THE FUTURE OF NOVA SCOTIA'S DYKELANDS: UNDERSTANDING THE LANDOWNERS' PERSPECTIVE

by

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A Thesis Submitted to Saint Mary's University in

Partial Fulfilment of the Requirements for the Degree of M.A. Geography

August, 2021, Halifax, Nova Scotia

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August 27, 2021

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Abstract

In the 1600s, French Acadian settlers built dykes to drain tidal wetlands for agriculture. Much of these dyked lands or dykelands exist today but are vulnerable to sea level rise and flooding. Managed dyke realignment is one approach that supports a new tidal marsh buffer. Little is known about how landowners view managed realignment as an adaptation strategy in Nova Scotia. Communicating with groups of landowners known as marsh bodies about managed realignment has shown promise in implementing it on dykelands. Property owners (n=12) within a marsh body were randomly selected and interviewed over the phone. Positive views of managed realignment were supported by knowledge of its implementation and an inevitable view of climate impacts. Support for managed realignment conflicted with aesthetic, environmental, and agricultural values. Future work should incorporate the views of stakeholders and Mi'kmaq communities to capture the full range of trade-offs inherent with managed realignment on dykelands.

Date: August 27, 2021

Acknowledgements

This thesis document and the entire research journey would not have been possible without the help and support of many people. First, I'd like to thank Dr. Danika van Proosdij for her support during the research as well as the opportunity to conduct it. Thank you to Kate Sherren for providing valuable guidance during otherwise uncertain times. To my external examiner, Dr. Ronald Rudin, I send my appreciation for taking interest in my research and contributing valuable information in the discussions.

Thank you to everyone who helped me execute the research, including Chris Ross and the Nova Scotia Department of Agriculture for their early insight. Additionally, thank you to the twelve people who participated in the interviews for your contributions and the kindness you all showed me. Your eagerness to help others despite global challenges reminds me fondly of my Cajun roots. I am thankful for these Acadian ancestors who inspired me to persevere during all parts of the research process.

Lastly, thank you to my new family in Canada, as well as my friends and family back home, for believing in me and pushing me to succeed. I am beyond blessed to have been able to learn, grow, and experience life alongside all of you.

Chapter 1
Introduction

1.1 Research Topic

Beginning in the 17th century, Acadian settlers along the Bay of Fundy built embankments known as dykes to drain tidal wetlands for agriculture. By taking advantage of the region's high tidal range, the Acadians built dykes with innovative sluice gate structures to drain water behind the dykes during low tide. The reclaimed land was more fertile than the surrounding uplands and allowed the Acadians to produce enough crops for subsistence, as well as a modest surplus for trading (Bleakney, 2004). The forced deportation of many Acadians by British Governor Charles Lawrence in 1755 threatened to return many of these reclaimed lands back to the sea. Instead, the arrival of new settlers from the New England colonies expanded the practice of reclaiming marshland for agriculture. Over time, the practice of marsh reclamation through dyking expanded across the Bay of Fundy and produced many working landscapes including the UNESCO World Heritage Site, The Landscape of Grand Pré (UNESCO, 2012).

Today, these reclaimed lands, referred to as dykelands, are still used primarily for agriculture. However, in many cases the dykes themselves are now responsible for protecting non-agricultural property. Dykeland has been developed into homes, businesses, and infrastructure. Because many of the dykes were originally designed to protect agricultural land, some dykes cannot keep up with the relatively higher standard needed for protecting community property. As

a result, some dykeland communities today are vulnerable to flooding (van Proosdij et al., 2018).

Dykeland flooding is expected to worsen with climate change. Sea level rise as a result of climate change will exacerbate flood risk for communities around the world (IPCC, 2019). Nova Scotia in particular may see a rise in sea level between 75 and 100 cm by 2100 (Bush and Lemmen, 2019). Many dykes in Nova Scotia do not meet the critical elevation required to prevent an 85 cm rise in sea level, and therefore intervention is required to prevent both social and economic losses (van Proosdij and Page, 2012).

The Nova Scotia Department of Agriculture (NSDA) is tasked with maintaining many of the dykes, but has suggested that continuing to reinforce dykes using traditional methods such as dyke topping could strain already limited financial resources (van Proosdij and Page, 2012). One adaptation strategy is to restore some dykeland back into tidal marsh through a process known as managed realignment (French, 2001). Reconnecting a dykeland landscape with natural tidal input could support marsh restoration via sediment deposition and subsequent vegetation colonization. The new marsh can act as a buffer to coastal flooding and can more naturally adjust to changes in sea level (Singh et al., 2007). Managed realignment has largely been studied and implemented in the European context (French, 2006). Managed realignment projects have recently been introduced into Nova Scotia in select locations (Sherren et al., 2019; Bowron et al., 2012). While managed realignment continues to be studied, its potential for supporting foreshore marsh development

suggests a viable alternative for adapting some reclaimed landscapes to sea level rise (Esteves, 2014).

Planning managed realignment requires collaboration with local stakeholders to limit potential conflict (Roca and Villares, 2012). Landowners are stakeholders with important roles in planning and implementing climate change adaptation proposals (Field et al., 2017). Private landowners in Nova Scotia are particularly important stakeholders who own roughly 86% of the coastline (CBCL Limited, 2009). Some dykeland owners are members of a marsh body, a collective of landowners incorporated by the *Agricultural Marshland Conservation Act* c.22, s.1 (Sherren et al., 2019). Under the Act, landowners within a section of dykeland may petition to become an incorporated marsh body with the power to acquire land, settle disputes, and maintain works including dykes and aboiteaux (*Agricultural Marshland Conservation Act* 2000, c.22, s.1). The unique governance system of marsh bodies, along with the high rate of coastal landownership, suggest the importance of understanding how dykeland landowners view managed realignment within the unique context of marsh bodies.

This project will build upon existing research in Nova Scotia that surveyed citizens on dykeland adaptation strategies (Sherren et al., 2016). We will explore current land management, flood risk perception, and views on managed realignment among dykeland owners specifically. Additionally, incorporating the social and historical context of marsh bodies could identify some of the underlying factors that inform a landowner's views on managed

realignment. Understanding how landowners view managed realignment can improve future outreach by recognizing gaps in communication as well as opportunities for mutual understanding. Identifying the key drivers and barriers of managed realignment would contribute to a more collaborative implementation in Nova Scotia while enriching understanding of its potential application more broadly.

1.2 Purpose and Rationale

This research addresses how landowners view their property within the context of sea level rise and their views on adaptation strategies such as managed realignment. While no research has been done on public perception of managed realignment in Nova Scotia, past implementation on the Cornwallis and Missaguash Rivers and current plans for the Onslow River suggests that it will be used in the future. The NSDA's new Working with the Tides program, funded by the Disaster Mitigation and Adaptation Fund (DMAF), includes options for managed realignment alongside traditional dyke topping and holding the line (NSDA, 2021). This indicates a shift towards considering managed realignment as an alternative to traditional hard-engineering when holding the line is no longer feasible. Understanding how landowners view managed realignment will assist decision-makers and researchers in designing communication that identifies areas of mutual agreement to build from.

The research also considers the marsh bodies in Nova Scotia and how they influence landowner perceptions of managed realignment. Consultation with marsh bodies has been shown to help communicate and implement

managed realignment projects (Sherren et al., 2019). A marsh body's responsibility to vote on development within the marsh body under the Agricultural Marshland Conservation Act 2000 c.22, s.1 gives them significant power to make decisions on proposed projects. The demonstrated ability of some marsh bodies to work together to protect dykeland from non-agricultural development in *Bishop-Beckwith Marsh Body v. Town of Wolfville, 1996* suggests a high level of cooperation within and between some marsh bodies. However, little is known about whether the marsh bodies still promote this level of cohesion and how they have changed over time. Understanding the social context and trajectory of marsh bodies will identify best practices for collaborating with them on managed realignment projects.

1.3 Literature Review

1.3.1 Climate Change in Atlantic Canada

Climate change is expected to impact communities and ecosystems around the world. Climate change impacts will vary considerably based on geographical location (Salinger, 2005). Coastal systems in particular can expect a range of challenges including sea level rise and erosion alongside anthropogenic pressures in coastal zones from development and encroachment (Wong et al., 2014). Coastal systems in areas such as Atlantic Canada are already feeling the effects of climate change, including sea level rise and saltwater intrusion into groundwater systems (Adams, 2011; Ferguson and Beebe, 2012).

The Atlantic Canadian province of Nova Scotia is vulnerable to a variety of climate change impacts. The macrotidal Bay of Fundy hosts the world's

largest tidal range, with the largest recorded tides (16.4 m) taking place in Cobequid Bay, NS (Archer, 2013). In the Bay of Fundy, global sea level rise is combined with increased tidal fluctuations and local crust subsidence due to post-glacial rebound (Richards and Daigle, 2011). This produces a higher relative sea level rise and increases the risk of flooding in the future (Greenberg et al., 2012).

1.3.2 Dykeland Vulnerability to Sea Level Rise

The Bay of Fundy dykelands are a series of reclaimed landscapes created by dyking and draining intertidal wetlands for agriculture. Despite the agricultural advantages that they provide, the dykes have also resulted in the loss of roughly half of Nova Scotia's original wetlands along with a $2 billion annual loss in the ecosystem services that they provided (Nova Scotia Environment, 2013). Altering tidal wetlands in this way increases flood risk because it reduces their natural ability to attenuate waves and retain floodwater (Shepard et al., 2011).

The current system of dykes is vulnerable to flooding and erosion, with an estimated 70% of dyke tracts considered to be vulnerable to erosion and overtopping by 2050 (van Proosdij et al., 2018). Some communities like Truro, NS, experience regular flooding now due to the combination of rainfall, high tides, and ice blockages (Rahman et al., 2019). Foreshore erosion has also been observed in some areas and may increase dyke vulnerability through scouring (van Proosdij and Page, 2012). However, erosional patterns vary considerably

based on local hydrodynamics and may not be a consistent factor in the flood risk of an area (Robinson et al., 2004).

The ramifications of these increasing flood risks include impacts on human and natural systems at multiple scales. Roughly 70% of Nova Scotians live in a coastal community (CBCL, 2009). Additionally, homes and businesses located within dykelands are vulnerable to flooding due to increased development in future flood-prone areas (Richards and Daigle, 2011). Residents also value dykes and dykelands for recreational activities as well as for their aesthetic value (Chen et al., 2020).

Dyke vulnerability may also present challenges to the infrastructure, energy, and cultural heritage of Nova Scotia at the national and international level. For example, dykes in the Chignecto Isthmus protect an estimated $70 million in assets including the TransCanada Highway and CN Railway, as well as homes and infrastructure in the city of Amherst (Spooner, 2009; Webster et al., 2012). The same area of the Chignecto Isthmus contains over a dozen wind turbines producing roughly 35MW of wind energy (Nova Scotia Power Corporation, 2021). In the future, dykes will also protect a growing demand for freshwater aquifer resources due to the acceleration of private development on the coast in recent years. This development includes businesses associated with agriculture as well as industries such as tourism (George, 2013; Grieve and Turnbull, 2013). Lastly, dykelands represent cultural identity for displaced Acadians and symbolize universal value as recognized UNESCO Landscape of

Grand Pré (Gagné, 2013). Altogether, the dykes now protect a growing number of assets in addition to the agricultural land they were originally built to protect.

1.3.3 Climate Change Adaptation and Managed Realignment

Climate change adaptation research has become increasingly necessary due to the expected, irreversible impacts of global climate change such as sea level rise (McCarthy et al., 2001). Climate change adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as "The process of adjustment to actual or expected climate and its effects" (IPCC, 2014). This definition recognizes that adaptation is a process rather than a single set of decisions made at one time. The push in climate change research to contextualize climate impacts in different spatial settings suggests that different parts of the world will be impacted in different ways (Hulme, 2008). Nevertheless, the IPCC recommends that adaptation should generally foster resilience by favouring dynamic approaches found in adaptive management (Noble et al., 2014).

Engineered and technological adaptation continue to be the most common adaptation responses (Noble et al., 2014). For example, many low-lying coastal areas are adapting to rising sea levels by building embankments known as dykes, a method employed in some places for thousands of years (Roca and Villares, 2012). Building or reinforcing hard-engineered defenses may only provide short-term protection, while potentially exacerbating risk by encouraging development. For example, coastal squeeze occurs when foreshore wetlands are unable to naturally grow due to the presence of structures such as a dyke (French, 2001).

Alternatives to hold-the-line strategies are favoured to optimize the natural benefits of ecosystems during sea level rise (IPCC, 2007). Managed dyke realignment is one alternative used in European and increasingly North American coastlines to support or restore ecosystem benefits, primarily of wetlands. Managed realignment approaches can enhance coastal resilience by allowing for more flexibility than hard-engineered structures (Luisetti et al., 2011). Managed realignment often leads to the planned removal of coastal defenses to restore tidal influences and support wetland growth (van Proosdij and Page, 2012). Newly-formed wetlands can then adapt more dynamically to environmental changes such as sea level rise (Esteves, 2014). Managed realignment implementation is still relatively novel despite active research projects to understand its potential applications (French, 2006). Managed realignment has been applied in a broad range of settings for a variety of purposes (Rupp-Armstrong and Nicholls, 2007).

