property lot to the ecosystem scale? That's kind of a bit of a challenge..."*
> *— Interview with provincial government participant*

Land tenure can simplify or complicate putting NbCA into practice. The federal, provincial, and municipal governments and the Mi'kmaq or Mi'kmaw communities can implement projects where they have jurisdiction. NbCA projects on public or common land can provide examples for the broader community. The extensive private ownership of coastlines in Nova Scotia results in fragmented control of the coast. Many landowners, who may not be aligned with the same approach to coastal management, make individual, uncoordinated decisions about large sections of coastal land. For example, a landowner interested in implementing NbCA may abut a property protected with armour rock. The armouring may affect the sediment available for an adjacent NbCA treatment.

Some coastal areas have coordinated decision-making among landowners, such as marsh bodies which operate along parts of the Bay of Fundy coast. In 1948 the Maritime Marshland Rehabilitation Act was proclaimed, representing the first direct federal investment on the dykelands, bringing modern equipment to repair failing dyke infrastructure. The Act formed the Maritime Marshland Rehabilitation Administration (MMRA) to oversee the repair of dykes in Nova Scotia and New Brunswick.

The federal government withdrew from the Maritime Marshland Rehabilitation Act in 1968 and passed responsibility for the dykes to the provincial governments. Marsh bodies are incorporated under the Agricultural Marshland Conservation Act, 2000 c.22 s.1. The Act lays out the powers of marsh bodies and specifies their role in marshland land use regulation. A marsh body comprises landowners of a section of marsh with collective decision-making authority over the dykeland area. Marsh bodies are unique governance areas within the province with land use decision-making authority for dykelands similar to municipal land use authority. The Act requires that non-agricultural uses of the dykelands obtain a variance permit approved by at least two-thirds of the marsh body. Managed realignment, living dykes, saltmarsh restoration of dyked lands and other projects on dyked marshes require the agreement of the local marsh body where one exists.

Participants

> *"...it has to be a partnership to have it happen on a large scale. Like, it has to involve a mixture of external people who've got resources, expertise, facilitation, coordinating skills, passion, commitment, and willing partners inside government who are willing to accept this help..."*
>
> *— Interview with provincial government participant*

There is a range of participant groups involved in the governance and decision-making processes that affect coastal adaptation, including NbCA approaches. They include local government, provincial and federal government agencies, Indigenous organizations, and societal participants such as NGOs, community groups, and private industry. The societal participants influence and help guide decisions made by councillors and ministers at the three government levels.

Research findings

The Making Room for Movement interviews with coastal practitioners gave insight to how champions of NbCA used their positions within the decision-making process to advocate for NbCA options in Nova Scotia. Strategies included building trust, participating in public consultations, supporting the Coastal Protection Act, supplying background data such as flood mapping, willingly offering support and expertise, circulating new resources on NbCA, obtaining grants from private foundations to support pilot projects, and including NbCA in options presented to clients.

Political culture

> *"...as a place where most people live within 50 kilometres of the coast, coastal issues are sensitive to people. Like, a lot of people have cottages, a lot of people have grown up on the coast, a lot of people have old family homes or money invested in the coast, so when you start playing with regulations you're playing with people's culture and livelihood and investment, and for a small municipality the politics of that can get challenging."*
>
> *— Interview with private industry consultant*

Political will is a significant challenge to promoting NbCA across Nova Scotia but also an opportunity. Bringing nature-based approaches into the mainstream of coastal management practice requires political leadership and the willingness of politicians to proceed within the cultural, emotional, and behavioural context of their communities.

Political leaders can help community members understand the multiple social and ecological benefits of NbCA and its effectiveness against coastal hazards. Political leaders can be community champions for new initiatives and motivate their community to lead by example, as is the case for the living shoreline initiative in Mahone Bay (Withers, 2021). Community involvement can act as a driver or barrier of political will; however, a supportive community is not always enough to implement NbCA.

Political constraints can be minimized when political leaders use their leadership skills to gain public support, which can be aided by community engagement in both the planning and implementation processes. In contrast, public opposition can influence political leaders if a decision involves wider public interest, weak leadership, inadequate community engagement, or poor knowledge sharing.

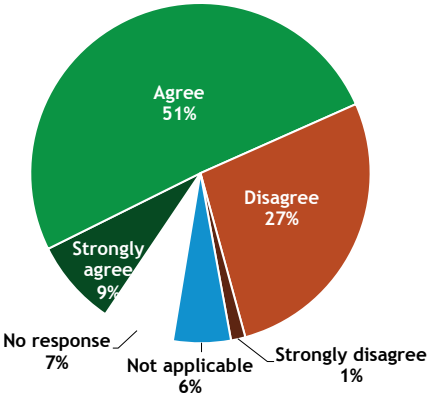

FIGURE 20a: "There is political support for implementing nature-based approaches or natural infrastructure at the coast."
Almost two-thirds of survey respondents (N=73 coastal decision-makers and practitioners) agreed with the statement.

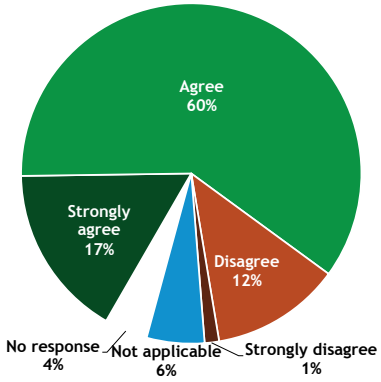

FIGURE 20b: "There is public/community support for implementing nature-based approaches or natural infrastructure at the coast."
More than three-quarters of survey respondents (N=73 coastal decision-makers and practitioners) agreed with the statement.

Research findings

In 2019, our team surveyed decision-makers and practitioners to collect information about their understanding of NbCA and their views on its use in Nova Scotia. Seventy-three participants responded. Sixty per cent of the survey participants believed that there was adequate political will (Figure 20a) to undertake these types of projects and 77 per cent believed there was adequate public support (Figure 20b).

Partnerships

> *"I think we should keep exposing the network of people that are gonna be involved with this kind of decision-making – and they're from the consulting world, the municipal world, and the provincial world – to the information, and experiences, and case studies, and field trips. But I don't think there's any one of them that is, like, the person that if they miraculously understood everything about nature-based approaches they would solve all of our problems."*
>
> *— Interview with provincial government participant*

Successful implementation of NbCA requires access to a wide body of knowledge that is only available through partnerships. Organizations within all levels of government, Indigenous organizations, NGOs, private industry, community groups, and academia can contribute information, resources, and expertise to any initiative. Each brings its own form of knowledge and expertise. Coming together in a partnership enables many organizations to share their assets and knowledge in order to reach a common goal.

Research findings

Collaboration on NbCA in Nova Scotia started with various departments within the provincial government converging to discuss vulnerability to sea level rise and potential adaptation options. A shared knowledge helped develop a common agenda for decision-making among multiple departments that had not historically collaborated on coastal issues.

It is evident from the NbCA and wetland restoration projects across the province that NbCA approaches serve the multiple environmental commitments of many departments (e.g., NSE[28], NSTIR[29], NSDA[30], etc.). The cost-benefit analysis and long-term effectiveness of various alternative adaptation approaches, such as those conducted in Truro and Mahone Bay for flood risk minimization, identified NbCA as the most immediately viable option (Marvin & Wilson, 2017; Sherren et al., 2019). These projects used advanced scientific tools and methods, and coastal practitioners assisted in promoting messages related to both flood risk management approaches and future flood potential to inform the present decision-making context.

FIGURE 21: The climate resilient coastal natural infrastructure workshop, May 2019, brought together coastal practitioners from across the country to share their knowledge and experiences. Photo: Lydia Ross.

[28] Nova Scotia Environment (now the Nova Scotia Department of Environment and Climate Change)
[29] Nova Scotia Department of Transportation and Infrastructure Renewal (now the Nova Scotia Department of Public Works)
[30] Nova Scotia Department of Agriculture

Governance Strategies

Determining the best NbCA options for an area requires understanding the governance structure and tools. The following section presents strategies for understanding governance, the barriers and drivers of each strategy, questions to consider, and illustrative case studies.

Consideration of the organization's principles

"In theory, the whole municipality should have a coherent set of policy objectives that we work together with our own mandates to support it. That doesn't always happen but that's how it should happen."
— Interview with local government participant

"...the overarching goal in, kind of, the larger impact that we want to have beyond the habitat restoration itself is to provide communities with the resources that support them and help to develop their own capacity to do this kind of coastal restoration work into the future."
— Interview with NGO participant

Every organization has a culture of decision-making and guiding principles that support it. Recognizing an organization's guiding principles and identifying where they align or conflict with the Guiding Principles in this framework will identify barriers and drivers for using NbCA. An organization's official governance and planning documents, such as charters, strategic plans, and planning strategies[31] often include mission statements, vision statements, and guiding principles which could be used to determine how they align with this framework.

Barrier or constraint	Driver or opportunity
• Organization principles conflict with or do not align with NbCA principles.	• Organization principles align with NbCA principles. • Principles of different organizations align and also align with NbCA providing opportunities for collaboration.

Questions to Consider when planning adaptation

- *What are our [the organization's, our community's] guiding principles? Where do we state these principles?*
- *Do our [the organization's, our community's] principles align with the Guiding Principles for the Making Room for Movement framework? Do they contradict them?*
- *What is our community vision? Does the vision statement reflect principles of environmental sustainability and/or resilience?*
- *What are our municipal planning goals and objectives? Do they include environmental and climate change goals and action strategies?*
- *Have we evaluated our adaptation options in the context of other economic, social, and environmental priorities?*
- *Does our municipality have a climate change action plan? What are the plan objectives? Does the plan include nature-based strategies to address climate change impacts?*

Policy and legislation scan

"...when I do something, I have to follow the present rules, but the stuff that we do in protecting the environment is a lot of [the] time outside the rules, or they cross lines. We shouldn't have to cross lines."
— Interview with community group participant

"...the red and white book [building code], that they have to – when they build something – must consider nature-based decision-making."
— Interview with community group participant

A policy and legislative scan involves identifying policies and statutes (Acts and regulations) that support implementing nature-based approaches and climate change adaptation and those that might be a barrier to implementation. Provincial policy and legislation support local level NbCA implementation. Activities that involve modifications to the coastline below the low-water mark may also require federal regulatory approval. Descriptions of legislation and governing roles at the provincial and federal level are in Appendix B.