Despite its novelty, research into the process of managed realignment has increased in the past thirty years. During a managed realignment, wetland growth is fueled predominantly by local hydrodynamics and sedimentation processes (French et al., 2000). As sedimentation occurs, vegetation colonies can help to further stabilize and engineer new wetland habitat (Virgin et al., 2020). However, there remains a high level of unpredictability in managed realignment in practice, suggesting the need for a case-by-case analysis to determine the suitability of applying a managed realignment scheme (Ledoux et al., 2005).

Managed realignment in the Bay of Fundy context can help support both the natural and human systems constrained by hard-engineered coastal defenses. The NSDA defines dyke realignment to include dyke retreat inland or an alteration to an existing dyke alignment (NSDA, 2021). These actions could occur in tandem, in which a new dyke alignment supports tidal marsh growth while a reinforced landward dyke protects valuable assets against flooding (Sherren et al., 2019). The process of tidal marsh growth occurs when sediment deposition from tides allows for vegetation growth and stabilization. The ability of the new marsh to protect against sea level rise largely depends on this rate of marsh growth. The Bay of Fundy's high sediment concentration could increase the rate of sediment deposition in some areas (Wollenberg et al., 2018; Virgin et al., 2020). These synergies are crucial considering the current and projected vulnerability of dykes to sea level rise and overtopping (van Proosdij and Page, 2012).

1.3.4 Barriers to Implementing Managed Realignment

Considering its potential use for climate change adaptation, managed realignment could be a suitable strategy to implement in some low-lying coastal areas. Managed realignment implementation, as any adaptation strategy, can be limited by a number of factors (Biesbroek et al., 2015). For example, climate change adaptation can be limited by decision-making at multiple scales of governance (Moser and Ekstrom, 2010). Adaptation planning can also meet resistance by institutions who favour status quo approaches over making changes necessary for adaptation (Barnett et al., 2015; Rahman et al., 2021).

Climate change adaptation is often "limited by the values, perceptions, processes and power structures within society" (Adger et al., 2009). Adaptation should incorporate local values to develop culturally-sensitive knowledge of climate risk in affected communities (Magnan, 2014). This requires understanding and incorporating the complex social interactions that exist between people and place (Barnes and Dove, 2015).

Negative public perception is a commonly cited barrier in the implementation of managed realignment. Understanding public sentiment is crucial as managed realignment projects can create social conflict among stakeholders and the local community (Roca and Villares, 2012). For example, farmers may cite their generational history of working the land, suggesting a strong attachment to agricultural heritage (Parrot and Burningham, 2008). Public perceptions of managed realignment can be influenced by a number of factors that can result in views that are negative, positive, or indifferent (Goeldner-Gianella, 2007). The highly variable perception of managed realignment suggests that understanding it may require a case-by-case approach (Myatt-Bell et al., 2002).

Support for managed realignment can be largely dependent on perceived flood risk and its ramifications (Needham and Hanley, 2019). Knowledge of the biophysical context often help to create accurate accounts of managed realignment and promotes acceptance (Goeldner-Gianella, 2007). For example, awareness of ecosystem services provided by wetlands are not always fully understood by the public, who may instead cite concerns over aesthetics or pests

(Bowron et al., 1999). Some are wary of the landward movement of coastal water because it admits defeat (Ledoux et al., 2005). Communities may instead prefer to maintain the status quo of their landscape by continuing hold-the-line strategies that are minimally disruptive to existing values and livelihoods (Roca and Villares, 2012).

These factors of place attachment and flood risk on managed realignment perception are also reflected in the wider literature on climate change adaptation (Gifford, 2014; Kettle and Dow, 2014). Both climate change adaptation and managed realignment literature acknowledges the role of actors in their planning processes (Dow et al., 2013). Actors are individuals or institutions with the ability to help facilitate climate change adaptation (Klein and Juhola, 2014). Actor-oriented climate change adaptation could improve adaptation planning despite the differences in values and contexts that often exist (Eisenack et al., 2014). Involving stakeholders including citizens, landowners, and farmers is suggested in order to improve collaboration on managed realignment during the planning and implementation process (Liski et al., 2019).

Climate change adaptation research has been criticized for not effectively incorporating the perceptions of landowners and farmers (Soubry et al., 2020a). Landowners can play an important role in facilitating climate change adaptation (Field et al., 2017). Research incorporating the views of landowners can help decision-makers understand motives behind land management and decision-making (Hansson et al., 2012). Little to no research has been done to incorporate the views of dykeland landowners in climate change adaptation. Nova Scotia's

high coastal population and high rate of private landownership suggest that landowners are important stakeholders for implementing coastal climate change adaptation (Sutherland, 1997). Understanding the context that landowners operate in is essential for understanding perception of managed realignment.

1.4 Knowledge Gaps

This research will help fill three knowledge gaps related to managed realignment and climate change adaptation more broadly. In the Nova Scotian context, it will contribute to knowledge on climate change risk perception among coastal landowners. Risk perception can help inform views on managed realignment among dykeland owners. Additionally, interviews with marsh body members can help understand how marsh bodies have changed and how they function today. This can reveal opportunities for working with marsh bodies and landowners on managed realignment projects.

This research can also contribute to the growing body of literature on managed realignment perceptions by stakeholders. Few studies have looked into perceptions of managed realignment by private landowners specifically. Additionally, literature on managed realignment perception is largely from Europe and represents a spatial knowledge gap. This research can compare its findings with European studies and help introduce the North American perspective of managed realignment perception.

Lastly, this research will contribute the views of landowners, particularly farmers, in climate change adaptation literature. Climate change adaptation can fail to fully understand and incorporate perceptions of farmers by favouring

statistical surveys over more in-depth methods (Soubry et al., 2020a). By interviewing landowners, this research will enhance adaptation planning by incorporating the views of landowners, who are crucial in implementing climate change adaptation (Field et al., 2017). This can enable a more collaborative response to climate change and help bridge the gap between stakeholders and adaptation practitioners.

1.5 Research Questions

The knowledge gaps identified above represent broad, yet answerable questions about the role that landowners play in adapting the dykelands to climate change. More specifically, this research will address the following questions:

1) How do Nova Scotian dykeland owners perceive flood risk as a result of sea level rise?

2) How do Nova Scotian dykeland owners perceive the social dynamics of their marsh body or community over time?

3) How do dykeland landowners viewed managed realignment and subsequent marsh restoration?

Chapter 2
Study Area

2.1 Dykeland History

From the rolling pastures along the shore of Cobequid Bay, to the UNESCO Landscape of Grand Pré, the dykelands are an important part of Nova Scotia's agricultural industry and culture. Grand Pré in particular is a major cultural hub for tourism, a key industry in rural Nova Scotia (George, 2013; Chen et al., 2020). In addition to being a tourist attraction, Grand Pré and the surrounding dykelands in Kings County are highly productive agriculturally, contributing 30% of the province's agricultural output in 2001 (Campbell, 2016). The cultural value and agricultural productivity of Nova Scotia's dykelands suggests that they are cultural agricultural landscapes embedded with a range of meanings and experiences (Sherren et al., 2016).

Given the threat that climate change poses to the dykelands, as well as the different options for adaptation, it is unclear what the future holds for Nova Scotia's dykelands. However, a clue to the future of the dykelands could be found in understanding their historical evolution. A historical overview will help situate the research within an appropriate historical context by acknowledging how past events have helped to shape the current actions decision-makers face today (Parsons et al., 2019). Additionally, management realignment and other ecological restoration strategies should be situated within the environmental history of the local landscape during their planning processes (Higgs, 2003).

2.1.1 Pre-colonization

French Acadians were the first settlers to use dyking technology to reclaim wetlands in present-day Nova Scotia (Bleakney, 2004). However, these settlers were not the first to inhabit and use the wetlands that would eventually become the dykelands. Therefore, it is important to first understand how local indigenous communities, specifically the Mi'kmaq, related to these tidal wetland landscapes. Integrating indigenous value systems into climate change adaptation could help disrupt maladaptive patterns of decision-making (Parsons et al., 2019). Additionally, it will help tell the full environmental history of these landscapes while providing a contrasting perspective on the tidal wetlands and their uses.

The area of present-day Nova Scotia is located in the unceded territory of the Mi'kmaq. The name Mi'kmaq is derived from the term *nikmak*, or "my kin-friends." For over 11,000 years, the Mi'kmaq and their ancestors have lived in the land of Mi'kma'ki, which includes the Canadian provinces of Nova Scotia, Prince Edward Island, and parts of New Brunswick and the Gaspé Peninsula of Quebec (Figure 2.1). The territory of Mi'kma'ki was communally owned and did not belong to any individuals. The Mi'kmaq viewed their land as part of the Natural law and believed it should be inherited by ancestors and passed on for future generations to use (Berneshawi, 1997).

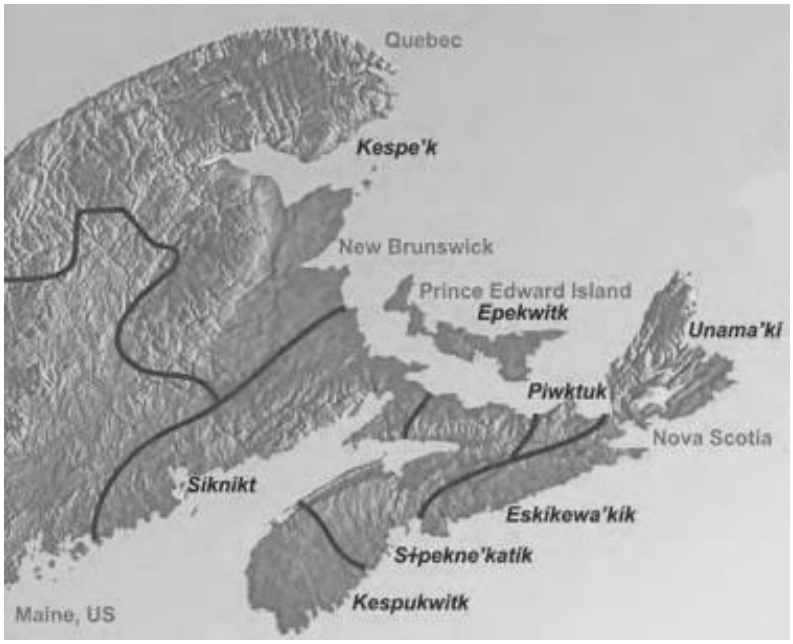

Figure 2.1. Mi'kma'ki Territory with associated place names according to the Confederacy of Mainland Mi'kmaq. Modified from Bernard et al. (2015).

Prior to colonization, the Mi'kmaq used tidal marsh in the Bay of Fundy seasonally for harvesting food and other resources (Hatvany, 2003). The Mi'kmaq fished, hunted waterfowl, and collected plants commonly found in the tidal marsh (Johnston, 2007). Some tidal marsh plants such as kiw'eswa'skul or Sweetflag (*Acorus americanus*) were used to treat diseases and prevent illness (Lacey, 1977). The Mi'kmaq collected these resources during the spring and summer months and then returned to upland communities during fall and winter (Hornborg, 2008). These seasonal migration patterns suggest that the Mi'kmaq valued tidal wetlands for the food and resources they offered.

Today, the Mi'kmaq Conservation Group, an environmental group administered by the Confederacy of Mainland Mi'kmaq (CMM), works to restore wetlands to reestablish an important cultural connection to wetlands and the species that rely on them (Saltwire, 2021). The influx of European settlers

into Mi'kma'ki began a long history of colonization and exploitation of the land and its original inhabitants. Today, there are 13 Mi'kmaq communities in Nova Scotia representing about 2% of the provincial population. Mi'kmaq influence on place names along the Bay of Fundy include the Kennetcook River (knektuk) and Shubenacadie (Sikipne'katik). These original stewards of the land offer an alternative view of dykeland management that could improve decision-making around flood protection in a changing climate (Parsons et al., 2019).

2.1.2 Acadian reclamation (1604-1755)

Acadians arrived in present-day Nova Scotia in 1604 and created their first successful settlement at Port Royal in 1605. Between the first case of reclamation near Port Royal around 1607 and their deportation in 1755, Acadians dyked and drained more than 5,200 hectares of tidal marsh (Hatvany, 2003). Historians note that the original Acadians settlers included surveyors and salt miners familiar with practices of dyke construction and drainage employed in France at the time (Butzer, 2004). As a result, Acadians overwhelmingly preferred reclaiming land to clearing uplands by an estimated ratio of 26:1 (Hatvany, 2003). Their preference for dyked land is significant considering the roughly five years required to dyke and drain the land for agriculture. Some British and Mi'kmaq peoples were skeptical of the reclamation process given the loss of valuable wetland habitat for Mi'kmaq peoples who harvested food from them (Johnston, 2007).

However, the geographical terrain that the Acadians were settling was conducive for draining tidal wetlands for agriculture. First, the upland soils

proved to be acidic and hard to work, resulting in low agricultural yields (Bleakney, 2004). Meanwhile, the large tidal range found in the Bay of Fundy resulted in expansive tidal flats with fine sediment and minerals suitable for agriculture. These tidal deposits created much more fertile conditions than the surrounding upland soil, composed of igneous rock created from glacial deposits (Butzer, 2004). Over time, the rich soil deposits, along with the lack of stones and trees, provided a suitable alternative to clearing upland areas for agriculture.

To access this fertile soil, the Acadians needed to prevent tidal water from entering by building structures known as dykes. This Acadian process of dyke construction was so efficient that it would be passed down through successive generations, largely unchanged (Bleakney, 2004). Dyke construction began with building the earthen base of the dyke using topsoil and then topping it with square blocks of sod (gazons) from nearby marsh hay (*Spartina patens*). These sod-cutters used a tool known as a dyking spade with a modified shape to easily position sod onto a new dyke roughly 5-6 feet tall, depending on the tidal amplitude that varied along the Bay of Fundy (Bleakney, 2004; Johnston, 2007). The sod was effective in preventing water from breaching due to the high density of root mass found in each of the sod bricks. These tasks were often performed in teams of six or more men, each one working on a different step of the process (Cormier, 1990).

Along with dyke construction, the invention of the Acadian aboiteau also improved the process of reclamation by increasing drainage within the dykeland area. An Acadian aboiteau consisted of a wooden sluice gate structure with a

valve that remained open during low tide and closed during high tide. This function helped drain excess rainwater landward of the dyke while also preventing tidal water from entering the newly-reclaimed land. This new technology symbolized the state-of-the-art dyking techniques that the Acadians were using at the time (Johnston, 2007). In fact, 'les aboiteaux' came to represent the entire system of dykes and aboiteaux by future generations of Acadians (Rudin, 2015) (Figure 2.2). Over time, the aboiteau became a symbol of Acadian ingenuity and was instrumental in protecting Acadian identity in areas of southern New Brunswick (Cormier, 1990; Rudin, 2015).

Figure 2.2 Dykeland system today (les aboiteaux)

Acadians expanded into new settlements such as Beaubassin and Grand Pré, bringing the practice of land reclamation with them (Figure 2.3). Families reclaimed land as it was needed, creating a patchwork of landscapes to allow

future generations to eventually use the land (Kennedy, 2013). Newly dyked land was often passed down through the family through marriage, forming a tight, interconnected community (Kennedy et al., 2018). Reclamation projects were largely planned and executed by the community body of marshland owners rather than from a recognized institution such as the French government or Church (Johnston, 2007). This grassroots process of reclamation through marsh bodies was a unique form of land governance and may have played an important part of fostering a sense of identity among Acadian settlers (Johnston, 2007). Further, the legacy of these marsh bodies including the larger Grand Pré and Bishop-Beckwith marsh bodies that formed in 1760 would continue the tradition of communal ownership of dykeland into the present day.

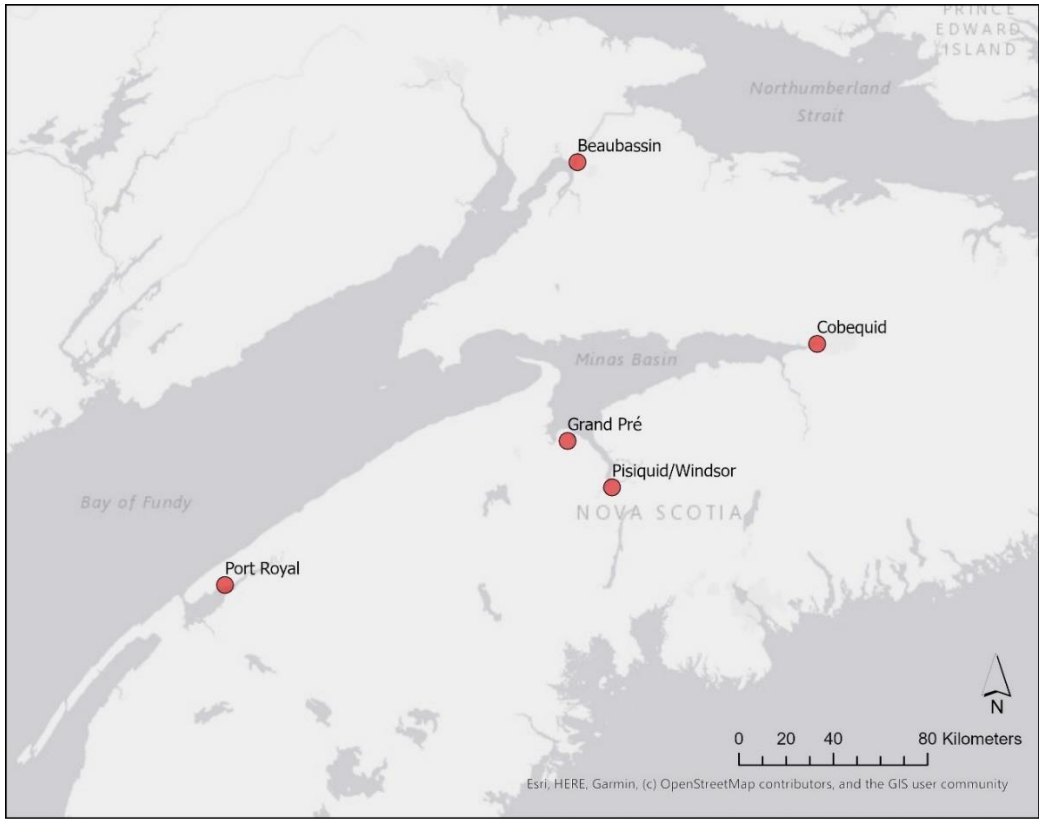

Figure 2.3 Locations of major Acadian settlements by the 18th century

The deportation of Acadians beginning in 1755, an event known as Le Grand Dérangement, would drastically change the future of the dyked landscapes. Acadians who refused to swear an oath of allegiance to the British Crown were removed from the land and forced to abandon the dyked lands built by generations of Acadian settlers (Wynn, 1979). These dyked landscapes would come to define the legacy of the Acadians and remain as a living testament of their presence in Acadie. In their place, British colonists as well as new immigrants would come to own and build dykes of their own, continuing the tradition of reclamation started by the Acadians.

2.1.3 Dykeland Expansion and Rebuilding (1755 – 1940)

The deportation of the Acadians predictably caused issues for the dykes and aboiteaux. Due to the overall neglect of the dykes, a storm in 1759 breached and flooded the Grand Pré marsh (Bleakney, 2004). After recognizing the damage, the British government passed the 'Act for Appointing Commissioners of Sewers' to permit communities to monitor dykes and their repairs (Percy et al., 2005). This Act represented the first government investment and repair of the dykes, which would come partly with the help of Acadians who fled deportation (Milligan, 1987). As British settlers learned more about the dykes and aboiteaux from Acadians, a renewed investment in dyking ensured a continuation of dykeland agriculture rather than a decline (Wynn, 1979). Through the rest of the 18th and 19th centuries, the dykelands underwent social, physical, and technological changes. After the Acadian deportation, Governor Charles Lawrence in the early 18th century invited New England Planters to settle

Acadian land and provide much-needed labor for repairing dykes and farming dykeland. This was followed by the influx of United Empire Loyalists leaving the New England colonies after the American War of Independence. Over the years, more families would immigrate to Nova Scotia to farm the rich soil, including Yorkshire emigrants as well as people of German and Dutch descent (Milligan, 1987). The new influx of farmers also brought changes to the farming practices and agricultural uses of dykeland. Whereas Acadian farmers used the dykelands for a variety of crops, new immigrants used the land mostly for pasturage and hay (Wynn, 1979).

As the dykeland acreage expanded in the 19th century, instances of dyke breaching became more frequent. One of the most notable flooding events came in 1869 during the Saxby Gale, where dykes were overtopped by 1-2 m (3-6 ft) and it took years for the land to be reclaimed and re-ditched (Bleakney, 2004). These floods were partly correlated with a natural variation known as the Saros cycle that creates a peak of high tidal ranges every 18.03 years (Bleakney, 2004; Desplanque and Mossman, 2004). In addition to the Saros cycle, the lunar nodal cycle occurs every 18.61 years, with the next projected peak to occur in 2034 (Haigh et al., 2011). These events served as a reminder that the dykelands are situated in a highly volatile environment due in part to natural fluctuations in tidal range.

Technological change also defined Nova Scotia's dykelands in the early 20th century. For example, the invention of machine-powered vehicles caused the price of hay to fall drastically, negatively impacting the dykeland farmers who

still relied on hay as their dominant crop (Milligan, 1987). Economic devastation during the Great Depression, along with Canada's involvement in World War II, limited the labour required to maintain dykes, leading to their widespread neglect. Despite these negative impacts, the invention of motors also improved dyking techniques, with heavy machinery soon replacing manual labour. Heavy machinery also become a major source of investment from government officials, leading to more government intervention and centralized management of the dykelands (Bleakney, 2004).

2.1.4 Government intervention and social organization (1940 – Present)

As World War II ended, Provincial and Federal Governments saw the need to repair the neglected dykes that protected some of the region's most productive farmlands. In 1943, the Federal and Provincial Governments formed the Maritime Dykeland Rehabilitation Committee (MDRC) to conduct emergency repairs on dykes in immediate danger of flooding. When it became clear that the dykelands would require a more substantial investment, the Federal government passed the Maritime Marshland Rehabilitation Act, the first direct federal investment of the dykelands. The Act formed the Maritime Marshland Rehabilitation Administration (MMRA) to oversee the repair of dykes in Nova Scotia and New Brunswick. The MMRA used modernized equipment such as drag lines and steam shovels to reinforce existing dykes, many of them sitting atop original Acadian or Planter dykes.

In an effort to streamline the process of dyke repairs, the MMRA required dykeland owners to consolidate into 'marsh bodies' to request

assistance with activities including repairing dykes and aboiteaux. In many cases, these marsh bodies already existed to improve dykeland management and the MMRA requirement only formalized their existence. The physical boundary containing the marsh body was determined using the high water line at the time and was agreed on by two-thirds of the marsh body collective (Milligan, 1987). Marsh bodies also provided a formal platform for neighbouring dykeland owners to work together on mutually beneficial projects and settle disputes should they arise. This collaboration provided a formalized structure for dykeland management and development to provide for the common interest. For example, a marsh body could work together to develop a centralized drainage plan instead of a more fragmented approach.

The Federal Government in 1968 passed responsibility of the dykes over to the Provincial Governments (van Proosdij et al., 2013). In Nova Scotia, the Nova Scotia Department of Agriculture and Marketing became the governmental body responsible for maintaining the dykes. Over the years since, the now-NSDA would acquire ownership of many of the dykes themselves, with the consent of the landowners (Milligan, 1987). This change in ownership signaled a wider recognition that the dykes were protecting assets other than agricultural land, including residential and commercial, as well as major pieces of infrastructure.

The lack of stones and other obstructions in dykeland soils led to non-agricultural development pressures within dykeland communities. The increased development on dykeland for commercial uses introduced tensions between

developers and landowners, who sought to retain dykeland for agricultural purposes (Connell and Cameron, 2016). These tensions peaked in Wolfville during the 1990s, when the town received push-back from marsh bodies for planning to develop dykeland, despite the land being within the boundaries of the town of Wolfville. This dispute led to a court case (*Bishop Beckwith v. Town of Wolfville*), with several marsh bodies including the Grand Pre, Bishop-Beckwith, and Wellington marsh bodies working together to protect the dykelands from development. While the original court decision was awarded to the marsh bodies, the appeal would decide that the municipal ownership of the dykeland was a stronger case than the Provincial Act that gave marsh bodies regulation over the dykelands. As a result, the land was used to develop retail stores, offices, and a soccer field.

Continued non-agricultural uses of dykelands in the 1990s for purposes such as recreation and industry led to legislative action to protect dykelands from further nonagricultural development. Nova Scotia passed the *Agricultural Marshland Conservation Act* c.22, s.1 to enumerate the powers of marsh bodies and restrict their use for agriculture. The AMCA requires that non-agricultural uses of the dykelands obtain a variance permit approved by at least two-thirds of the marsh body. Recently, these variances have been issued for a variety of non-agricultural land uses that provide economic, environmental, and cultural benefits to local communities and the Province.