[31] See *policy and planning evaluation*, page 37

Barrier or constraint	Driver or opportunity
• Overlapping and/or competing or contested provincial and federal jurisdiction, policies, and laws. • Lack of provincial coastal policy, planning, and management. • Lack of provincial guidance to municipalities for coastal planning, climate action planning. • Lack of a Statement of Provincial Interest on coastal protection, management, and planning. • Lack of a Statement of Provincial Interest on climate change action planning. • Contradictions and loopholes in environmental protection legislation, such as grandfathering clauses. • Lack of nature-based or ecosystem-based language or considerations in permitting legislation.	• Integrated coastal zone management. • *Coastal Protection Act* and regulations. • Wetlands protection policy, including the Nova Scotia Wetlands Conservation Policy. • Environmental impact assessment. • Climate action policy and guidance for municipalities on climate action planning. • Acknowledging provincial regulations that support environmental, natural area, and coastal protection, including statements on coastal protection regulations, wetlands conservation, protected beaches, and protected areas generally. • Provincial guidelines, standards, and regulations that municipalities adopt into their land use planning policies and by-laws and other policies and regulations that can support a regional approach to protecting environments that cross municipal boundaries.

Questions to Consider when planning adaptation

- *Is our project in the tidal zone? Does it extend to the deeper water beyond the low tide line?*
- *Is our project on the backshore or upland above the high tide line?*
- *Does our project occupy space on either side of these tide lines?*
- *Does our project incorporate wetlands? Beaches? Dunes? These sensitive habitats fall under provincial jurisdiction. Some are protected or are areas where activities require special permits.*
- *What provincial legislation supports our project?*
- *What provincial legislation contradicts or impedes our project activities?*

Municipal policy and planning evaluation

> *"...the MCCAPs [municipal climate change action plans] have been invaluable because what they're doing is this risk assessment template..."*
>
> *— Interview with provincial government participant*

> *"It's basically a nature-based planning policy, or policy framework...to say 'Here's the benefits of nature in parks and the benefits of natural processes and stuff like that, so we should be adopting that...' "*
>
> *— Interview with local government participant*

Most climate change adaptation action occurs at the local level and nature-based coastal adaptation is no exception. Municipal land use policies, planning and regulation, development permitting, environmental protection, and watershed planning and management tools will strongly influence the opportunity to use NbCA options, especially those in the backshore and upland coastal zone.

The municipal planning strategy (MPS) is the official plan in Nova Scotia municipalities. The MPS lays out a community's vision for its future, the principles that guide the community, and the strategies it will use to get there. The MPS emerges from a process of community engagement; the vision statement, goals, and objectives are a reflection of community values.

A municipal planning strategy that clearly articulates the vision of a resilient community and a healthy environment has a foundation from which to incorporate NbCA approaches to coastal land management within the municipality. A plan that acknowledges climate change and its challenges, combined with environmental awareness, policies, and strategies to work with nature, and regulations (by-laws) and implementation plans

to ensure action is especially well-equipped to support NbCA. While the MPS is the statutory plan, other planning tools can also support NbCA initiatives, including climate action plans, sustainability plans, and watershed management plans.

Research findings

The Making Room for Movement project team investigated six case studies of nature-based coastal adaptations in the province. The case studies included municipal plan evaluations to identify policy barriers and drivers for implementing nature-based adaptation to climate change impacts at the coast. The evaluation indicated acknowledgement of climate change in the plans and some policies that encourage protecting natural systems, but support for nature-based approaches was implicit, not explicit. Each plan contained contradicting policies: some could enable while others could be a barrier to implementing NbCA. See Warren, 2020 for details of the plan evaluations.

The six case studies can be found here.

Barrier or constraint	Driver or opportunity
• Lack of land use planning. • Lack of connection between provincial and local policy and planning or lack of connection in municipal planning to Statements of Provincial Interest. • Lack of planning or development regulation for coastal zones. • Lack of site planning tools. • Lack of policy or planning for environmental and natural area protection. • Lack of hazard/vulnerability/exposure/risk assessment, especially coastal climate change impacts. • Lack of environmental planning. • Lack of climate change adaptation policies and implementation strategies.	• Land use planning, in both rural and urban parts of the municipality. • Coastal protection zone in the land use by-law; development controls; set-backs (riparian buffers, vertical setbacks). • Site planning for best practice tools for coastal zones, e.g., subdivision design that includes conservation. • Green Shores-Local Government Working Group. • Environmental protection policies and regulations, including vegetation (natural) buffers upland from shoreline. • Hazard/vulnerability/exposure/risk assessment for impacts of coastal climate change. • Environmental planning, climate change adaptation policies, and implementation strategies specifically for the coastal zone. • Inter-municipal or inter-jurisdictional coordination in land use and climate adaptation planning across shared watersheds and coastlines.

Questions to Consider when planning adaptation

- *What are the municipal policies and by-laws pertaining to our project area and relevant to adaptation initiatives in the coastal zone (e.g., land use policy and by-laws; environmental protection policies, coastal setbacks)?*
- *Do the policies and by-laws enable or restrict implementing nature-based approaches in our project area? How do they enable or restrict nature-based approaches?*
- *What are supporting or compatible strategies in other planning documents such as MCCAPs (Municipal Climate Change Action Plan) or ICSPs (Integrated Community Sustainability Plan)?*
- *Does our project support the goals or objectives of the municipal planning strategy? If so, how? If not, why not?*

  [For non-governmental organizations, private industry, or other interests outside of municipal government]
- *Who can we contact in the municipality for information about local planning policies and regulations?*
- *If our project extends across municipal boundaries, are there comparable strategies and by-laws in neighbouring municipalities?*
- *What are the partnership opportunities with adjacent jurisdictions, including other municipalities, First Nations and provincial and federal government managed lands (such as parks, protected areas)?*

CASE STUDY

The town of Mahone Bay on Nova Scotia's South Shore is leading Nova Scotia municipalities in adopting a nature-based solution for climate adaptation in its coastal zone. The town commissioned the Mahone Harbour Flood Prevention and Shoreline Enhancement Plan, developed by CBCL Limited in 2016. Coastal Action, a local ENGO, obtained funding from the Intact Foundation's Adaptation Action Grant to initiate the plan in a phased approach, starting with 250 metres of living shoreline. Further implementation will include research, monitoring and community engagement. *Additional details are available here*.

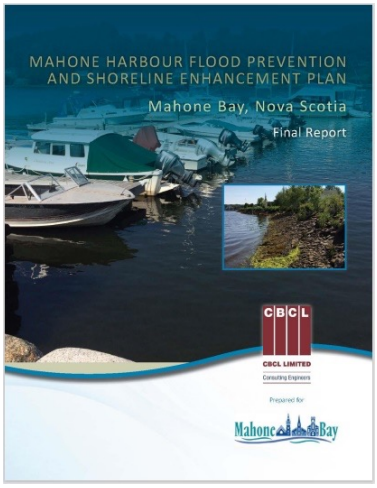

FIGURE 22: The Mahone Harbour Flood Prevention and Shoreline Enhancement Plan led to the town securing funding to implement a beginning section of the overall shoreline plan. Town of Mahone Bay, 2016.

Valuation

> *"...there's a lot of money going into mitigation. How come we can't communicate those amazing features as the mitigators that they are and show the value of them? We're not good at that..."*
>
> *— Interview with non-government organization participant*

> *"...an incremental increase in costs that gets you greater social licence and community support is now of greater value than putting down another kilometre of asphalt."*
>
> *— Interview with provincial government participant*

Valuation provides an estimation of worth, or value, which is important for understanding the net economic cost or benefit of an NbCA project for a community. Some estimates of worth can be quantified into monetary value whereas others are less tangible or even intangible, but still hold real value for a community. Values are often assigned to capture a range of impacts from social to economic to environmental. Some values have long-standing methods of valuation; for example, cultural values can be estimated based on archaeological impact assessment, and economic values can be estimated based on cost-benefit analysis. Environmental impact assessments also seek to assign values to impacts, and newer valuation methods such as blue carbon assessments have been used for natural systems. These valuation methods require guidance from experts as well as input from the community to fully capture the value of a project's expected outcomes.

Coastal ecosystems provide a broad range of services deriving from their habitat function, including commercial and recreational fish and shellfish harvesting and passive natural area recreation opportunities like birdwatching. Other services derive from the structure of the coastal ecosystem and its position along the shore, including erosion regulation, storm surge and flood reduction, and water purification. Draining, filling and then building on a site once occupied by a wetland diminishes the natural runoff regulation capacity of the landscape which the community must (but rarely does) replace with artificial retention ponds, storm drains, and water treatment facilities. Dredging or filling in coastal wetlands destroys habitat and leave shorelines vulnerable to erosion and flooding.

Recognition of the service value of natural assets is increasing, along with interest in incorporating ecosystem services into planning and decision-making (e.g., the Municipal Natural Assets Initiative[32]). Ecosystem service assessments (ESAs) support identifying and quantifying ecosystem services and benefits (see Appendix C). The ESA process also provides a way to explore the broader societal implications of a project or decision and to examine trade-offs, inequities, and intangible elements of human well-being.

Ecosystem service assessments range in complexity from a relatively simple identification of key ecosystem services and benefits to quantification and monetary valuation of all the benefits a community obtains from the ecosystem service. The type of ESA that is most appropriate will depend on the nature and scope of the project and the capacity to conduct the assessment. Regardless of the ESA methodology chosen and level of detail desired, a successful ESA requires an appropriate timeframe for meaningful stakeholder engagement and/or primary research studies

[32] https://mnai.ca

Barrier or constraint	Driver or opportunity
• Developing monetary values for natural and community assets requires a commitment for a larger endeavor that includes help from professional experts and community input.	• ESAs highlight additional social and ecological benefits that NbCA provides and that may otherwise go unrecognized.

and expert consultation. Consulting a professional (e.g., environmental economist) who is familiar with ESA early in the process will save time and resources, as they will be able to narrow down appropriate methodologies, provide guidance for information gathering, identify other expertise that may be needed, and interpret the results.

Research findings

Nature-based coastal adaptation such as managed retreat and coastal setbacks directly restore and/or prevent the loss of existing tidal wetlands and indirectly improve their health and resilience by creating space for vegetated buffers. Loss of tidal wetlands eliminates their future carbon storage potential and releases stored carbon into the atmosphere. Estimates for mid-Atlantic salt marshes suggest that the loss of approximately one hectare of salt marshes translates to $5.19 million USD for the social costs of CO2 emissions. (Carr et al., 2018). The marsh soils in the Bay of Fundy are on average four times the depth of those used in this estimate and may therefore provide a higher per hectare carbon storage capacity (Wollenberg et al., 2018).

Questions to Consider when planning adaptation

- *What ecosystem benefits will NbCA provide for our community?*
- *Will we perform an ecosystem services assessment? If so, What ESA approach will we use: with monetary evaluation of benefits (quantitative) or without (qualitative)? Which ESA tool is feasible for our organization? What is our internal capacity to conduct an ESA? What other supports or resources do we need?*
- *What are the valuable natural assets in our project area?*

Asset identification and evaluation

> *"...the district that I represent is primarily coastal, so more and more I'm hearing from residents their concerns of erosion, concerns of infrastructure being more or less busted up or destroyed because of what's happening on our coastline."*
> — *Interview with elected official*

> *"...we have a ton of infrastructure that isn't even – really, it's not even mapped out."*
> — *Interview with elected official*

It is important to consider all the assets that hold value for the community when identifying options for coastal adaptation. Assets include built infrastructure and natural assets as well as cultural and social assets that contribute to community identity. Asset mapping supports identifying risks associated with climate change impacts and opportunities for coastal adaptation.

From 2010 to 2012, thirteen Nova Scotia municipalities participated in climate change adaptation capacity building through the Atlantic Climate Adaptation Solutions Association (ACASA) initiative. The Town of Yarmouth, the Municipality of the District of Yarmouth, and the Municipality of the District of Lunenburg were among the municipalities and worked with researchers from Dalhousie University to understand coastal flooding risks to community assets (Manuel et al., 2012; Rapaport et al., 2012).

The researchers used community-based mapping and overlay mapping to identify valued social, cultural, economic, and infrastructure assets at risk of flooding from sea level rise and storm surge in 2025 and 2100. Community-based asset mapping showed that 199 of 284 assets in Lunenburg District Municipality, and 99 of 353 assets in the town and district of Yarmouth, combined, could be at risk from coastal flooding.

Research findings

Decision-makers and practitioners who responded to our survey exploring knowledge of and experience with nature-based coastal adaptation indicated that many categories of public and private assets and land uses are at risk of climate change impacts in coastal areas where they work. Participants most frequently identified roads (65 of 73 responses) and private homes (60 of 73 responses) followed by harbour infrastructure, private and municipal water and sewage disposal systems, commercial and recreation areas (selected by more than half of the respondents).

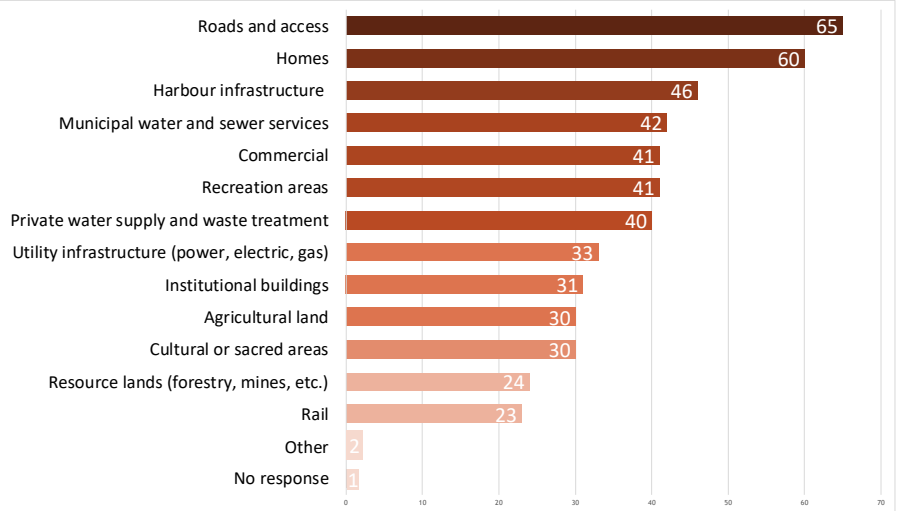

FIGURE 23: Making Room for Movement Decision-makers and Practitioners Survey, 2019. Frequency with which survey respondents (n-73) indicated categories of assets and land uses at risk of climate change impacts in the coastal areas where they work. Respondents selected options from a list and indicated all that applied, including "other."

Barrier or constraint	Driver or opportunity
• Lack of knowledge about exposure of assets to coastal processes. • Lack of monitoring of assets at risk or potentially at risk. • Assets that cannot be moved if they are, or become, vulnerable to coastal dynamics and sea level rise.	• Asset inventory and mapping. • Floodline mapping. • Assessment of asset vulnerability or exposure to risk or hazard. • Monitoring of assets at risk or potential for exposure as climate change projections change. • Natural assets already provide coastal protection and other community and ecosystem services that communities can include in their financial planning and asset management programs.

Questions to Consider when planning adaptation

- *What infrastructure and cultural assets are in high-risk coastal areas?*
- *Who in our community is located in high-risk coastal areas (e.g., residents, businesses)?*
- *What natural assets are already providing ecosystem services and what are the services?*

Risk identification and assessment

"Well, I mean, if it was something in my own community, I agree with the gentleman who just spoke... show me where it was 20 years ago, and where it is now, or where it was 50 years ago [and] where it is now and where do they project it's going, but over what time period? Are we talking about a metre, a metre rise over 200 years, or a metre rise over 20 years? That makes a big difference. I mean, if we're talking about a couple of centimetres a year, takes a long time before that works into something really significant and so I think that would be one of the keys."

— Coastal resident in focus group

"...at the end of the day, the community decided that rather than trying to manipulate they were going to just actually let nature run its course and step back. So that was an interesting project where from a living shorelines standpoint and a shoreline climate change adaptation standpoint going 'Okay, we need to stop this erosion,' but then the more they get into it, looked at it, going 'Well, actually, no. What we need to do is, we just need to get the heck out of the way and let nature do its thing'."

— Interview with private industry consultant

Conducting a risk assessment helps to identify priority areas for adaptation and the urgency of implementing a coastal management project or policy. Determining areas and infrastructure at risk requires consultation with community members and partners. Areas or infrastructure at risk may become apparent after a major storm or flooding event, through observed changes over time, or by infrastructure nearing the end of its lifespan.

Questions to Consider when planning adaptation

- *Is there protective infrastructure at the coast that is already failing or nearing the end of its lifespan?*
- *Do we know what areas and infrastructure are at risk to sea level rise?*
- *What is the level of urgency in implementing a coastal adaptation project in our project area? What areas or infrastructure should we prioritize?*
- *Are our MCCAP assessments still current? Has the situation changed since 2012–13?*
- *How will we communicate risks to others in the community?*

The province is mapping flood risk areas for the entire coastline. Between 2011 and 2013, the Nova Scotia Department of Municipal Affairs and Housing guided municipalities in preparing Municipal Climate Action Plans (MCCAPs), which involved identifying and prioritizing risks to climate change and prioritizing actions (Province of Nova Scotia, 2011; Righter, 2021).

Nature-based coastal adaptation considers the entirety of the coastline and inherently factors in the dynamic nature of the coast, allowing for a holistic understanding of risks and adaptation options (van Proosdij et al., 2016). A good risk assessment, in addition to being informed by local residents, is also a good communication tool with residents or other affected parties.

As sea levels rise, the infrastructure already in place at the coast is more vulnerable to failure and shorter lifespans. The need for change is often identified when existing hard infrastructure is not performing to an expected, or perceived, standard. In Nova Scotia there are already examples of communities looking for – and implementing – alternative, NbCA methods rather than resorting to traditional methods of coastal protection.

Research finding

Participants in our focus groups really wanted to better understand how urgent climate change issues were and asked for clearer and more direct communication on such issues[33].

Barrier or constraint	Driver or opportunity
• Data on sea level rise varies among municipalities. • Failing infrastructure is expensive to repair and may require ongoing repair into the future if new approaches aren't explored.	• Province-wide coastal flood mapping to inform minimum building elevations for the Coastal Protection Act regulations.

[33] Sutton, K. (2020). Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

CASE STUDY

Dyke infrastructure in Kings County is decreasing in effectiveness, particularly in Kentville, Wolfville, Port Williams, and New Minas. The Municipal Climate Change Action Plan for the municipalities in Kings County states that given sea-level rise predictions, many of the dykes are likely to fail. Repair and maintenance of dykes is costly and will cause finical stress for the municipalities. (Kings County 2050, 2013)

At the Belcher Street marsh, erosion of dyke infrastructure was increasing vulnerability on the landward side of the dyke. The Nova Scotia Department of Agriculture (NSDA) identified the site for managed realignment and carried out the project in partnership with CB Wetlands and Environmental Specialists and Saint Mary's University as part of the Department of Fisheries and Oceans-funded Making Room for Wetlands project. This NbCA method mitigates coastal and river flooding by realigning the dyke and implementing a living shoreline using a novel inverted root wad technique. The realignment reduced dyke length by 500m and restored 9.7ha of wetland. Furthermore, straightening the dyke will decrease erosion risks in the future.

Continued monitoring indicates that the flooded area transitioned from a mudflat into a vegetated wetland within two years of tidal waters being re-introduced. While some adaptive management was required, overall the project can be considered a success and has resulted in additional co-benefits of ecosystem services and recreation as the re-aligned dyke has become popular for local walkers. *Additional details are available here.*

FIGURE 24: Belcher Street managed realignment site. Pre-restoration (top left); immediate post-construction (top right); year one post-restoration (bottom left); year two post-restoration (bottom right).

Financial assessment

Like any project or undertaking, implementing nature-based coastal adaptation options needs resources to plan, design, build, monitor, and maintain the initiatives. Developing a budget for nature-based projects contributes monetized information to practical decisions in the short-term about proceeding with a nature-based option, and to comprehensive longer-term cost-benefit valuations of NbCA.

How much a project will cost in services, compensation, materials, and labour is crucial information for deciding to go with a nature-based coastal adaptation option and for determining how to pay for it. Knowing the cost of options may also result in re-calibrating the scale of a project to fit existing budgets or funding programs, human resource capacities, and time.

Costing natural infrastructure projects for which the coastal space is under the control of the proponent (such as landward of the highwater mark for municipalities, or with federal permits in the tidal zone or coastal water) can be straightforward calculations.

Initial considerations might include whether staff is capable and, if so, available to manage the project stages, including planning, design, installation, and monitoring. Without internal expertise, external contracting could be required for design, construction, and maintenance.

Another consideration is public-private partnership agreements for flood infrastructure projects (Chen et al., 2013). Partnerships can bolster the human resource capacity and address some costing requirements such as involving community groups as volunteers in some aspects of installation (with training as necessary) like planting, maintenance, and monitoring.

Partnerships may also open up access to funding opportunities. For example, following a study of its coastal flooding risk and solutions focusing on a nature-based approach, the town of Mahone Bay, on Nova Scotia's South Shore, committed to a coastal wetland living shoreline approach along 700 metres of its harbour. The 2015 cost estimate for installation, which also included some amenity infrastructure, was $2.5 million, well beyond the ability of a small municipality to finance.