2.1.5 Dykelands today

Today, roughly 30% of dykeland areas are either not currently productive or are used for commercial, residential, industrial, and energy uses. Renewable energy such as wind turbines have been built on dykelands due to the availability of constant wind on the coast (NSDA, 2021). Ducks Unlimited Canada (DUC) are investing in wetland restoration and freshwater retention ponds to provide habitat for migratory waterfowl (Loder et al., 2018). In 2012, the dykelands of Grand Pré were formally acknowledged as a UNESCO World Heritage Site due to their historical significance and testament to Acadian culture (Gagné, 2013). These projects reflect the high land value and multiple potentials that dykelands still possess.

The diversification of dykeland uses comes at a time when farming as an occupation continues to decline due to decreased profitability in the industry, as well as lingering economic damages from diseases such as mad cow disease (NSDA, 2010). Loss of cropland cover among dykeland counties shows that some dykeland is going unused, with Kings County losing 10% of dykeland in active production between 2001 and 2006 (Devanny and Reinhardt, 2011). The decrease in dykeland acreage in active production has prompted development pressures for commercial, industrial, and residential land uses (Connell and Cameron, 2016). To innovate, dykeland farms have begun testing out new crops for different markets, including fruits and vegetables (Milligan, 1987). This contributes to increased rates of specialization among farms in dykeland areas compared with other parts of the province (Figure 2.4). Social changes in

farming include age and gender, where the gender gap between male and female farmers continues to shrink and farmers are becoming older on average (Devanny and Reinhardt, 2011).

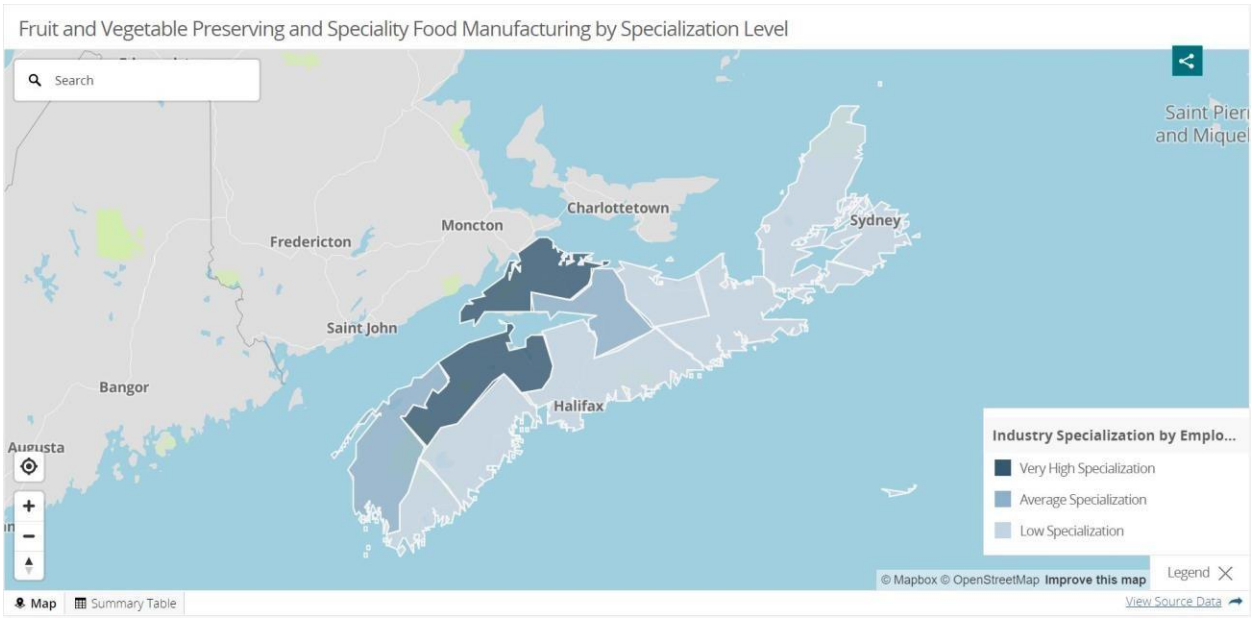

Figure 2.4 Farm Specialization Levels in Nova Scotia by County. Data Source: Department of Inclusive Economic Growth

Climate change also poses potential risks to dykeland agriculture in Nova Scotia. The NSDA's Working with the Tides Program funded by the Disaster Mitigation and Adaptation Fund (DMAF) directs dyke reinforcement, aboiteaux construction, and drainage work in preparation for sea level rise on select dykeland sites (NSDA, 2021). New Provincial Legislation such as the Coastal Protection Act (CPA) is expected to help balance environmental protection with economic development in coastal areas including dykelands (Province of Nova Scotia, 2019). These partners and landowners suggest that the dykelands are active landscapes with multiples values and benefits attached to them,

highlighting the need for collaboration. Understanding how these stakeholders view adaptation strategies will improve collaboration around project implementation to protect the future security of the dykelands.

2.2 Research Study Area

This research seeks to understand how climate change adaptation projects like managed realignment are perceived by dykeland landowners within a marsh body. Recruiting landowners from within a marsh body allows a more systematic approach to invite landowners that represent dykeland landscapes as they exist today. Marsh bodies also constitute physical space, providing a concrete study area from which to select research participants. Spatial data from the NSDA was used to map marsh body boundaries (Figure 2.5). In total, these marsh bodies cover over 17,400 hectares of land in Nova Scotia across Annapolis, Colchester, Cumberland, Digby, Hants, Kings, and Yarmouth Counties (Province of Nova Scotia, 2021).

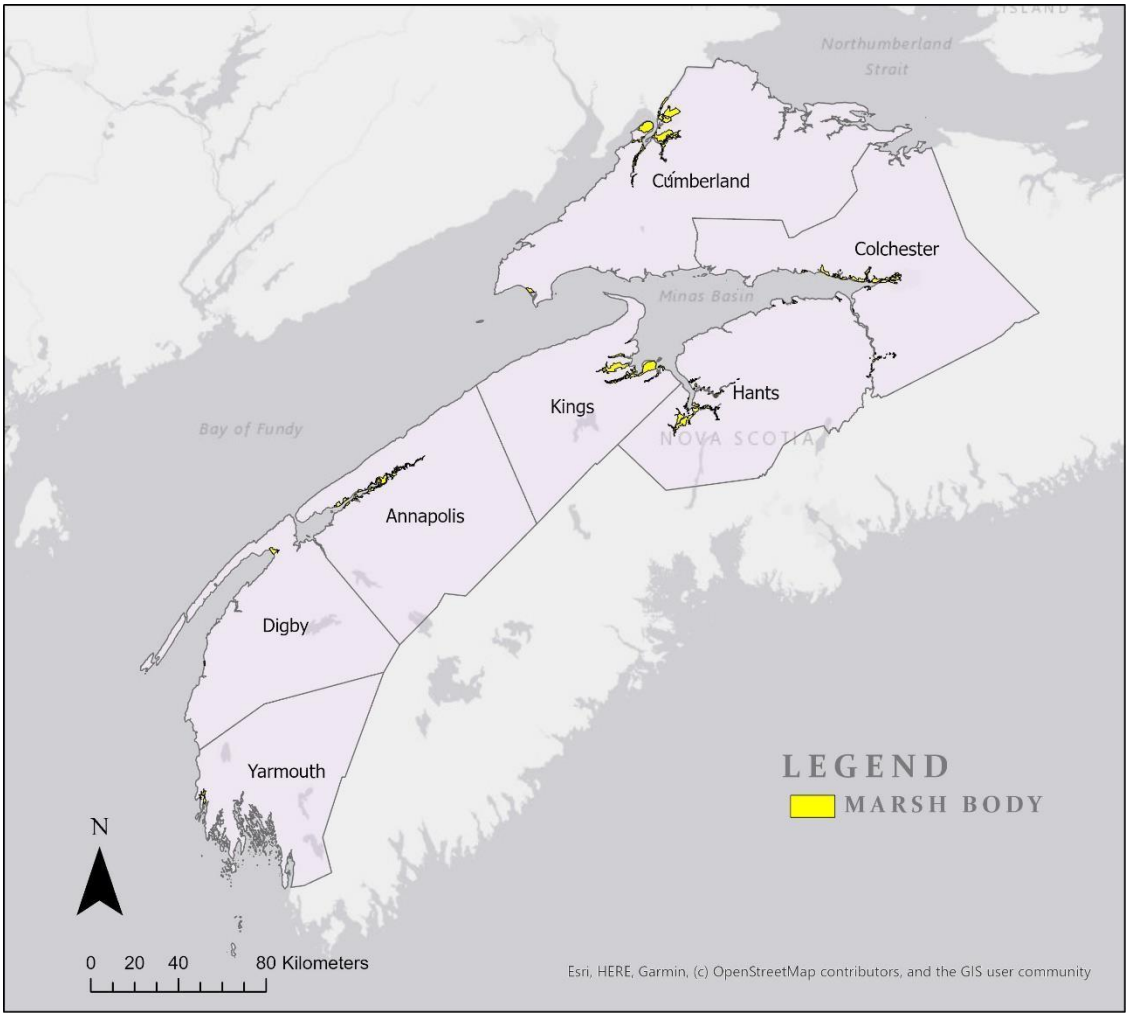

Figure 2.5 Distribution of Incorporated Marsh Bodies in Dykeland Counties of Nova Scotia. Data Source: Nova Scotia Department of Agriculture

Chapter 3
Research Methodology

3.1 Research Methodology Overview

The purpose of this research is to understand how dykeland owners view managed realignment within the social and historical context of marsh bodies. Proposed managed realignment projects can cause social conflict for a variety of reasons and therefore implementation requires a place-based approach (Myatt-Bell et al., 2002). Dykelands and their tidal wetland counterparts may be perceived differently by citizens based on where they live or their experiences as a direct stakeholder (Sherren et al., 2016). Because people perceive dykelands differently depending on their position, it is important to select a methodology that fully incorporates the lived experiences of dykeland landowners.

This research followed a phenomenological methodology consisting of semistructured interviews with landowners about their experiences owning dykeland, their views on managed realignment, and their involvement in marsh bodies. The next section describes the review of gray literature to inform the methodology and guide the research. The subsequent two sections explain the procedures used to select and invite marsh body landowners to participate in an interview. Interview responses were recorded using a handheld digital recorder and then transcribed using the Descript software. Subsequently, the analytical methods are described. The participant responses were analyzed using inductive qualitative coding in two separate cycles. Following this chapter, the resulting

themes will reveal opportunities to collaborate with dykeland landowners on managed realignment.

3.2 Interview Design

Despite the availability of literature on landowner perceptions of managed realignment, there is no corresponding research in the dykeland context. This knowledge gap may consequently leave out important background information or context that could otherwise be incorporated into the methodology. For example, perceptions of managed realignment on working coastal landscapes can be highly influenced by history and local idiosyncrasies (Roca and Villares, 2012). Additionally, dykelands are influenced by larger-scale processes, from climate change to agricultural demand. To account for a lack of prior knowledge, some qualitative researchers use extant gray or non-academic literature to inform their methodology (Garousi et al., 2019). In this research, using relevant gray literature can help focus the methodology by using relevant knowledge from local residents and marsh body members.

Documents related to marsh bodies were accessed digitally from the Grand Pré marsh body fonds available online at the Acadia University Esther Clark Wright Archives. These documents included official correspondence, public speeches, and meeting minutes from the Grand Pré, Bishop-Beckwith, and Wellington marsh bodies. These three marsh bodies are located in Kings County, NS, and the documents span the years 1949-1996. While this presents an incomplete spatial and temporal record in the gray literature, these documents

ultimately provided helpful context in the perception of land use and dyke maintenance among marsh body members.

Marsh body documents were coded using handwritten notes or tags that labeled by the topic being discussed. Recurring codes were highlighted and then grouped into preliminary topics including land use, development, future potential, and community (Table 3.1). Topics were used to inform interview questions and help ground the research process.

Table 3.1 Emergent topics coded from marsh body documents

Topic	Code
Land Use	Agricultural Dykeland Use Dykeland Fertility Generational Agriculture
Development	Decreasing Agricultural Land Base
Future Potential	Dykeland Irreplaceability Dykeland Preservation
Community	Marsh Body Collaboration Dykeland Public Good

Interview questions were created based on a semi-structured interview format. A semi-structured interview format is comprised of open-ended interview questions allowing the researcher to ask secondary or follow-up questions (Burke and Miller, 2001). The follow-up questions provide some flexibility for researchers to elaborate on emergent themes during the interview. Follow-up interview questions are especially important in this research due to the

fact that no prior work has been done with dykeland landowners specifically and therefore new themes were likely to emerge during the interviews.

Interview questions were also written with the broader research questions in mind (Appendix A). In particular, this research explores how dykeland owners view sea level rise and managed realignment approaches within the historical and social context of marsh bodies. Interview questions were created that aimed to uncover how participants view future climate risks (Q3 and Q4), dyke vulnerability (Q5), managed realignment (Q6 and Q7), and community/marsh body responses and dynamics (Q8). Based on the emergent topics from the marsh body documents, three additional interview questions were added to ground the interview responses and increase their relevancy for farmers and marsh body members. These interview questions (Q1, Q2, and Q9) sought to explore the emerging topics of intergenerational land ownership, land use and development, and future dykeland potential, respectively (Appendix A).

3.3 Sampling

Sampling is the process of selecting and inviting people to participate in a research study. Deciding who can participate in a research study is an important part of the research process. Sampling strategies should reflect the purpose of the study being conducted and should strive to select a representative sample (Arcury and Quandt, 1999). Given the diverse set of experiences that exist on dykelands today, this research certain considerations such as the land use, geography, and marsh body features of the dykelands were accounted for.

3.3.1 Land Use

This research targets private dykeland landowners within a marsh body in Nova Scotia. However, dykelands themselves represent a diverse range of land uses, including agricultural, residential, commercial, recreational, and cultural uses. The sampling strategy used in this research targeted mostly agricultural and residential properties. Landowners using their dykeland for commercial or industrial purposes were not considered for this research because these activities fall outside the target audience of private landowners. By considering the multiple land uses present on dykelands today, this research hoped to account for the diverse ranges of experience that dykeland owners have.

To assess which properties correspond with a certain land use, I used Google Maps, which revealed some clues of how the dykeland was being used. For example, lines of hay bales suggested that hay was cultivated and that the land could be used for agriculture (Figure 3.5). Additionally, I used the Google Maps Streetview tool to establish residential or agricultural uses of the land, including the presence or absence of a barn, tractors, and other agriculturally related equipment. Although using Google Maps could not definitively assign land uses to dykeland properties, it did improve my knowledge of the local area and identified areas of recent agricultural activity.

Figure 3.1. Aerial imagery showing hay bales in dykeland areas of Nova Scotia (Source: Google, n.d.)

3.3.2 Geography

Properties were chosen based on geographic distribution throughout the dykeland counties of Nova Scotia, namely Annapolis, Colchester, Cumberland, Digby, Hants, Kings, and Yarmouth county. Dykelands vary geographically across the Bay of Fundy and so it is important to capture this spatial diversity. For example, tidal ranges are different between the upper and lower Bay of Fundy, meaning that perceptions of sea level rise and adaptation could vary. Additionally, dykelands are located in different municipalities and political jurisdictions, meaning they could have significantly different histories. For example, local disputes such as *Bishop-Beckwith Marsh Body* v. *Wolfville*, in 1996 may have a strong impact on local dykeland owners. Therefore, landowners

were initially sampled in each of the dykeland counties according to how many marsh bodies were present in order to reduce spatial bias in the sampling.

3.3.3 Marsh Body Features

Because this research seeks to understand the perspective of marsh bodies, landowners were also sampled based on their location relative to a Nova Scotia marsh body. In this context, a marsh body can refer to the physical landscape that encompasses the land owned by members of the marsh body. Marsh bodies have geographically defined boundaries under the *Agricultural Marshland Conservation Act* 2000 c.22, s.1. These boundaries were created by the NSDA and are agreed upon by members of the marsh body.

While marsh bodies may still be incorporated today, many marsh body organizations throughout the province are not considered active. Inactive marsh bodies suggest that the members meet infrequently or not at all. Data from the Nova Scotia Department of Agriculture (NSDA) lists the activity status of each marsh body in the province (Chris Ross NSDA Project Engineer, Personal Communication, Sep 11, 2020). The sampling strategy in this research targeted both active and inactive marsh bodies in order to assess how changes in this activity could affect views on managed realignment.

Along with NSDA marsh body data, civic address point data from the provincial GeoNOVA database was used to select addresses within the study area (Province of Nova Scotia, 2018). Additionally, Nova Scotia Property Data (NSPRD) boundaries were used to select addresses within a section of marsh

body (NSDSIS, 2017). Using the property boundary was especially useful considering that relatively few (668) civic address points actually fall directly within a marsh body boundary. Additionally, many civic addresses within a marsh body were commercial businesses and therefore unsuitable for recruitment. Instead, using the NSPRD property data made it possible to identify civic addresses within properties that intersect a marsh body, expanding the total number of civic addresses that could be sampled.

After making considerations for the multiple land uses, geographic variations, and marsh body features present among Nova Scotian dykelands, a total of 80 addresses were sampled across the seven dykeland counties of Nova Scotia. A breakdown of how many addresses were sampled in each county can be found in Table 3.2.

Table 3.2 Distribution of recruitment letters by dykeland county

County	Number of Addresses Sampled
Cumberland	18
Colchester	16
Hants	15
Kings	17
Annapolis	10
Digby	1
Yarmouth	3
Total	80

3.4 Recruitment

Recruitment letters were mailed to selected addresses via Canada Post (Appendix B). Recruitment letters included information on the research topic, the information that the prospective participant could contribute, and the telephone or virtual format of the interview. Letters were mailed in four separate stages to accommodate unintentional gaps in response rates that could arise as the research progressed. For example, the first recruitment phase saw overrepresentation from participants in Kings County, prompting a need for higher sampling and recruitment in other counties. Using this staged approach for recruitment allowed some flexibility in gathering a more representative sample of marsh body landowners. Another reason for this staged approach was to accommodate different occupations, including farmers, and their busier work schedules at certain times of the year. Lastly, spreading out the recruitment process also allowed for a steadier stream of responses as opposed to a heavy workload upfront.

In addition to the mail-outs, other recruitment methods were implemented to reach dykeland landowners. A digital advertisement campaign was launched via the Saltwire Network, a newspaper publishing company based in Atlantic Canada. A digital advertisement campaign was launched on January 20, 2021 and ended on February 10, 2021 (Appendix C). The advertisement was targeted in the dykeland counties and ran for 30,000 impressions or views. Overall, 0.21% of views resulted in a click, which is above the industry standard of 0.11%. However, no one reached out to participate in the research project as a

result of the advertisement. While the digital campaign did not result in any participants, it could be used as a learning experience for future research and outreach with dykeland stakeholders.

3.5 Interviews

Interviews took place from November 2020 to May 2021 after approval from the Saint Mary's University Research Ethics Board (File Number 20-120) and completing the Course on Research Ethics by the Tri-Council Policy Statement (TCPS) (Appendix D). The interviews were originally planned to be in-person but due to the COVID-19 pandemic, participants were given the option of either speaking over the phone or on a virtual platform like Zoom. While a few participants were originally interested in speaking on Zoom, all interviews took place over the phone. The phone interview format did present some clear limitations as well as some learning opportunities about best practices in communicating with dykeland landowners.

Telephone interviews have been studied in order to compare their output and reliability with more traditional in-person interviews. Compared to in-person interviews, telephone interviews are often shorter in length and usually result in the loss of contextual, nonverbal cues (Novick, 2007). Alternatively, the anonymity of interviewing over the phone may help participants feel more relaxed and can lead to information that would not usually be offered up (Novick, 2007). Additionally, researchers conducting phone interviews should be upfront about expected interview length as a consideration since it is not in person and often unscheduled (Burke and Miller, 2001). Phone interviews in this

research were targeted to be within 30 and 60 minutes in length but were actually between 15 and 90 minutes long. Being transparent about the phone interview format due to COVID-19 helped build trust and gave the interview a more relaxed feel.

Before the interview began, participants gave verbal consent to participate after reviewing the Informed Consent Form (Appendix E). The informed consent form gave participants an overview of the project and information about the interview process. It also included a list of potential risks in participating as well as resources for help if needed. One risk made explicit was the use of the Descript software to transcribe the interviews and temporarily store audio files on American servers.

After each interview was conducted, research notes were journaled for future reference and to improve interview techniques. Pre-selected prompts were used to facilitate comparisons between interviews. Some of the prompts included topics such as my positionality as a researcher, the participant's engagement with the topics discussed, and a general takeaway of how the participant viewed managed realignment approaches. Taking notes helped to supplement some information that was lost in the research process including helpful context such as emotional cues.

At this stage, each participant was given a random alias, in this case a letter (A-Z) that did not coincide with their order of participation. All interview recordings were transcribed digitally using the Descript software. Descript

helped to streamline the transcription process by offering a powerful audio to text function that cut down on transcription time considerably. Audio files were transferred directly from the handheld recording device to a computer and uploaded to Descript, but were not stored on the computer afterwards. The recorded conversations were then transcribed, with comments made on emotions and other context that could assist in the analysis and would be otherwise lost in the transcription process.

3.6 Analytical Framework

Interview responses were analyzed using contextualized thematic analysis to produce a set of themes that can help answer the research questions. Contextualized thematic analysis is used to construct themes using qualitative codes that can then be assembled into a narrative of the research findings (Baxter and Eyles, 1999). Qualitative coding is the process of tagging sections of data with a symbolic word or phrase to capture the essence of the data (Saldaña, 2013). Additionally, quantitative counts of the emergent themes described by participants were used to make theme-generation more explicit and improve qualitative rigor or confidence (Baxter and Eyles, 1999).

Once transcribed, the raw interview responses were exported to a Word document format for final corrections and organization. The final data was uploaded as text in the Atlas.ti coding software. Atlas.ti provided the structure to organize and code the interview responses, along with the ability to write analytical memos during the analysis. Additionally, the gray literature was stored in the same project file to facilitate comparison between data.

Coding took place in two cycles, with a preliminary generation of themes taking place in between. The first cycle of coding, known as descriptive coding, highlighted sections of the text and labeled them strictly with the topic being discussed. Instead of assessing the content of the text, descriptive coding allowed an initial organization of the data. Responses were coded if it pertained to a research question or explained a relevant topic such as family history, occupation, or dyke protection from flooding.

After the initial cycle of coding, the most frequently mentioned codes were counted to make a crude inventory of the topics discussed. Having an inventory of participant responses based on these initial topics accelerated the coding process by facilitating comparison across all interviews. Additionally, these quantitative summaries identified the messages that were shared by multiple participants. Known as code landscaping, this technique organized the data and allowed for the codes to be grouped into several themes (Saldaña, 2013).

The second cycle of coding, known as process coding, used the identified categories to group codes into major themes. Classifying the codes further allowed for higher levels of meaning to emerge from the data. While this coding helped simplify the data, it may have reduced some of the more complex relationships due to the interrelated nature of the topics being discussed. In other words, when coded data are put into strictly defined categories, it is important to remember the multiple degrees of belonging that exist in the data (Dey, 1999). For example, a single interview topic such as dyke maintenance could be

described in terms of flood risk, governmental funding, or recreational trails. Despite its limitations, the qualitative coding process was able to distill the raw data into themes that provide insight on the research questions.

3.7 Limitations

This research used a mixed sampling strategy including both strategic and random sampling to maximize diversity in landowner participants. While this sampling strategy helped to target the most appropriate participants, it may have inadvertently biased some socioeconomic groups. For example, the participation of young and low-income individuals was limited by the fact that participants must own property in order to be invited into the research. Furthermore, sampling properties located next to or around a tract of dykeland did not guarantee that the homeowners owned the dykeland. While the property boundary data helped by mapping the property locations, it may not accurately reflect recent changes or local anomalies such as leased dykeland.

Recruitment is an essential part of many qualitative studies, yet many studies must also contend with bias in the research. For example, participants in this study chose to participate for a variety of reasons. While some participants said they simply wanted to help in the study, many interview responses suggested that the participants ultimately wanted their voice to be heard. While this is a positive sign that the participants were engaged, it also potentially biased input from more outspoken participants. This disparity was also noted in speaking about marsh bodies with participants, where some noted a variety of personalities that are involved in them. Additionally, the recruitment letter may

have contributed to participant bias during interviews by prompting prepared responses to topics in the letter such as climate change and flooding. Some participants mentioned these specific topics during the interview and may have modified their responses to suit the objectives of the study.

The interviews were heavily limited by the COVID-19 pandemic. As discussed, phone interviews are appropriate for many qualitative studies, but their success is largely dependent on the research itself. In the case of dykelands, landowners had mixed feedback about the phone interview format. While some liked the convenience of speaking on the phone, others highlighted the importance of seeing their land in-person in order to understand their opinions through their eyes. This suggestion is further supported by the fact that many of the participants invited me to personally visit and see their land firsthand, not possible due to university research constraints during COVID-19. While this limitation prevented a potentially deeper understanding of the interviews, it could also inform future communication by promoting more on-site outreach.

Lastly, qualitative research relies heavily on how the researcher interprets the research process, including the topic, methodology, and data analysis. Reflexivity is the process of understanding how a researcher's positionality or background impacted the research and ultimately its findings. To promote accountability, I took detailed notes after each interview about my positionality during the interview. This included whether my personal family history as an Acadian may have influenced the interview. Despite this connection, I also played the role as an outsider due to my national identity as an international

student. My status as an outsider may have convinced participants of my neutrality and may have lessened the stakes of the interviews.