While the municipality received a grant to pay for the study and then design the solution, it was not successful in securing other federal–provincial cost-shared funding to move the project forward. In 2020, the town partnered with Coastal Action, a local ENGO with experience in nature-based infrastructure projects. The partnership then expanded to include TransCoastal Adaptations at Saint Mary's University in Halifax. Coastal Action received a private sector grant and in 2021, six years after the project design, installation is moving ahead for 250 metres of the shore. Installing the entire project will require additional funding.

Financing infrastructure renewal and new development, generally, is difficult for communities with a small tax base. Provincial and/or federal funding programs, like the federal Gas Tax Fund, is an annual source of funding for municipal infrastructure development. In addition to physical infrastructure, the fund supports capacity development, such as the integrated community sustainability plans and the municipal climate change action plans in Nova Scotia in 2013.

Financing experimental or less-established infrastructure, like nature-based approaches, may be challenging; however, the Gas Tax program extends to disaster mitigation infrastructure to address the long-term impacts and risks associated with natural disasters.

For Mahone Bay, partnerships helped to solve some of the resourcing problems in the short-term; success with the first installation can support future funding applications, but small communities need support from targeted programs that they can rely on. In larger municipalities with potentially more capacity, natural infrastructure will still need to compete with established programs for budgets; an institutional priority shift to natural infrastructure would improve the chance for success in the competition.

Non-infrastructure NbCA approaches include planning and regulatory tools, implementation of which more commonly considers the longer-term cost–benefits of restricting development and reserving the space for coastal processes and ecosystems. A municipality could potentially forgo property or business tax income but gain in savings from emergency response and in ecosystem services.

There are direct cost considerations for some planning and regulatory mechanisms, however, notably retreat or relocate, which can involve moving public and private infrastructure out of hazard zones. Where elevated risk to flooding or erosion is becoming apparent, cost–benefit analyses would first assess the longer-term impacts within a risk timeframe for choosing the relocate option. The cost of relocating infrastructure and potentially compensating private landowners for their properties is part of the cost–benefit analysis, as is the cost for services to support the affected community in coming to terms with and planning for the move. If, as a result of the cost–benefit analysis, relocation becomes a reality, the cost becomes a real short- to medium-term expenditure. A coastal hazard emergency such as catastrophic flooding, erosion, or landslide, may also necessitate immediate permanent relocation.

The budget for relocation varies greatly depending on what needs

to move, the cost of land available for relocating the infrastructure (if land purchase is necessary), types of compensation to affected property owners, the support services required, and the time frame involved (Saunders-Hastings et al., 2020). The need to consider relocating communities at high risk of either erosion or flooding is increasing; assessing the resources available for relocation will become a critical component of adaptation planning.

There are few examples of relocation in Nova Scotia or the Atlantic region, especially large-scale relocation; however, it has occurred when hazardous conditions present themselves repeatedly. An example of this is the recurring flooding of the Saint John River in New Brunswick, which led to the purchase of 20 homes that were damaged beyond repair (Government of New Brunswick, 2012).

Another example is a slope failure in 2006 in the coastal community of Daniel's Harbour on the Gulf of St. Lawrence on Newfoundland's Great Northern Peninsula, which led to a relocation that eventually impacted 33 properties and rerouted the main highway around the community and away from the coast (Government of Newfoundland and Labrador, 2009). The government of Newfoundland and Labrador compensated property owners based on property replacement cost. Residents had eight to twelve months from the time the properties were condemned as unsafe to move to a new location.

Several more landslides followed the original event and threatened water mains in the community. In a media report of the events, the mayor describes that the community lost an estimated 30 per cent of its land mass over the several years of coastal landslides from 2006 to 2013 (Elliot, 2013). The clay-based coastal cliff at Daniel's Harbour failed due to excess water in the slope.

Barrier or constraint	Driver or opportunity
• Lack of internal budget or human resources to plan, design, install, or monitor NbCAs. • Competition for internal resources with other priorities and established programs. • Lack of published examples documenting costs of NbCA initiatives from small to large scale, and structural and non-structural approaches. • Lack of funding programs to finance NbCA. • Lack of flood and erosion hazard assessments to identify infrastructure, properties, and land uses at high risk of exposure and that may require relocation. • Continued development in flooding- and erosion-prone areas. • Reluctance to consider relocation for political, financial, or psycho-social reasons.	• Established funding programs for mainstreaming NbCA initiatives. • Partnerships with other government agencies, NGOs, and research groups experienced in NbCA, community volunteers. • Access to information on the cost of established NbCA initiatives. • Knowledge of infrastructure and land uses at risk of flooding and erosion under different climate change scenarios and different time periods. • Coastal hazard zone management, including protection zones and development restrictions. • Relocation planning, including education programs, community engagement, identification of relocation space options in the community, financial assessment, and strategies.

Questions to Consider when planning adaptation

- *What is our internal expertise to plan, design, install, and monitor NbCA?*
- *What resources can we allocate to NbCA from existing budgets and staff? What scale of initiatives can we manage internally?*
- *What funding programs support NbCA? Do we meet the eligibility requirements?*
- *What partnerships could increase our capacity to implement NbCA?*
- *For a municipality, what is the financial cost (property or business tax) for restricting land uses and development from a specified distance from the coast? Are there location alternatives in the community for these land uses?*
- *Are there properties or infrastructure in our community that may require relocation? If so, what is the replacement cost value of these properties and infrastructure?*
- *What are financing strategies for relocation? Can we self-finance? If not, what programs could support relocation financing?*

Incentives

"I look at Solar City as an example. There's a program where you're not going to regulate solar on people's houses, but they've created a program that makes it easy to do it, has all the resources in one place, has the financing in one place. HRM did it, it was successful and now everybody's kind of taking that template and other communities are starting to apply it to their community."

— Interview with private industry consultant

"...municipal government can step in and maybe provide financial incentives..."

— Interview with local government participant

Creating grants, incentives or rebate programs can encourage the adoption of NbCA by landowners. Eighty-six per cent of Nova Scotia's coastline is privately owned (Province of Nova Scotia, 2018) and offering homeowners incentives to adopt NbCA can help gain wider use of these methods. Incentives can include property tax rebates or reductions, homeowner grants, financing programs, and a Green Shores credit and rating system. All of these strategies are being used in Nova Scotia now but, with the exception of Green Shores (in BC), they have not been applied to coastal management.

The Green Shores initiative, developed by the Stewardship Centre for BC, has partnered with TransCoastal Adaptations Centre for Nature-based Solutions at Saint Mary's University to deliver its Level I and 2 training programs (https://www.transcoastaladaptations.com/green-shores). The Green Shores program uses a credit and rating system rather than a monetary incentive to promote sustainable ecosystems on the coast and minimize the impacts of shoreline development.

Barrier or constraint	Driver or opportunity
• Individual properties are not large enough to have an impact on the overall ecosystem. • Wide adoption of NbCA is needed to boost social and ecosystem benefits.	• Incentive programs that can be copied for NbCA have been successful in encouraging landowners to adopt new technologies and methodologies. • Expedited permitting can act as a legislative incentive for NbCA projects.

Research findings

Coastal practitioners interviewed in 2019 for the Making Room for Movement project saw the potential for using existing incentive programs and applying them towards encouraging NbCA. For example, participants spoke about using the Halifax Regional Municipality's Solar City (Halifax Regional Municipality, 2020) model, which involves financing the upfront cost for landowners with a low-interest lien on the property to pay back the cost of the project.

Questions to Consider when planning adaptation

- *What experience does our organization have with incentive programs? How are they transferable to NbCA?*
- *How can our organization create an incentive program to encourage landowners to adopt NbCA principles?*
- *How can incentives be offered for projects that span a length of shoreline where multiple neighbouring properties are involved?*
- *How is the Green Shores rating system applicable to our project?*

Practitioner Engagement

> *"So, everyone had to be willing to do something a little bit, or quite a bit, beyond their normal comfort zone to make it work."*
> *— Interview with provincial government participant*

The implementation of NbCA requires a collective vision of resourceful coastal practitioners with a strategic distribution of roles and responsibilities among them. These practitioners need to overcome existing inertia that impedes the implementation of NbCA. Overcoming such inertia is important in bridging disconnects among partners and mobilizing shared knowledge, financing, and other required resources.

Research findings

In our interviews with decision-makers and practitioners, participants often identified trust among all those involved as a key driver for implementing NbCA. In contrast, a lack of trust was seen as a barrier.

A trust-based network has emerged in Nova Scotia as a result of long-term collaboration. This network includes scientists from Saint Mary's University and Dalhousie University; engineers and practitioners from company's including CBWES Inc., CBCL Limited, and Helping Nature Heal; environmental NGOs including Ecology Action Centre, Clean Foundation and Coastal Action Foundation; and with officials from Nova Scotia's departments of Municipal Affairs and Housing (NSMAH), Transportation and Active Transit (now Public Works), Agriculture (NSDA), and Environment and Climate Change (NSECC). This network creates space for sharing views and ideas for building a common language and understanding among those involved.

Barrier or constraint	Driver or opportunity
• Practitioners outside of the existing trust-based network are not always aware of who to contact for support on NbCA. • Not all practitioners are confident in their understanding of NbCA and their ability to advocate for it. • Decision-makers often do not have the same level of knowledge about NbCA as the practitioners guiding their decisions. • No direction from decision-makers to pursue NbCA projects.	• There is a trust-based network of coastal practitioners who support NbCA. • Mutual support through trust-based relationships for more innovation when faced with project uncertainties. • There is increased support for NbCA at the federal level including professional development opportunities, supporting documents, and experience sharing across Canada.

FIGURE 25: Coastal practitioners and researchers learning about the tidal bore in Truro during the climate resilient coastal natural infrastructure workshop, May 2019. Photo: Lydia Ross.