Chapter 4
Results

4.1 Participant Overview

Eleven phone interviews were conducted between October 2020 and April 2021. Interviews lasted from 15 minutes to 1.5 hours and all took place via audio phone calls. Although some participants expressed interest in using Zoom in the beginning, technical challenges and convenience ultimately led to a preference for phone calling. One interview consisted of a married couple, bringing the total number of participants to twelve.

From the eleven interviews, nine were the result of direct invitation via recruitment letters. The other interviews were referred by another research participant or through persons affiliated with the research project. These referrals were valued for their participation because they provided a different perspective and a more representative sample of dykeland landowners that fit the purposes of the study.

Despite targeted sampling during each round of recruitment, there were no responses from Digby, Hants, and Yarmouth Counties (Table 4.3). The dykeland county with the most marsh bodies (24) that is not represented in this study is Hants County. Each represented marsh body had only one landowner participating. These spatial and numeric gaps in representation may limit the relevancy of the resulting themes for all dykeland areas.

Table 4.1. Participant responses by county

County	Recruitment Letters Sent	Number of Participants
Cumberland	18	3
Colchester	16	4
Hants	15	0
Kings	17	4
Annapolis	10	1
Digby	1	0
Yarmouth	3	0
Total	80	12

Demographic data including gender, place of origin, and occupation was derived from interview responses or in correspondence related to the research. Demographic data helps to contextualize the sample of participants. In terms of gender, men were disproportionately represented over women by a factor of 5:1. This may be explained in part by the participation of farmers who, in many parts of Nova Scotia, is a male-dominated profession (Devanney and Reinhardt, 2011). Full-time farmers made up one third of the participant pool, which is higher than average but can be expected on dykeland properties surrounded by agriculture. Two participants moved to the area from another Canadian province, with one having moved within the past two years.

The participants' properties were classified by their land use based on information obtained during the interview. This background information allows

participant responses to be better understood within the spatial and demographic context for each landowner.

Despite only one-third of the participants being full-time farmers, over half of the properties are actively farmed whether on a small or large scale. This discrepancy can be attributed to the participation of landowners who do not farm themselves and smallholders. Other notable uses of sampled dykeland included tidal marsh habitat as well as recreational trails built and maintained by the participating landowner.

4.2 Emergent Themes

The interview responses were analyzed to develop themes that can help understand how dykeland owners view managed realignment. Interview responses to managed realignment ranged from staunch opposition to enthusiastic agreement and included a myriad of reasons and methods of reasoning. Understanding the discourse around the subject of managed realignment through coding allows an easier understanding of the complex interactions present.

Figure 4.1 presents the major themes and their in-depth sub-themes, while Table 4.1 presents a quantitative summary of mentions for each sub-theme. The sub-theme mentioned the most by participants was the topic of regulation, while dyke protection was the only sub-theme described by all twelve participants. Overall, each sub-theme was mentioned by at least half (6) participants, indicating a shared interest in the themes and their significant in the context of this research. To understand how these themes interact, sub-themes

are explored in the following sections and are used to construct a narrative of emergent landowner perceptions of managed realignment.

Figure 4.1 Emergent themes from data analysis weighted by number of mentions

Table 4.2 Number of mentions per sub-theme from participants

Sub-theme	Number of Mentions	Number of Participants (%)
Climate Risk	19	11 (92)
Dyke Protection	20	12 (100)
Tidal Reintroduction	17	9 (75)
Community	12	7 (58)
Representation	15	8 (67)
Regulation	24	11 (92)
Decision-Making	19	8 (67)
Environment	12	6 (50)
Aesthetics	9	7 (58)
Recreation	9	6 (50)
Cultural Legacy	23	10 (83)
Food Security	15	7 (58)
Productivity	16	7 (58)
Development	11	6 (50)
Perseverance	18	8 (67)

4.3 Flood Risk & Protection

The first research question aims to understand flood risk perception and climate change among dykeland landowners. Participants generally expected climate change to exacerbate existing flood risk. Reinforcing dykes was largely viewed as positive, especially for participants who confidently believed they were effective in preventing flooding. Other participants were open to alternatives given the high cost of maintaining dykes, but otherwise were neutral to the potential benefits of marsh restoration. Participants who were optimistic about managed realignment approaches had both a solid understanding of its process and were realistic about inevitable sea level rise.

4.3.1 Climate Risk

Overall, 11 of 12 participants shared a concern for flood risk as a result of sea level rise. The least-concerned participant felt comforted by the historical success of his dykes as well as recent dyke reinforcement. Four other participants had direct experience with flooding on their property. Of these four properties that flooded, two were agricultural land, one was the participant's front yard, and the last was tidal marsh that floods frequently. Experience with flooded dykeland did not seem to contribute to a higher awareness of flood risk.

Instead, risk perception was highly nuanced and depended on the interaction of local environmental factors. Participants acknowledged the variation in risk due to factors like their proximity to a coastline or river and the destruction of upland forests that absorb precipitation. Multiple climate change-induced hazards were mentioned throughout the interviews, with Participant H saying, "We're getting winds here we never seemed to get before…We do have some storm surge. That's not uncommon. You notice the tides seem to be a little higher too." Dykes in particular were described in terms of their vulnerability to projected sea level rise. Farmers seemed the most aware of future flood risk, even using exact values:

> In the next fifty years… dyke walls aren't going to be able to hold back the extra water. They're predicting the tides are going to rise a meter. Most of the dykes… when the tide is at its fullest, there's less than a meter to the top of the dyke." (Participant W).

This participant's reference to one meter of sea level rise by 2100 is one commonlyreported projection that could indicate effective risk communication from sources such as the NSDA.

Risk perception was also influenced by the incremental nature of climate change impacts. Some participants noted the insidiously slow process of sea level rise and erosion. One participant noted this phenomenon using an analogy:

> People aren't really seeing what the change is yet. And one of the things that I've learned in museum work is that nobody goes to look at an old building as it's decaying. They only go when there's a fire… If there was a king tide that topped one of the dykes, then that would get people's attention (Participant F).

In this case, a decaying building is used as a metaphor for perceived slow impacts from climate change. This observation of incremental change in flood risk is in contrast to the dynamic context of tidal wetlands, where change is relatively frequent and extreme.

4.3.2 Dyke Protection

In contrast to the dynamic nature of the dykelands, dykes themselves were viewed as a stable component of the dykeland environment. This was largely due to the current role of dykes in protecting valuable assets including homes, agricultural land, and infrastructure. Participants acknowledged that valuable assets like transportation infrastructure are vulnerable and may require modification to future sea levels. One participant suggested a form of retreat:

> But logical common sense to me is, if you relocate two lanes of the TransCanada Railway and they're built high enough for the railway track to withstand storm surge, it's like building three dykes versus building one super dyke (Participant L).

This suggestion to raise assets protected by dykes was mentioned as enhancing the effectiveness of dykes by reducing the risk posed to valuable assets. However, this suggestion to relocate assets protected by dykes was uncommon and participants largely trusted dykes for their flood protection.

Dykes were widely considered an effective flood protection strategy despite common acknowledgement that maintenance is necessary to keep dykes functioning properly. Male participants in particular adhered to the belief that dykes and other hardengineering technology can fix the issue of sea level rise and flood inundation. For example, male participants often quoted engineering solutions, with Participant A saying "There must be a way to figure that one out using engineering somehow. Because the water is coming up. Obviously the ice is melting and the water has to go somewhere else." Participants cited engineering examples from around the world such as the Dutch Zuiderzee network and the Thames estuary as evidence of the effectiveness of hardengineering. The "techno-fix" mentality is further supported by the language that some participants used to describe these approaches. For example, two participants described the use of armour rock as "stopping" or "correcting" the issue of erosion.

However, not all participants agreed that dykes are the best strategy for flood protection. A minority of participants (n=3), including both female

participants, suggested alternatives to dykes such as improved ditching and building marshland. One female participant described potential harm caused by an over-reliance on dykes:

> Securing the dykes better by building this and building that. When you do that, the water has no place to go. And it's going to cost a lot of money to do that kind of thing. But I think the ditches are one of the prime things that need to be done before anything else is done... I'm not an engineer, but you can't stop the tide, right? (Participant R).

This view was the most apprehensive attitude towards dykes and represented a small minority of participants. However, these responses suggest that some participants were aware of disadvantages from using hard-engineered flood protection and instead believed there may be consequences in relying on them too much.

4.3.3 Tidal Reintroduction

While most participants showed an appreciation for dykes, the discourse around tidal reintroduction in a managed realignment strategy was more varied. Overall, 9 of 12 participants were aware of managed realignment strategies, including four participants who cited specific examples in places such as Hantsport and Truro. Mentions of tidal marsh restoration were optimistic for some participants who believed it would help with drainage or provide a buffer for agricultural land. However, these views were not shared by all participants. Participants' views on managed realignment were directly influenced by their understanding of the marsh restoration process, their recognition of dyke

maintenance costs, or their perspective that the inevitable sea level rise as a result of climate change will require new ways of protecting dykelands.

Participants perceived the process of tidal reintroduction differently. Participant Q described the process of marsh restoration, saying that "…[A]s long as there's lots of silt, it will be deposited and the grass would grow vertically up through it." This could be due to experience, since Participant Q lives in an area with historical dyke breaches and is likely more familiar with the process of marsh growth. Two other participants suggested that the intent of tidal reintroduction is to reduce pressure from river flooding:

> … [I]n Truro they bought a bunch of marshland and moved the dyke or are moving the dyke. But Truro will flood... If they did the math and figured out how many gallons a minute runs down that river in a spring flood. Adding a foot a depth or two over 200 acres… they would soon realize that it doesn't matter. The river is going to overflow no matter what. (Participant S).

This view that managed realignment is intended to divert river flow was shared by another participant who also owns dykeland in an estuary dominated by rivers. This suggests that local geography and past experience could shape how landowners view managed realignment.

Tidal reintroduction was also described as an alternative to continued dyke maintenance. Much of this discourse was neutral to the benefits offered by marsh restoration, and instead focused on the financial constraints of continued dyke maintenance. A common description of managed realignment among these participants included one by a farmer who said:

> I don't think there's any benefit in doing [managed realignment] myself. But I can see that the Department of Agriculture doesn't want to spend the money on maintaining dykes if there's nobody using the dykes behind the wall… It's a shame they… probably will be flooded because they're not going to maintain the dyke wall (Participant W).

The issue of dyke maintenance costs was shared by a variety of participants, including landowners who did not farm and those who were new to the province.

Other views on managed realignment were informed by an understanding that the dykes are temporary fixes to the more long-term problem of sea level rise flooding. One participant even suggested a way to advertise this approach to farmers:

> Some farmers would have to give up farmland really in order to do that plan… Especially around here because pretty well all of the dykes where we are is used as farmland. But I guess a good sell would be to do this now or lose it all in years to come. Lose a little now to save the rest of it later (Participant C).

Participants in this category also tended to characterize change, including climate change impacts, as inevitable. Interventions such as managed realignment were therefore logical for some participants despite the potential sacrifice, which was the case for one farmer:

> If they did that, then they're leaving more land on the outside to hold the extra water in high situations. So that's one approach. That's probably the most economical approach… You would have to give up a bit of land to do that, but erosion is going to do that to you sooner or later (Participant P).

Overall, awareness of future climate change impacts contributed to a more proactive view of flood protection and coastal adaptation and retreat. These views of climate risk, dyke protection, and tidal reintroduction are summarized in Figure 4.2.

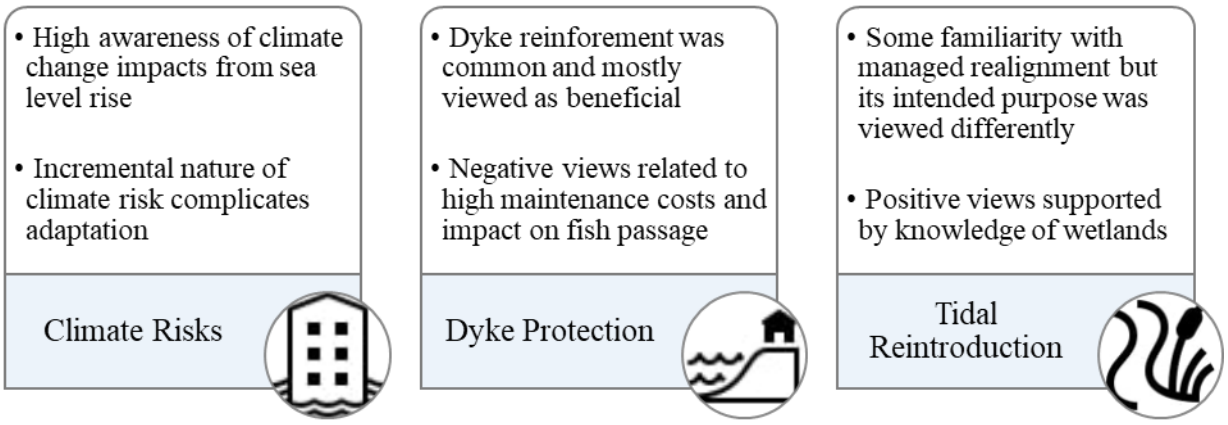

Figure 4.2 Flood risk and protection theme summary

4.4 Governance

The second research question concerns social dynamics within dykeland marsh bodies. Much of the discourse surrounding social dynamics involved dykeland governance. Governance included local collaboration at the community level, representation at the marsh body level, and regulation at the Provincial level. Subsequently, participants discussed how these levels of governance impact decision-making and planning for the future.

4.4.1 Community

Interview discussions about dyke and dykeland governance typically began with a recognition of the physical assets present in dykeland communities today. This served to reinforce the idea that dykes and aboiteaux are essential in protecting communities such

as Kentville, Truro, and Amherst. Important assets mentioned included agricultural land, homes, trade routes, and energy infrastructure. One participant summarized the impact of the dykes on his agricultural livelihood by saying:

> Well if I lost all my dykes, I would lose one-third of my land. So I would lose one-third of the land that I could produce livestock on. It would change my farming I would say to the point that I couldn't do it. I don't think I'll see that in my lifetime, but I don't know. (Participant P)

Participants generally held the view that dykeland communities were heavily centred around dykelands and depended on them for a variety of uses.

The idea of community was also brought up as a way to mobilize around future climate change impacts. Some participants suggested that community members should come to together to reinforce dykes and assume a more communal responsibility over their protection. However, this community contribution towards flood protection did not necessarily apply to considerations for managed realignment:

> And what do you do about sea level rise? To put it into government hands, the prices are astronomical for that. So they have been floating the idea of converting the shoreline back to tidal marsh and making that tidal marsh buffer… The unfortunate thing is unless you get a community member who is willing to give up hard-fought land that they have been farming, or that they've at least got their name on, then as an individual, why should I give up my land? And you get into game theory now. Why should I give up my land in order to benefit the community? Why can't the community as a whole do something? So that was the probably the biggest challenge for that idea in the area (Participant F).

Other participants were involved in advocating for dykes and aboiteaux through the local government and marsh body meetings with the NSDA.

4.4.2 Representation

Five out of twelve participants were current or past marsh body administrators. Marsh bodies were viewed as an avenue to get people together to work on projects that benefitted all landowners. Some examples include ditching and laying gravel roads for machinery. Marsh body administration costs were paid with land taxes based on how much land each person owned. Although some marsh body members noted difficulties in getting some people to pay or contribute, they generally viewed it as a good system that provides an essential voice for landowners:

> You have to be in the marsh body to get a voice. Because there's not enough money to go around. So the marsh body that's really active, they'll get more help and that's only natural. They should if they're aggressive enough to have a good marsh body. And that they can get their voices heard (Participant P).

This quote shows the dual role that marsh bodies play in providing both a voice for individual landowners as well as representation in external matters such as government funding. Despite their positive contribution, marsh bodies were not immune to wider changes in agriculture. All four farmers described that there are significantly less farmers farming considerably more land. Because of this agricultural consolidation, the number of landowners making up a marsh body has declined drastically. Less marsh body members creates a situation where marsh bodies became obsolete for some members:

> It's an antiquated sort of set up where everybody who owns marsh inside the dyke is part of the marsh body… It worked back in the 50s and 60s when there were 50 different owners on every marsh to have every voice heard. But now it's more consolidated (Participant S).

Less landowners also resulted in more closely knit marsh bodies according to some current members.

Agricultural consolidation not only affected the social dynamics of marsh bodies, but their political representation as well. Some participants described a decline in the political power and representation of the agricultural industry:

> It's the opportunity cost. Seventy-five years ago, 50% of the population was either from farms or was a first-generation off a farm. Back then the agricultural community was a politically large lobby… Now with agricultural consolidation, you have a lot fewer farmers doing a lot more on bigger operations. So basically there's not the votes there anymore and the Province figured that out… and said it's not worth it anymore (Participant H)

These changes from agricultural consolidation led to a perceived disinvestment in dykeland agriculture and limited the political representation of marsh bodies.

4.4.3 Regulation

Dykeland regulation concerned the active roles of governing agencies such as the NSDA, who provide oversight and assistance to landowners and marsh bodies. The contribution of government partners like the NSDA were considered necessary for dykelands to function properly. For example, the transfer of dyke ownership from landowner to the NSDA as described by some participants also placed responsibility on regulating agencies to protect dykelands. Both farmer and non-farmer participants acknowledged the critical role of government, like for Participant H who said "…[T]here are certain things which don't happen unless government supports it."

Despite the importance of investment into dykelands, participants suggested that reduction in funding and changes to governance indicated a disinvestment into dykeland agriculture. All farmers were acutely aware of changes in access to funding for important work like ditching. Lack of resources for this type of work may have led to the dissolution of some marsh bodies:

> I think there was a Maritime Dykeland Commission and that dissolved. So the marsh body didn't serve a purpose any longer without that provincial support. Somebody had to fund the work that was being done… There used to be funding for farmers and landowners to do proper ditching so the dykeland would drain and all that. But that funding disappeared (Participant G).

Participants did not necessarily blame the agencies themselves for the reduced funding and instead understood some of the nuances involved. Participant P praised the NSDA by saying "The NSDA protects the dykes in good faith. They do the best they can. The budget for the Department of Agriculture is not what it used to be." Participants largely viewed the NSDA as unbiased in their support for marsh bodies and immune to external politics.

Regulation in the form of requirements and permitting on dykelands was viewed as an additional barrier for some landowners. Excessive regulation was viewed as slowing necessary work even for agricultural development:

> Right now there are regulations and stuff that we can't do anything else on dykeland other than cropping without getting buried in that kind of stuff. We're not allowed to build barns if we're going to build on dykeland. We're not really allowed to do too much on dykelands other than cropping (Participant W).

Participants cited agencies such as Nova Scotia Environment and Department of Fisheries and Oceans as well as specific requirements such as the Species at Risk Assessment. These regulatory requirements were seen as financial barriers by some landowners:

> I used to work regulatory… There's a lot of regulatory pathways that you need to go down. And it's not something that the individual landowner can afford to do… Simply put, we're not a big enough fish (Participant H).

However, not all participants shared a negative view of dykeland regulation requirements. One participant who used armour rock to combat erosion was able to acquire the permits without any problems, suggesting different experiences exist for landowners in the regulatory process.

4.4.4 Planning and Decision-Making

Participants described the future potential of their dykeland in a wide range of ways, from 'stagnant' to 'limitless potential.' Participants who thought in terms of the future were more likely to favour long-term investments in their land. Some participants complained about the lack of a long-term plan for the dykelands in their area:

> Well the long-term of it here is that everybody could benefit… But there needs to be a plan. There's no real plan for the marsh. There's no long-term plan… The Provincial government seems to be doing very little, if anything, of looking into proper usage of the land (Participant A).

This discourse also applied to discussions of flood protection, particularly when considering marsh restoration as the only sensible long-term solution.

Participant responses suggested high variability in levels of long-term investment into their dykeland. Participants acknowledged that landowners with different levels of investment into their dykeland creates different sets of priorities among landowners. Participants suggested that this discrepancy in how landowners are invested in their land could create barriers during decision-making:

> If I don't have an investment or long-term connection to that idle land and I'm just enjoying the lapping of the water against the shore until I pass away, then I don't care what happens once I'm in the ground. And I do see that that is going to be a big challenge. It's those that are trying to think long-term that are going to be more invested in what might happen. And then 300 years from now, somebody might say well, why did they make that decision at this time (Participant F).

Overall, participants with future long-term investments in the dykeland were viewed as prompting more action to protect them than participants focused on the short-term. These views of governance including community, representation, regulation, and decision-making are summarized in Figure 4.3.

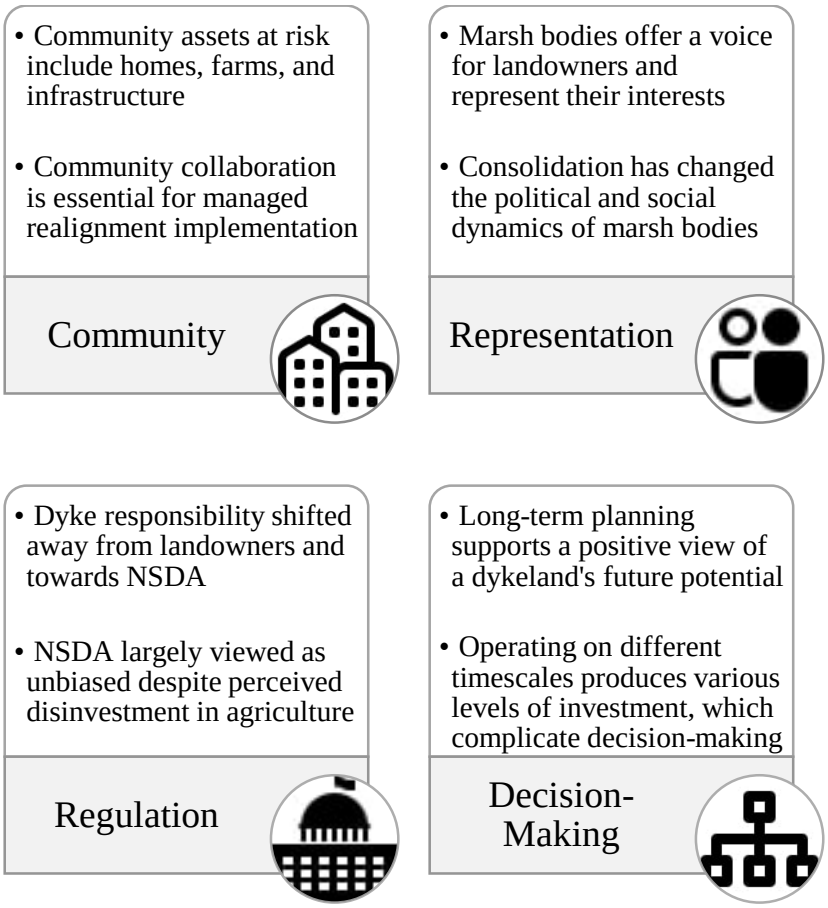

Figure 4.3 Governance theme summary

4.5 Values

Values also played a role in mediating the different priorities and levels of investment that landowners have on dykelands. Values contributed to these different types of investments within dykeland owners. Non-use values that are typically difficult to quantify and monetize further differentiated how participants view dykelands. The cultural, recreational, aesthetic, and environmental values associated with dykelands ultimately provide context in understanding landowner priorities.

4.5.1 Cultural Legacy

Many participants viewed their dykeland within the context of its historical uses. Ten of twelve participants showed appreciation for the history of their dykeland by sharing stories of activities like sod-cutting or sharing knowledge about relic structures like aboiteaux. Farmers in particular showed respect for the hard work required for protecting and working their dykeland over many generations. Participants admired original, hand-built dykes and aboiteaux:

> Everything now is getting so automated… They have no self-esteem from doing some of the tasks that used to be great for older people to get together and fix dykes and work together and accomplish a lot with hard work… They didn't have dozers. They had horses and oxen. But that land is still productive (Participant P).

Other mentions of history included relic dykes, aboiteaux, and drainage systems from Acadians, which in some cases were viewed as superior to modern flood defenses. These relic flood defenses were respected for their endurance and gave some participants a sense that their land is more prepared for flooding.

Participants were also aware of the culture that they inherited as a dykeland landowner. For example, multigenerational farmers viewed their current dykeland as a continuation of past agriculture by previous generations. In this context, farming was described not only as an occupation, but as a generational role to be filled, like for Participant W who said that "We like farming. I enjoy what I'm doing. We were born into it." The Acadian culture was also inherited by one participant with Acadian descent, who hoped to see Acadian-era dykeland reclamation return to Nova Scotia:

> The farms have deteriorated year after year… they never went back to the system that the Acadians had, which was the dyking… and reclaiming certain parts of the property and then flooding the other part and then draining and flooding. That's what they used to do. And they don't do that anymore (Participant A).

The cultures associated with dykelands and their communities were viewed as a unique part of the legacy left behind by previous generations of landowners.

Participants also shared a desire to pass down the history and culture inherited from previous landowners. Participants viewed these traditions and practices as a legacy that needed to be continued. Other considerations for land use like in the case of managed realignment were viewed negatively because they infringed on this legacy:

> The dykes were built for a reason… Most of these farmers that upgrade the land, you know, it was all undersea at one point. So they did it for a reason back in the old days. People have been farming that land for over 300 years. So it's kind of hard to go back (Participant G).