TABLE 2: Practitioner Engagement Strategies Identified as Drivers for NbCA Use in Nova Scotia

Strategy	Description	Quote
Professional learning	Professional learning is vital to building knowledge within institutions and agencies. There has been an increase in the number of webinars and resources available for professional learning around NbCA, and they are becoming more accessible and common, especially with the transition to online work environments due to COVID-19. In addition to learning opportunities, national networks of professionals are supported by organizations including Natural Resources Canada, Coastal Zone Canada, Cold Regions Living Shorelines Community of Practice, and the Municipal Natural Assets Initiative.	*"…we need to have nature-based approaches as part of the training of our engineers. We also need to have that as part of the training for our planners… climate change adaptation and nature-based approaches need to be part of their training as well."* — Interview with private industry consultant
Develop a common working language	Interpreting scientific knowledge in non-technical language helps to develop a common meaning and commitment to NbCA and gives the approach legitimacy over a broader audience. This working language is built from the technical, tacit, and experiential knowledge of coastal practitioners and the communities they work within[34].	*"We need to show pictures, we need general language, we need to put it in…the local situations and scenarios that people can see, they can understand…"* — Interview with provincial government participant
Build trust-based networks	Building trust-based networks with coastal practitioners is important for normalizing the use of new technologies. Gathering multiple sources of knowledge helps to minimize individuals' uncertainty when pursuing NbCA options. Rahman et al. (2019) identified that because societal participants are less embedded in government, they are able to offer new technical solutions to government officials and provoke change to rigid institutional practices. Building networks among coastal practitioners requires mutual respect, recognition and continual dialogue to agree upon principles, norms, and rules.	*"…we like to get together every couple [of] months or every month, have a coffee and chat about things and see where we may be able to – a lot of it is just, like, we agreed to help each other behind the scenes and not in any official capacity… 'If I can help you, you can help me' and we're all moving forward."* — Interview with provincial government participant
Create and recognize opportunities	Creating or recognizing opportunities within existing governance structures is a key task for building inter-agency collaboration for the successful implementation of NbCA.	*"So, it was an interesting case where, I think, four different partners had interests that were aligned enough that we could kind of broker a deal to make it work."* — Interview with provincial government participant
Utilize authority and resources	The openness and ability of government officials involved in coastal management helps build a network of collaboration for undertaking NbCA. Representatives from different agencies of government have their own interests and priorities; they need to have the authority to represent their respective agencies in the dialogue. In these scenarios, resourceful and motivated bureaucrats can be champions for institutional change.	*"…we may need to take a couple of projects and section them off and say 'we're gonna do this this way.' And we do it all the time…with roads: 'We're gonna try this type of pavement instead of that type of pavement.' So I think, though, from a policy perspective, one of the opportunities may be to say 'government's gonna pilot a few of these things.' "* — Interview with provincial government participant
Distribute roles and responsibilities	The distribution of roles and responsibilities involved in implementing a NbCA project needs to be based on the capacity and resources available to each organization.	*"…we've got the communication back up to the federal level, we've got people listening to us, we've got funding streams… if there's support at the top and a belief in a certain kind of approach…then that really helps."* — Interview with provincial government participant

[34] The Canadian Council of Ministers of the Environment is currently developing a Natural Infrastructure Terminology Framework.

CASE STUDY

Repeated interaction among government officials helped build trust and a commitment to work as a unit towards a common goal in the case of the Onslow-North River managed realignment and salt marsh restoration project. An internal NSE-organized training program created an opportunity for the participants to communicate and interact among themselves; they could explain their respective departments' positions on coastal adaptation and find common goals. This training program enabled officials to set aside their departmental identities and hierarchal positions and communicate in an informal fashion.

Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR)[35] saw the suggested restoration as an opportunity for its compensation activities, as outlined in the provincial Wetland Conservation Policy. The NSDA recognized salt marsh restoration as an opportunity to minimize dyke maintenance cost, particularly where the dykes were no longer being used for agricultural protection. To capitalize on this opportunity, NSDA agreed to give up its jurisdictional authority over dykes and dykelands. Nova Scotia Environment, as the province's adaptation champion, supported these projects and performed an effective role in both the province's adaptation to climate change and its commitment to enhancing carbon sinks.

This project illustrates that NbCA champions within NSTIR[36] and NSDA during the NSE-organized training program was a main turning point for the project. These people had the necessary autonomy to represent their departmental interests when distributing roles and responsibilities among the government officials involved. (Sherren et al., 2019) *Additional details are available here.*

Questions to Consider when planning adaptation

- *What existing partnerships or former collaborations can we leverage for the current project or problem being addressed?*
- *What other organizations have goals that could be met using this adaptation approach?*
- *Who can we partner with that has experience with NbCA projects?*
- *Do we need help communicating NbCA to decision makers?*

FIGURE 26: Oblique aerial view of excavated channels, borrow pit and new re-aligned dyke constructed at North Onslow in May 2018 prior to breach. Site will be opened to full tidal flow in late October 2021. Photo: CBWES Inc.

[35, 36] Now the Nova Scotia Department of Public Works

Community Engagement

> *"That kind of story collection – if there was a way to do that and get both kind of the stories of devastation, but also stories where people have done something and it's worked and 'Hey, others could do this.' We need to get that information and share them."*
>
> *— Interview with NGO participant*

Community engagement is critical for connecting with the community at large, eliciting their knowledge and experiences, and gaining public and political support for NbCA projects. Engagement enables a two-way sharing of information between a project team and the wider community. The project team can educate the community on NbCA options, while the community shares locally specific information about risks, culture, and community assets. Ongoing engagements that build on previous discussions and foster trusting relationships among partners are helpful in overcoming some barriers to implementing NbCA.

Research findings

Focus group participants felt strongly that their community members would respond enthusiastically to engagement sessions on coastal adaptation issues if the events took place in the communities themselves. The experimental part of the focus groups also demonstrated that such engagement should be communicated in terms of responsibility to future generations or as a collective responsibility, however difficult[37].

Interviews from the Making Room for Movement project indicate that public engagement has helped drive an environmental approach to infrastructure projects in Nova Scotia. Participants also noted that early public engagement is important for meaningful dialogue and that discussions held after an issue arises have been complicated by public fear and misinformation.

FIGURE 27: "Meet the Marsh" was a community engagement event that invited people of all ages to learn about the Halfway River system in 2019. Photo: Caytlyn McFadden

[37] Sutton, K. (2020). Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

Communication and framing

"...we need to have it in our – in a common language... So much of the discussion to this point is, really, it's been science-heavy, it's been data-heavy and in big, broad terms which are very difficult for the individual person to understand or relate to."

— Interview with private industry consultant

"Instead of all of this effort and work being reactionary there needs to be proactive communication."

— Interview with an elected official

"Framing" describes intentionally communicating an issue to influence how listeners make sense of it, by carefully choosing what we focus on and what language we use. All communication is framed to achieve a particular outcome, whether it is to strengthen bonds or make new ones, or to simply amuse. When we frame a conversation about adaptation, we are seeking to create a receptive audience rather than an oppositional one. Framing is not about lying, misleading,or omitting facts. It is meant to show the audience how our goals may align with theirs by drawing parallels and using shared values and language. Political orientation is one way this is done; for instance, by appealing to conservatives on the basis of retaining tradition and to liberals on the basis of advancing progress (Hurst & Stern, 2020).

A range of framing devices exists for climate change communication, but it is not clear which ones work best for various contexts. For example, should we focus attention on desired future conditions or on immediate impacts, on local or larger-scale impacts, on preventing losses or making new ways of being, or on future or present generations? (Stern et al., 2020) Knowing how best to frame will be assisted in part by good groundwork in learning about the community. More complex or sensitive issues may require a more extensive social science research that can test different ways of communicating with the specific population using, for instance, experimental survey designs.

Research findings

Findings from our focus group sessions with coastal residents suggest that appealing to our duty to future generations is particularly useful in creating a sense of urgency to adapt to climate change, as well as (but slightly less so) referencing the collective meaning that comes from sacrifice. Some of the other framings referenced above may also be effective in different contexts.[38]

Trust and relationship

"...if you wanted to talk to the movers and shakers...the people that work in our group, they're either – their daughters, their sons, or their cousin's sister's brother. Like, it's a way to get the community and quite quickly – it's amazing how much influence that little group has locally because they know everybody. And that's – if you need the social licence for something, rather than coming in as government or a university, cold, into a community, you go through a group like ours..."

— Interview with NGO participant

"When we do our traditional knowledge study, we provide honorariums to each knowledge holder. But we also provide tobacco as gifts to every Elder that we work with, either in the study or outside of the study. So it's just really taking on that treaty people relationship through the project and understanding what that should look like, not from our point of view but from the Mi'kmaq point of view."

— Interview with NGO participant

The outcome of any given NbCA initiative will depend in large part on trust, which is our willingness to be vulnerable to another party in the face of uncertainty. There is a concept called "trust ecology," which describes the various characteristics of a trustor (in this case, a resident) and a trustee (a NbCA proponent) that might lead to that trustor's willingness to be vulnerable to the uncertainties NbCA may present to them (Stern, 2018). For instance, is the resident a trusting person, or risk averse, or particularly vulnerable? What are their values towards the option being discussed? Does the resident see the proponent as competent and moral and

[38, 39] Sutton, K. (2020). *Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada*. Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

FIGURE 28: At a "Meet the Marsh" event hosted by the Confederacy of Mainland Mi'kmaq and TransCoastal Adaptations at the Halfway River, ecologists talked about coastal habitat in a hands-on workshop for community members. Photo: Danika van Proosdij.

someone who has their best interests at heart? Is the proponent particularly charismatic and persuasive? The context also matters. What is the history related to the option in question, or between the parties around other issues? How might the resident think their peers would feel or behave? All these considerations lead to different forms of trust, distrust (its opposite) or, indeed, a lack of either (ambivalence). Proponents can earn trust and repair distrust through consistent and competent performance, by expressing positive interactions and shared experiences, and by putting strong controls and governance in place. All this provides good resources for proponents of NbCA.

Research finding

We observed that repeated interaction helped gain the support and commitment of marsh body members in some projects implemented in the Bay of Fundy region. By taking their queries seriously and answering them with scientific evidence, the government proponents indicated their care of and commitment to the interests of the marsh body members.

Knowledge and experience

> *"You asked about… the living shoreline and how we could best learn about that and I'm wondering if there was an area in the province, or a couple areas, where that could be started in one year, and then a year or two later people could come and see how it works and we would know of any – if there's any downside to it or that kind of thing. It's kind of brand new to many people, so I think having a show-and-tell certainly would help."*
>
> — *Coastal resident in focus group*

> *"Yes, we've had meetings here. We have a dyke that protects some farmland and some houses right now. And we've had meetings that they are finding it too expensive, and they're talking about shortening the dyke and letting some of the land go to marshland, which we were talking about the storm surges and things would certainly affect some homes. So, the community is kind of up in arms about cutbacks. They haven't decided to do this for sure, but it has been talked about and thrown around and of course most of us living here don't agree with that. We want the dyke upheld and protect everyone including the farmland. They say they're just responsible for the farmland."*
>
> — *Coastal resident in focus group*

Much environmental communication is designed with the assumption that the person on the receiving end simply lacks knowledge, or else they would be open to a new behaviour. Study after study has debunked this idea, called the "knowledge deficit model." Experiences (floods or storm damage) can be a useful lever for making a conversation relevant to an audience, particularly if those experiences are tangible, personal, and recent. While knowledge and experiences are significant parts of how we form our opinions, it is also important to know that they are often not enough on their own to motivate change. Cognitive limitations can reduce the likelihood that either knowledge or experience will encourage us to change a behaviour such as installing hard infrastructure or building too close to the coast. It can be difficult to have a multitude of things we're concerned about, and we will typically default to short-term, basic needs over longer-range ones like slow rates of climate change. We also tend to rationalize our status quo activities to avoid having to change them (this is called "motivated reasoning") and we can unconsciously manipulate facts and beliefs to do so. This helps us to continue to see ourselves as good people, which is important to everyone's well-being. This kind of reasoning is particularly prevalent when we feel threatened.

Proponents of NbCA must empathize with the complex situations of affected parties and understand that emotions will often outweigh knowledge and experience. The Reasonable Person Model (Stern, 2018) provides a set of guidelines for designing processes that will offer the best chances for rational behaviour among attendees of NbCA public engagements – for instance, including practical things like good food, breaks, and natural light, but also ensuring that people are comfortable with the activities and expectations placed on them. This is particularly important if the interactions being requested are likely to be unfamiliar, e.g., something more participatory than the typical open houses or public talks.

Research finding

The coastal residents that participated in our focus groups noted the value of having more examples of NbCA projects, for monitoring purposes. Examples can also reduce resident uncertainty about the implications of a particular project[39].

Leadership

"...I'm quite familiar with most of these nature-based activities, with the overland flow management and the living shorelines and whatnot, and I think at best they have a chequered success rate. I've been noticing where the presentations have been sourced, and it's quite a different environment that we live in. It's quite unique here. And I'm not so sure [I'm] able to 'buy the cookies from somebody else's shop' and put them in here, and I mean I hope it does work because it makes a lot of sense to do that. But I haven't seen a lot of success with it at this point."

— Coastal resident in focus group

"...if the municipalities have coastal land that was at risk, using a nature-based solution and highlighting that in your community, communicating it somehow, it would maybe increase the uptake in private residents' uses of this approach on their land."

— Interview with NGO participant

"I think I got, actually, a very good relationship with the public over the years. It didn't happen right away. Gotta fill the room more than once but after a period of time they got to trust you – the public in general... you get to be trusted after awhile, but you feed them good information. You say 'Yes, it floods here in [town] but it floods over there and it'll always be flooded over there. And it won't flood on top of the hill.'"

— Interview with local government participant

As trust ecology (page 51) would suggest, the source of a message is often as important as the nature of the message (i.e., its framing) (Hurst and Stern 2020). Thus, it is important to be alert to community dynamics and, if possible, tap into existing networks to transmit information and influence the way options are perceived. People never lose the desire to belong. Moreover, we are more influenced than we realize by the behaviour of others and often use cognitive shortcuts by adopting the thinking of opinion leaders in our communities of geography or identity.

Proponents of NbCA can use this knowledge when rolling out a new initiative and should take care to identify and engage with those who have influence over others. Proponents may also use this understanding of trust ecology to avoid having as the champion of a process someone who is a controversial figure for some other reason – for example, a person who is seen as radical, or a "come from away" who has not yet gained the community's trust. The risk is that a good idea may be shunned along with the person promoting it if a poor choice of local champion is made. Of course, this calls for a very fine-grained understanding of a given context and cannot be fully controlled. All members of a community deserve to be engaged.

Understanding the history of community conflict

"What is that plan? And does it include moving us quickly away from our homes? And if it doesn't, how much money is government prepared to spend for adaptations locally, given the disparity in populations between rural and urban populations in Nova Scotia, for instance? The population of Digby County is minute compared to urban populations even in this province. So, is the government prepared to spend resources to save these areas or do they just want to put up gates and say, 'Do not enter'?"

— Coastal resident in focus group

Discussions of NbCA should not proceed without the proponent having a good understanding of past experiences that the particular place, or nearby places, have had with the various options on the table. Stern (2018) considers the most important starting point for understanding the social dimensions of environmental management is the history of conflict over the issue at hand. Communication strategies will be entirely different depending on whether there has been low conflict or an acute or prolonged conflict.

At the very least, non-community proponents should consider undertaking media analysis and key local interviews to establish what experiences the subject community has had, directly or indirectly, with both climate impacts and NbCA options. To understand the community's history of conflict or experiences, proponents should ideally go beyond public opinion polling in an effort to elicit the reasons for local opinions. These will emerge best through interviews or oral history approaches.

Research findings

A few focus group participants spoke of the clearing of Newfoundland outports in the 1960s and 1970s as a reference point for discussions of coastal adaptation, and voiced suspicions that this might be the longer-term government strategy in relation to retreat options. Such cultural touchstones might shape local responses[40].

Questions to Consider when planning adaptation

- *Have you gained the trust of local community members or engaged with them in the past?*
- *Will you be returning to the community for future engagements?*
- *Who are the trusted local champions in the community you are engaging with?*
- *What are some recent examples of storms or flooding that community members can relate to?*
- *Are there local examples of NbCA you can provide to the community?*
- *Have buy-outs been mooted in the past?*
- *Have citizens protested re-zoning efforts taken to avoid future risk?*
- *Has a community or sub-community been historically relocated against their will; for example, Mi'kmaq or Black Loyalists, who were relegated to marginal landscapes?*

Further information about community engagement

Barrier or constraint	Driver or opportunity
• Public fear and miscommunication occur when urgent coastal issues arise in response to storm events and infrastructure failure. • Trust has not been built between a project proponent and community over time (can be more difficult for outsiders). • Coastal residents are not aware of examples they can look to for understanding NbCA in their local context. • People rationalize their behaviour to avoid changing it and may interpret facts to support their current behaviour. • Emotions outweigh knowledge and experience.	• Community members have close, personal knowledge of their own areas and can provide history and details about project areas. • Practitioners can gain public support by sharing their knowledge and building trust through ongoing engagements. • Working with established local champions helps to gain community trust when coming in as an outsider. • Framing conversations as a duty to future generations or collective responsibility helps with public reception of change. • Members of the public are gaining an awareness of NbCA and are already advocating for, enquiring about, and supporting NbCA. • Discussing experiences (i.e., storm and flooding events) makes information relevant and relatable to members of the public.

[40] Sutton, K. (2020). *Understanding perceptions of coastal climate change and nature-based coastal adaptation: Using communicative framing in experimental focus groups in Nova Scotia, Canada.* Unpublished MES thesis, School for Resource and Environmental Studies, Dalhousie University. http://hdl.handle.net/10222/80147

CASE STUDY

Carter's Beach is located near the community of Port Mouton on Nova Scotia's South Shore. The area is known for its community engagement in environmental stewardship. Carter's Beach and adjacent public land comprise a candidate provincial Nature Reserve under the provincial Parks and Protected Areas program. The Carter's Beach Community Liaison Committee provides community input and direction to the province on the management of Carter's Beach. Carter's Beach requires sensitive management and stewardship. The dunes at Carter's Beach comprise a full sequence of sand dune ecology and include rare lichens, mosses and orchids. The dunes are the highest on Nova Scotia's Atlantic coast. Healthy dune ecosystems are essential for ensuring coastal resilience to climate change impacts. The local community was concerned about the deterioration of the dune ecosystem at the beach. The Carter's Beach Community Liaison Committee engaged a geologist who studied the dunes and provided recommendations for management. The Carter's Beach restoration project has brought together volunteers from the community and local research and education organizations. The restoration involves planting Marram grass and monitoring growth, setting up physical barriers to discourage people from walking in the dunes, and installing signs so that beachgoers can understand the restoration project, why it is necessary, and how their behaviour affects the dunes. The hope is that education will foster cooperation and responsible use of Carter's Beach. The community conducted a survey to understand how people view dune health issues and solutions (Smith et al., 2019). The survey shows that 40 per cent of the 609 participants cannot recognize dune problems and more than half of the participants do not understand solutions (Smith et al., 2019). Restoration, education, and monitoring efforts are still ongoing, driven by the community of citizen scientists and volunteers at Carter's Beach.

See for example the Port Mouton story map here. Additional details are available here.

FIGURE 29: Marram grass growth and educational sign at one of the Carter's Beach dune restoration sites (left to right: April 2018, September 2019, September 2020. Photos: Coolen in Smith et al., 2019

THE PURPOSE OF THE Making Room for Movement project was to accumulate a wide body of knowledge about NbCA in Nova Scotia and summarize it as a generic guiding framework in order to pass along critical information to practitioners and those making decisions along the coast. Figure 30 summarizes the Making Room for Movement adaptation framework, which graphically recalls Heberlein's (2012) metaphor of rafting on a mountain river: one knows from the currents on the surface of the water roughly where the clear routes are and the rocks are, but you can't remove the rocks, you have to navigate them (Rahman et al., 2021). Similarly there are some rocks, or barriers, in nature-based adaptation that require careful navigation.

The top of Figure 30 represents "clear water." The top left current presents the seven guiding principles that emerged through our empirical work, as well as literature and policy review as critical principles for practitioners and decision-makers considering NbCA.

The top right current presents a sequence of steps required for implementing NbCA, as discussed in the *Implementing Nature-based Coastal Adaptation* section (page 24). These rotate around a reframed set of NbCA options that we have called the Five R's. These options include reserve, relocate, realign, and reinforce, but all of those call for a fundamental reimagining of the coast and what it means to inhabit it.

The third current, at the bottom, is where the rocks are: it represents places where barriers to NbCA could exist, as discussed throughout the *Implementing Nature-based Coastal Adaptation* section. Barriers are often interconnected – for instance, social-psychological issues influencing political will – but they are surmountable. We identify a number of strategies to navigate barriers that are aligned with the overall principles, building on many case studies in the region.

The Making Room for Movement adaptation framework as illustrated in Figure 30 is a quick reference for coastal practitioners and other users, built from rich engagement in the Nova Scotia context.

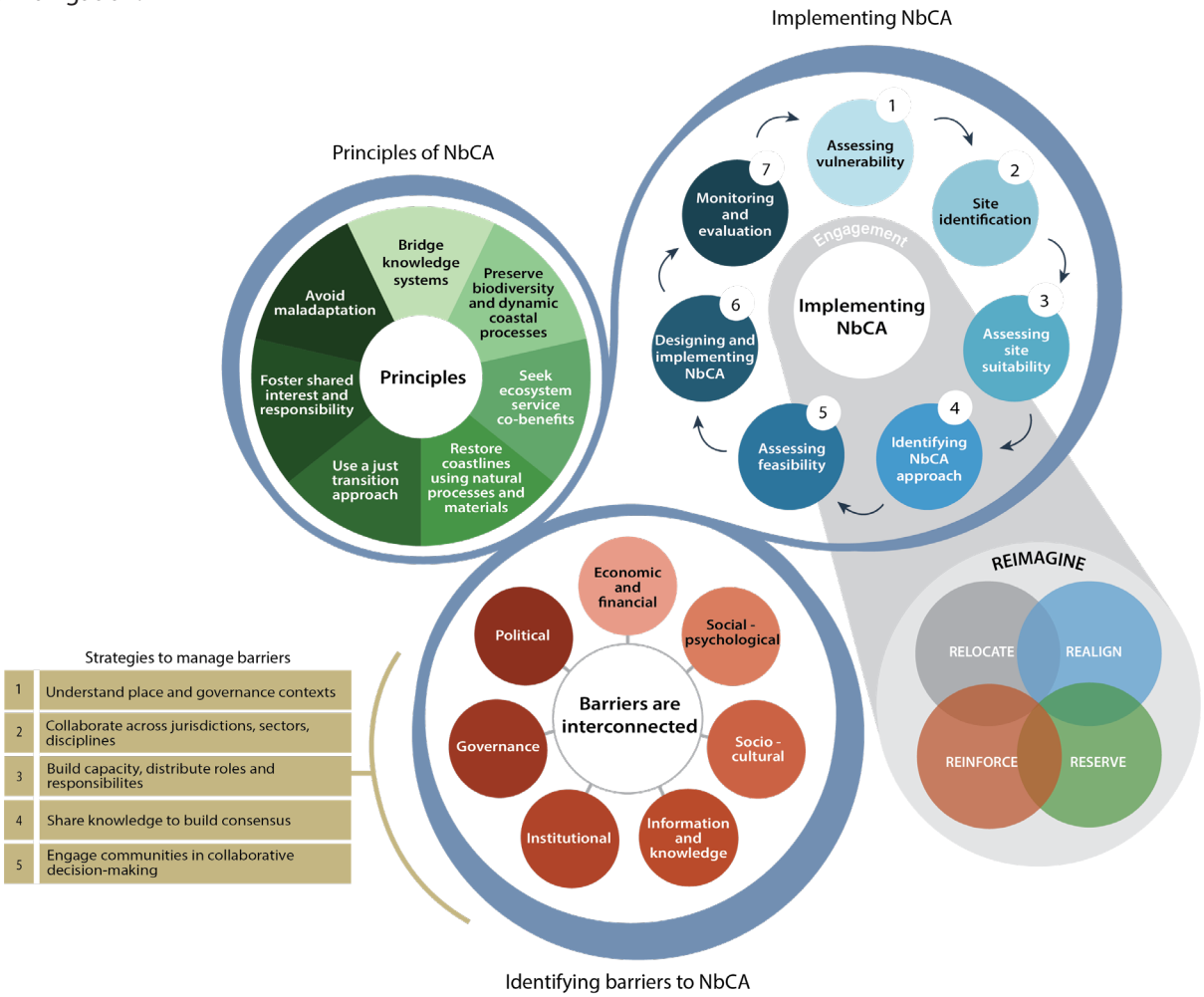

FIGURE 30: Making Room for Movement framework synthesis

CONCLUSION

NOVA SCOTIANS HAVE LIVED and worked along the coast for generations and have developed a sense of identity that is rooted in the coastal environment and its resources. This identity has attracted development in coastal areas that threatens ecosystems and places communities, services, infrastructure, and land use at risk of flooding and erosion, which will be exacerbated by climate change. Recognizing those risks and determining a path forward to create more resilient coastal communities is at the forefront of NbCA. Nature-based coastal adaptation is a means to help communities, practitioners, and decision-makers re-imagine the relationship with the coast and to bring forward an understanding of the benefits of coastal ecosystems into the mainstream.

Hard infrastructure has traditionally been the chosen method of coastal protection in Nova Scotia; however, increasing awareness of alternative options and a need to diversify our landscapes to reduce coastal squeeze and increase resilience, has led to important shifts throughout the province. Examples of this can be seen in the case study examples of Mahone Bay and the Truro North Onslow Managed Realignment Project where municipalities are choosing NbCA options rather than traditional hard armouring approaches. Another example of this is the introduction of Nova Scotia's Coastal Protection Act to regulate the ways in which development can occur along the coast.

There is growing recognition that coastal adaptation options must work with the dynamic nature of coastal environments to make room for natural processes to occur – i.e., making room for movement. This includes making room for coastal ecosystems and processes to migrate inland over time in relation to changing conditions.

The Making Room for Movement framework presented here provides concepts and tools for practitioners and decision-makers: guiding principles, barriers and strategies to manage them, implementation steps, and a new conceptualization of NbCA options, the Five R's. This is the first such framework to emerge *from* the Nova Scotia context *for* the Nova Scotia context, to ensure a safe, liveable and resilient coast in the face of its particular coastal challenges in the decades ahead.

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APPENDIX A – Additional Resources

Use existing natural resource and ecosystem management strategies

- Greater Than the Sum of Its Parts: Toward Integrated Natural Resource Management in Canada – Council of Canadian Academies
- Integrated Resource Management in Nova Scotia – Nova Scotia Department of Lands and Forestry
- Summary of integrated watershed management approaches across Canada – Canadian Council of Ministers of the Environment

Preserve biodiversity and dynamic coastal processes

- Nature-based solutions for people and planet – International Union for Conservation of Nature

Restore coastlines using natural processes and materials

- Engineering With Nature – US Army Corps of Engineers
- Building with Nature – Ecoshape

Seek ecosystem service co-benefits

- Municipal Natural Assets Initiative

Use a just transition approach

- The Long Time Project
- Deliberative Futures Toolkit: toward future-oriented communities and decision-making

Avoid maladaptation

- Coastal Community Adaptation Toolkit – Atlantic Climate Adaptation Solutions Association (ACASA)

Coastal landscape analysis

- Adapting to Climate Change In Coastal Communities of the Atlantic Provinces, Canada: Land Use Planning and Engineering and Natural Approaches – Part 1 – ACASA
- Coastal Risk Assessment and Adaptation Options at Miseners Long Beach, Lower East Chezzetcook, Nova Scotia – CBCL Limited

Jurisdiction

- Protecting the Coast: A Multi-Jurisdictional Legislative Review – East Coast Environmental Law Association
- Terms of Reference for a Mi'kmaq–Nova Scotia–Canada Consultation Process – Indigenous and Northern Affairs Canada

Policy and Planning Evaluation

- Municipal Climate Change Action Plan Guidebook – Nova Scotia Department of Municipal Affairs

Asset Evaluation

- Yarmouth: A Case Study in Climate Change Adaptation Part 2 Section 3: Social Asset Identification and Climate Change Impact Risk Mapping in Yarmouth, Nova Scotia – ACASA
- Municipality of the District of Lunenburg: A Case Study in Climate Change Adaptation: Part 2 Section 3: Social Asset Identification and Climate Change Impact Risk Mapping in the District of Lunenburg, Nova Scotia – ACASA

Valuation

- The Blue Carbon Initiative
- The Bay of Fundy Blue Carbon Story
- Carbon pricing dashboard – World Bank
- Verra

Incentives

- British Columbia Island Trust Conservancy
- Open Space Taxation Act of Washington State
- Smart Prosperity Institute
- Green Shores BC

Community Engagement

- Climate Adaptation Workshop Delphi Study Report: Facilitators' Viewpoints on Effective Practices – Virginia Tech and EcoAdapt
- Consultation – Nova Scotia Office of L'nu Affairs

APPENDIX B – Jurisdictional Roles

Federal resources and regulations

Resources

The federal government has been supporting NbCA with funding, education, science and research, and publicly available supporting documents. The departments supporting NbCA include Natural Resources Canada (NRCan), Fisheries and Oceans Canada (DFO), and Environment and Climate Change Canada (ECCC). For example, DFO has funded 40 projects across Canada through the Coastal Restoration Fund (Fisheries and Oceans Canada, 2019). Natural Resources Canada has also been supporting NbCA projects by funding supporting documents (such as Making Room for Movement) and knowledge sharing through webinars.

Regulations

The federal government is responsible for all activities that occur below the low-water mark. Federal regulations are important to be aware of when working at the coast. Federal legislation relevant to NbCA projects with activities below the low-water mark include:

1. Fisheries and Oceans Canada
   - Canada's Oceans Strategy
   - Oceans Act
   - Species at Risk Act
   - Fisheries Act

2. Environment and Climate Change Canada
   - Canada Wildlife Act
   - Canadian Environmental Protection Act, 1999 (CEPA 1999)
   - Fisheries Act, Migratory Birds Convention Act, 1994 (MBCA)
   - Species at Risk Act (SARA)
   - Canadian Environmental Assessment Act, 2012

Municipal planning and regulations

All land in Nova Scotia falls within a municipal boundary and any coastal project involving land above the high-water mark will need to comply with local regulations. Municipalities have land use planning authority through the Nova Scotia Municipal Government Act; they execute their authority for planning and development within their jurisdiction through the adoption of municipal planning strategies and land use by-laws. Many rural areas within the municipalities of Nova Scotia do not have land use planning in place but are now required to implement land use planning by the year 2023.

Indigenous resources and regulations

When undertaking a NbCA project, proponents should consider a Mi'kmaq engagement strategy which would outline best practices and processes, contacts, key messaging and methods for involving and engaging Mi'kmaw communities within Nova Scotia.

Guidelines for engaging with and involving the Mi'kmaq could include:

- Prioritize meaningful partnership that is based in shared benefit, reciprocity, and trust.
- Prioritize consultation where partnership is not possible.
- Incorporate Mi'kmaw values and ways of knowing for a more comprehensive understanding of coastal areas.
- Identify points of concern and opportunity that are relevant to Mi'kmaw groups.

Meaningful engagement can occur when particular principles are applied. For a proponent, this means gaining an understanding of Mi'kmaw communities, history, and rights, as well as engaging in a respectful and open process. The outcome of meaningful engagement is trust and collaboration, with the ultimate goal of advancing reconciliation (Lynch, 2019).

In Nova Scotia, the duty to consult is outlined in the Terms of Reference (TOR) that was jointly established by the Assembly of Mi'kmaw Chiefs, the Province of Nova Scotia, and the Government of Canada. The TOR is a made-in-Nova Scotia consultation process and was officially signed by the three parties in 2010. It recognizes that the Mi'kmaq never surrendered title to their land and still possess rights of Nova Scotia lands. Further, the document outlines how the province must consult with the Mi'kmaq on projects that may pose an impact to rights and title, including Crown land, water, and other natural resources (Mi'kmaq–Nova Scotia–Canada, 2010).

It is important to note that the duty to consult does not lie with the proponent; rather, that duty rests with the Crown, notably on projects that require provincial permits or licences. However, the Province will typically delegate all or a portion of the consultation activities to the proponent, as in practice they remain the project expert. To guide the process, the Nova Scotia Office of L'nu Affairs (formerly Aboriginal Affairs) has prepared guidelines for proponent consultation with the Mi'kmaq. A copy of this document can be found in the reference list (Province of Nova Scotia, 2012).

As part of an engagement plan, it is essential to consider the benefits of a particular project to Mi'kmaw communities as a means of advancing reconciliation and forming relationships based on trust and reciprocity. This may include building community capacity, such as employment,

training and educational opportunities, in addition to collaboratively identifying potential benefits that may arise in the habitat, flora and fauna restoration.

Below is a list of potential benefits:

- participation on project committees (e.g., advisory, monitoring)
- scholarships
- skills training (e.g., field work training)
- employment (e.g., student research assistantships or summer student sharing with the MCG)
- educational opportunities (e.g., school tours)
- data/info sharing

Provincial resources and regulations

Department	Relevant legislation	Role, programs and experience with NbCA
Department of Municipal Affairs and Housing	Municipal Government Act, Schedule B – Statements of Provincial Interest Provincial subdivision regulations Minimum planning requirements regulations	The Department of Municipal Affairs and Housing acts as the liaison between the province and Nova Scotia's municipalities and maintains the legislative framework for municipal operations. The department provides advice, assistance, and support to municipalities in the development of strategies, policies, programs, initiatives, and funding opportunities. The department also makes available programs, funding, and grants to community groups. The Department of Municipal Affairs and Housing administered the development of the Integrated Community Sustainability Plans and Municipal Climate Change Action Plans for the municipalities of Nova Scotia. In 2018 the department began managing the provincial flood mapping program, including river and coastal flooding. In 2019, the province approved the Minimum Planning Requirements Regulations under the Municipal Government Act and the Halifax Regional Charter. Prior to 2019, land use planning was optional for municipalities and was not well-developed outside of urban areas. With the new regulations municipalities must create land use plans that will meet specified minimum standards and will adhere to the Statements of Provincial Interest on agriculture, drinking water, flooding, infrastructure, and housing. Statements of Provincial Interest outline the province's vision for protecting Nova Scotia's land and water and address issues related to the growth of communities.
Department of Environment and Climate Change	Coastal Protection Act Environment Act Sustainable Development Goals Act Nova Scotia Wetland Conservation Policy Wilderness Areas Protection Act Special Places Protection Act	The Department of Environment and Climate Change is responsible for the management and protection of the environment through designation, monitoring, and inspection, including air, land, water, food safety, and some aspects of fisheries and aquaculture. The department is the lead agency for climate change action. The department has responsibility for coastal protection through the Coastal Protection Act; implementation of the coastal protection zone regulation will be through municipal development approvals and land use regulation. Protection of coastal wetlands falls under the Wetland Conservation Policy and associated regulations. The department has represented provincial involvement in the Atlantic Climate Adaptation Solutions Association (ACASA) which facilitated province-wide capacity building for climate change adaptation. The department has partnered on NbCA projects by coordinating the engagement process among project actors.
Department of Natural Resources and Renewables (formerly Lands and Forestry)	Crown Lands Act Beaches Act Beaches and Foreshores Act Wildlife Act Conservation Easements Act	The Department of Natural Resources and Renewables manages activities on Crown lands in Nova Scotia. Crown lands cover around 29 per cent of the province's land and includes most of the land between the mean high-water mark and low water mark; the exception to this is federally and privately (pre-confederation water lots) owned coastline. The department has an integrated resource management (IRM) process in place to guide government decisions on Crown land use. A variety of interests for Crown lands have the potential to cause conflicts. The IRM process is used for all applications for activities and leases on Crown lands in order to minimize land use conflicts.
Department of Agriculture	Agricultural Marshland Conservation Act	The mandate of the Department of Agriculture is to support the development of the agriculture and agri-food industries in Nova Scotia. The department has recently developed an evidence-based dykeland decision tool (DDT) to determine the most feasible design options for Nova Scotia's provincial dykeland system. The DDT examines nature-based solutions (e.g., managed realignment and tidal wetland restoration) alongside traditional engineering approaches (e.g., dyke reinforcement, aboiteau upgrade/construction, drainage improvement, and/or creation of dykeland system management plans). For example, managed dyke realignment and restoration of tidal wetlands has been conducted at Belcher Street (Cornwallis River) and Converse (Missaguash River).

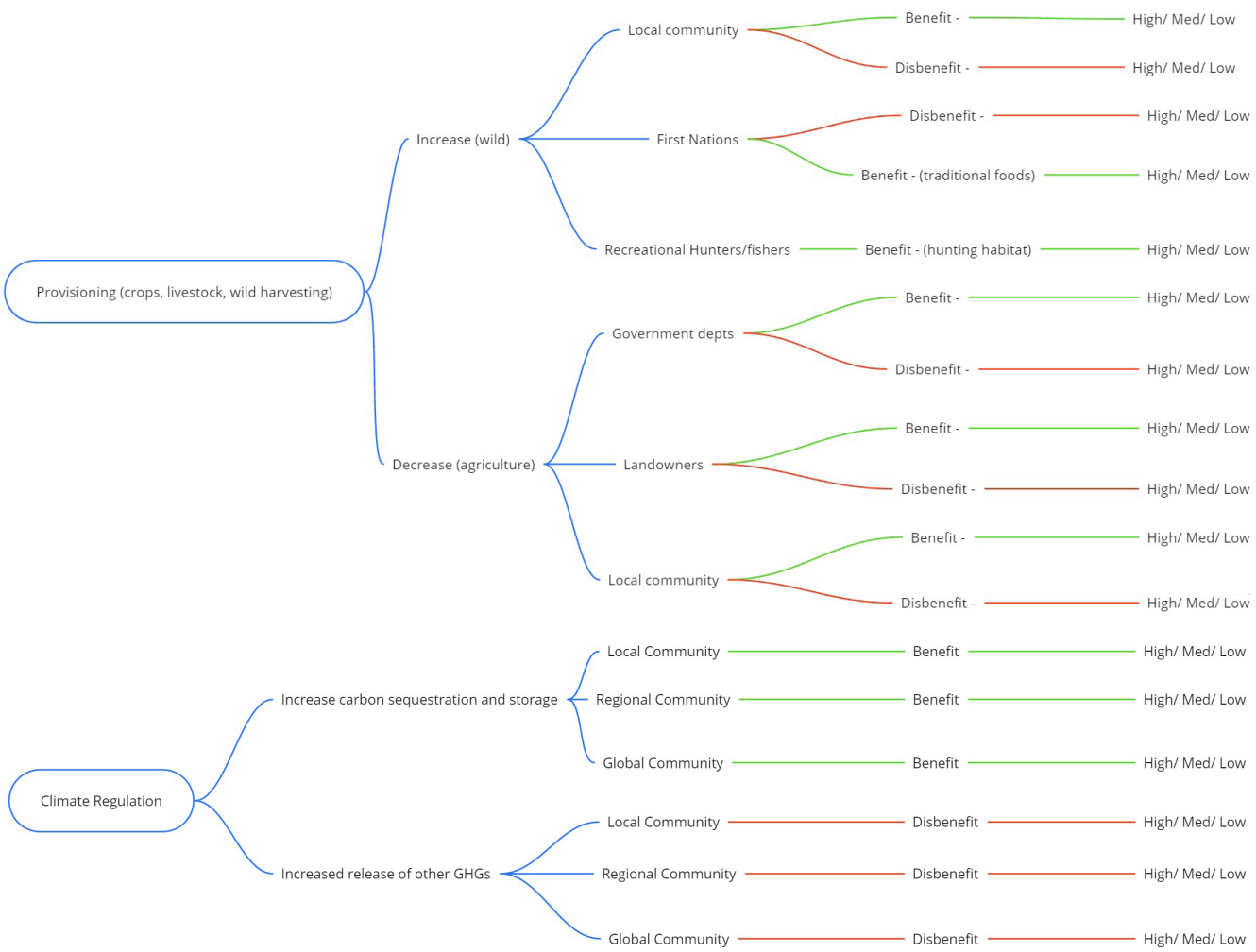
Provincial resources and regulations (*continued*)

Department	Relevant legislation	Role, programs and experience with NbCA
Department of Public Works (formerly Transportation and Active Transit)	not applicable	The Department of Public Works has partnered on NbCA projects through the wetland compensation requirements of the Nova Scotia Environment Act. The department also coordinates funding and engineering resources for provincial projects conducted by other departments.
Department of Communities, Culture, Tourism and Heritage	Special Places Protection Act	The Department of Communities, Culture, Tourism and Heritage is responsible for the well-being and prosperity of Nova Scotia communities and our culture, heritage, identity, and languages. Its mandate is relevant to NbCA projects where the landscape history of a place, including archaeological sites or artifacts, may be altered through project activities.
Department of Fisheries and Aquaculture	Fisheries and Coastal Resources Act	The Department of Fisheries and Aquaculture is responsible for the management of eel grass beds, seaweed aquaculture, and shellfish harvesting.

APPENDIX C – Ecosystem Services Mind Map

This mind map shows various aspects of evaluating the benefits and disbenefits of a hypothetical NbCA project. It serves as an example of the types of services, effects, and stakeholders/rightsholders that need to be considered and how their importance could be evaluated by experts along with the local community.

Ecosystem Service	Effect of Project	Stakeholders/ Rights Holders	Benefit/Disbenefit	Importance Rating



Ecosystem Service	Effect of Project	Stakeholders/ Rights Holders	Benefit/Disbenefit	Importance Rating
Erosion Regulation	Decreased erosion rates	Local residents	Benefit - secure access	High/ Med/ Low
			Disbenefit -	High/ Med/ Low
		Businesses	Benefit - reduced risk	High/ Med/ Low
			Disbenefit -	High/ Med/ Low
		Land owners	Benefit - property values maintained	High/ Med/ Low
			Disbenefit - cost of project	High/ Med/ Low
		Visitors	Benefit - secure access	High/ Med/ Low
			Disbenefit -	High/ Med/ Low
		Government depts	Benefit - Less maintenance costs	High/ Med/ Low
			Disbenefit - cost of project	High/ Med/ Low
		First Nations	Benefit - protect archeological resources	High/ Med/ Low
			Disbenefit -	High/ Med/ Low
Recreation and Tourism	Stable/ No change in visitor numbers	Local residents	Benefit - waterfront enjoyment	High/ Med/ Low
			Disbenefit - aesthetic change	High/ Med/ Low
		Businesses	Benefit - more people drawn to waterfront	High/ Med/ Low
			Disbenefit -	High/ Med/ Low
		Visitors	Benefit - waterfront more accessible	High/ Med/ Low
			Disbenefit -	High/ Med/ Low