4.5.2 Recreation

Participants viewed dykelands as having exceptional potential for recreation and tourism. Recreational trails, tourism, and heritage museums were all mentioned by participants as opportunities for dykeland recreation. Walking trails were described as a way of bringing communities together and bringing nature closer, especially during the COVID-19 pandemic. For example, walking trails were viewed as enhancing the use of marsh restored through managed realignment:

> The tourism for the marshland is just wow. In the summer days there will be like 400 bicyclists drive by it. So they're using it for recreation. If they build the second dyke and they actually build some sort of a trail in it that way people can enjoy looking out in the marsh, that would be cool (Participant D).

However, some participants were more cautious about walking trails on dykes because the dykes were at risk of tidal flooding or were a nuisance for the local marsh body to manage. These participants suggested that recreational uses of dykelands was not always appropriate and depended on how they are used.

Participants valued recreation on dykelands in a variety of ways. Some participants enjoyed the sense of community or access to nature that they offered. For one participant who built walking trails on his dykeland property, the trails offered him a connection to his Acadian ancestors who were the original settlers to reclaim and farm it:

> It's a good, relaxing walk. And it brings you back to where our ancestors worked. I mean you can imagine what they did when they farmed this land and how tranquil it is and how beautiful of a spot it is… You can sort of meditate on what our ancestors are doing on a particular day. Would they be outside digging the dirt… (Participant A).

This participant valued the recreational trails because they offered him a chance to connect to his heritage in new ways. This strong attachment to the land shows that dykeland recreation is experienced and valued differently.

4.5.3 Aesthetics

Participants admired the dykelands for being visually pleasing and bringing aesthetic value to their lives. Many interviews were conducted with participants looking out their window onto their land and describing farming operations or animals in real

time. Participants showed appreciation for the natural beauty and rural aesthetic of the dykelands in many ways, including bird watching:

> We love living here. With the beautiful view we get a view of the sky and we really enjoy it. We enjoy the rural life… It's nice to be out here. There's lots of birds, you know, bald eagles. All kinds of different birds we see (Participant C).

Participants often invited me to visit their land to meet me in person and help me understand their view of the dykelands more fully. For example, Participant S wished we could interview in person, saying "You would learn so much more… If you come here, you can get a good grasp of it through my eyes." This underscores the importance of experiencing dykelands with landowners in order to understand how their lived experiences shape their views.

Aesthetic value also influenced how landowners viewed flood protection measures including dyke reinforcement and managed realignment. For example, some participants viewed marshland created through managed realignment as adding aesthetic value to the area because it created a more natural environment that can be enjoyed by everyone. Other participants characterized tidal marsh as unattractive mud puddles that would take away from the current dykeland aesthetic. Further, some participants discussed how aesthetics impacted dyke reinforcement and the importance of making dykes more appealing and accessible:

> So he used to work two or three hours every evening. And I worked together with him. So we placed the rocks. We didn't just drop the rocks. We placed them right. It looks nice. And we finished the edge of the bank. We have a little pathway there where we walk (Participant A).

Placing armour rock in a way that adds aesthetic value suggests that some participants favour flood defense strategies that enhance aesthetic value over strategies that undermine it.

4.5.4 Environment

Participants shared a robust awareness of the current ecosystems found on dykelands. Participants viewed agriculture in particular as making positive contributions to the local ecosystem by providing habitat for prey species. Marsh restoration as a result of managed realignment were viewed as disrupting the existing ecosystem:

> The biggest enemy to the dyke system and the marsh ecosystem is people and their intent or goal to basically let them all back to the ocean and not recognizing that there is an ecosystem already because of them… Everything from pheasants to mice. It's all there (Participant S).

Farmers in particular viewed the existing ecosystems on their land as operating in concert with agriculture and suggested that species rely on farms for their survival.

In contrast to the appreciation of ecosystems found on dykelands, participants tended to describe tidal marsh in terms of the services they provide. These included storm surge buffering, water filtration and habitat for fish to spawn, which some participants suggested was important for First Nations communities by saying, "If you build a dyke across the river, then of course you're cutting the fish off. They can't get up to spawn… the Aboriginals want that removed so the fish can go up the river" (Participant Q). However, even when participants acknowledged that these services existed, some participants questioned their necessity in Nova Scotia. For example, although one participant admitted that wetlands filter water, he also doubted that we need more of them

due to the overabundance of inland wetlands. Additionally, the buffering ability of wetlands was viewed as less necessary for dykelands because it did not adequately address local issues of erosion and subsidence.

Other participants admired the opportunity to build more tidal marsh. In addition to the services they provide, some participants liked the idea of using natural principles to benefit the dykelands with foreshore protection:

> I think that would be wonderful if they did what you said and created more marshland and made it more environmentally friendly and used more natural ways to save the dykelands… That's one of the reasons why we're in the trouble we're in is because of the environment. Climate change and water rising. We need to work with her, not against her… That's really the only sensible long-term solution is trying to work with nature, not fight it (Participant C).

In this case, the importance of nature-based adaptation supported a positive view of managed realignment because it was perceived as a natural solution to an unnatural problem of climate change. The different characterizations of the tidal marsh environment suggest that tidal marsh ecosystems were understood differently by participants and influenced views on managed realignment in different ways. These values related to the environment, cultural legacy, recreation, and aesthetics are summarized in Figure 4.4.

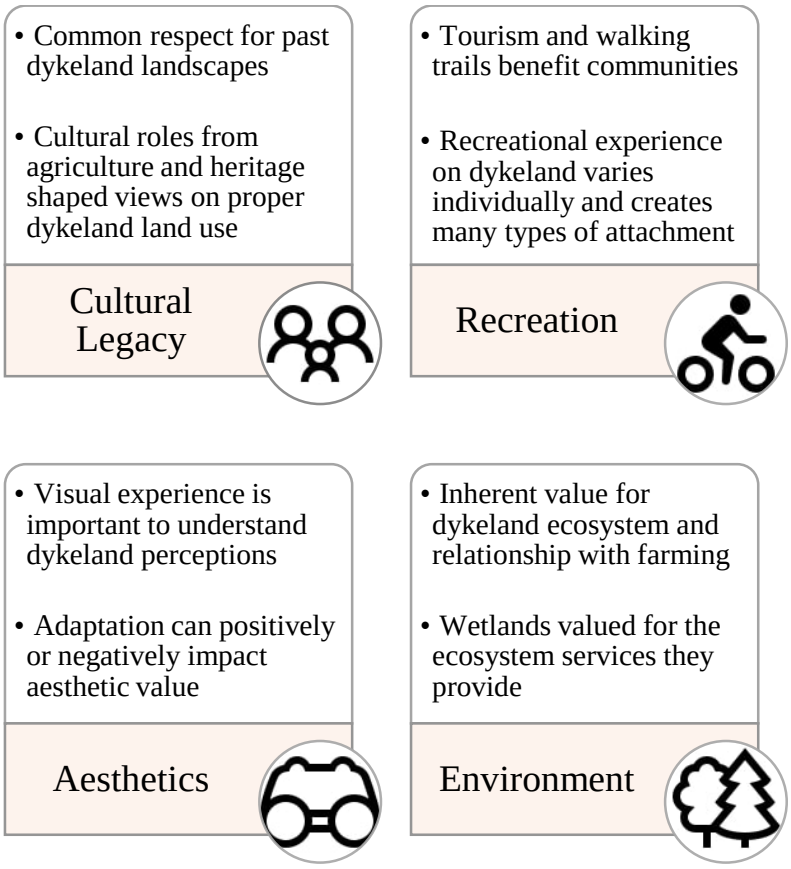

Figure 4.4 Values theme summary

4.6 Agriculture

Dykeland agriculture was viewed positively by all participants including those without farming experience. Food production on dykelands was especially important because of the dykelands high fertility and potential. Despite the increased pressures from development and economic changes in recent decades, all farmers found a way to persevere through hard work and dedication to the unique culture they were born into.

4.6.1 Food Security

As mentioned previously, participants viewed agriculture on dykelands as more than an occupation or livelihood. Farmers described food production as an essential

service they provide society. This discourse often stressed the importance of local food production and economic self-sufficiency at the individual or family level. Additionally, provincial food security was considered important, especially within the context of the COVID-19 pandemic:

> I would say reclaiming the land to grow food should be a priority… Now in this pandemic here, wouldn't it be nice if we could grow a lot of our own food here? Relying on somewhere else isn't going to help (Participant A).

Dykeland agriculture and food production contributed to an awareness of the importance of food security at both the individual and provincial level.

The importance of dykeland agriculture for food production also limited participants from supporting alternate uses of their land. For example, participants viewed tidal reintroduction as negatively impacting food security:

> I think people in this country are hungry. And if they had a choice between food and giving it back to the marsh, to the water. They would pick food every time. But they can't connect the dots or put any emphasis or benefit to local food production or food security (Participant S)

Other considerations for land use including duck retention ponds were viewed as less important than growing food and were characterized as unnecessary or inappropriate uses for dykeland. This trade-off between food security and alternative land uses suggests that food production is a high priority for participants as well as farmers who view its importance as beyond the economic incentives it offers.

4.6.2 Productivity

Both farmers and non-farmers viewed dykeland as being extremely fertile and capable farmland. Seven participants described dykelands as being naturally fertile farmland, largely due to the rich marsh soil:

> They were digging about 16 feet of soil in the deepest part… So it's very fertile land. They did a soil test on it. It had everything it needed except Nitrogen. Its pH was normal and… there's no stone in it… It's very good land to work with (Participant P).

Farmers also noted the environmental and economic benefits of using less fertilizer on dykelands due to their natural fertility. This awareness of dykeland fertility contributed to the belief that dykeland is intended for agriculture because it is naturally-suited for intensive farming.

Participants also discussed the agricultural practices required to keep dykeland productive. Despite the natural fertility of the dykelands, farmers stressed the importance of sustainability in agriculture. For example, using locally-sourced fertilizer creates sustainability:

> Every farm used to have livestock. Now some of them are just doing grains. So they don't have the by-products from the cows. And that's when you get sustainable agriculture, when you're putting back continually (Participant P).

Other methods farmers used to increase sustainability included investing in dozers and other equipment to increase self-sufficiency. These investments in productivity helped to reinforce the idea that dykeland agriculture will continue in the future.

4.6.3 Development

Participants described the increase of non-agricultural development on dykelands including residential, commercial, and industrial buildings. In some cases, participants viewed non-agricultural development as going against the intended agricultural purpose of dykelands. Some farmers viewed residential development on dykeland as introducing unnecessary flood risk:

> You don't want to build a house out in the middle of the Grand Pre dyke and have the dyke wall go alongside you. Twice a day you might have six feet of water go in and out of your living room (Participant W).

Alternatively, one farmer viewed certain development such as green energy and transportation as beneficial because it brings in additional funding for flood protection due to the increase in valuable assets. However, participants generally viewed unnecessary development as harmful to dykelands and their intended agricultural land use.

Participants largely viewed non-agricultural development as a major obstacle for the future of agriculture. The decline in available agricultural land created pressure for the agricultural industry according to farmers:

> Typically what's happening is the land that's really good for agriculture is also really good for building a subdivision on. And if you can't make a living farming, then you basically cut that farmland up for building lots. What you're talking about is taking some additional farmland and essentially sacrificing it even though it could actually be brought back into viable production if it wasn't being flooded. Because once you flood it, it's done. There's no recovering it. (Participant H)

However, these descriptions were highly variable due to different characterizations of the amount of dykeland currently being used. Some participants believed dykeland usage is high, while others worried that too much dykeland remains fallow. Discourse on the consequences of non-agricultural development helped further explain the changes in agriculture as well as the pressures placed on the agricultural industry.

4.6.4 Adaptation

The rapid changes in dykeland agriculture as described by participants created pressure for many farmers who felt that they were not given adequate resources to continue doing their work. The reduction in financial support from the provincial government created a sense that dykeland farming is overlooked and no longer invested in like it used to be. Some farmers suggested they do their work without appreciation, like for Participant S who said "Anybody who is… growing food for people continue to do it using all the tools they have in spite of the noise from the general public." These public pressures are added to outside pressure from environmental change and economic concerns about the future of agriculture.

Despite the challenges they described, dykeland farmers characterized themselves as adaptive to the obstacles they faced. For example, all farmers explained how they acquired expensive equipment from bulldozers to land levelers to replace the need for government assistance. Some farmers described helping other farmers by offering their equipment in return for labour or resources. This sense of community and collaboration was described by Participant P, who said that "The farmers are fewer and farther between and most are all on the same page." In addition to the hard work and perseverance of farmers, participants believed the culture of farming itself could help sustain it:

When it comes to the future, it depends on whether or not people believe strongly enough in the culture to be able to preserve it. If they do, they will move Heaven and Earth to preserve that… If people want to preserve the rural culture of Nova Scotia with small subsistence farming, they will do what needs to be done for that (Participant F).

These descriptions of agriculture as persevering through numerous obstacles depict dykeland farmers as active protectors of dykeland agriculture who strongly believe in its potential and strive to see its continuation into the future (Figure 4.5).

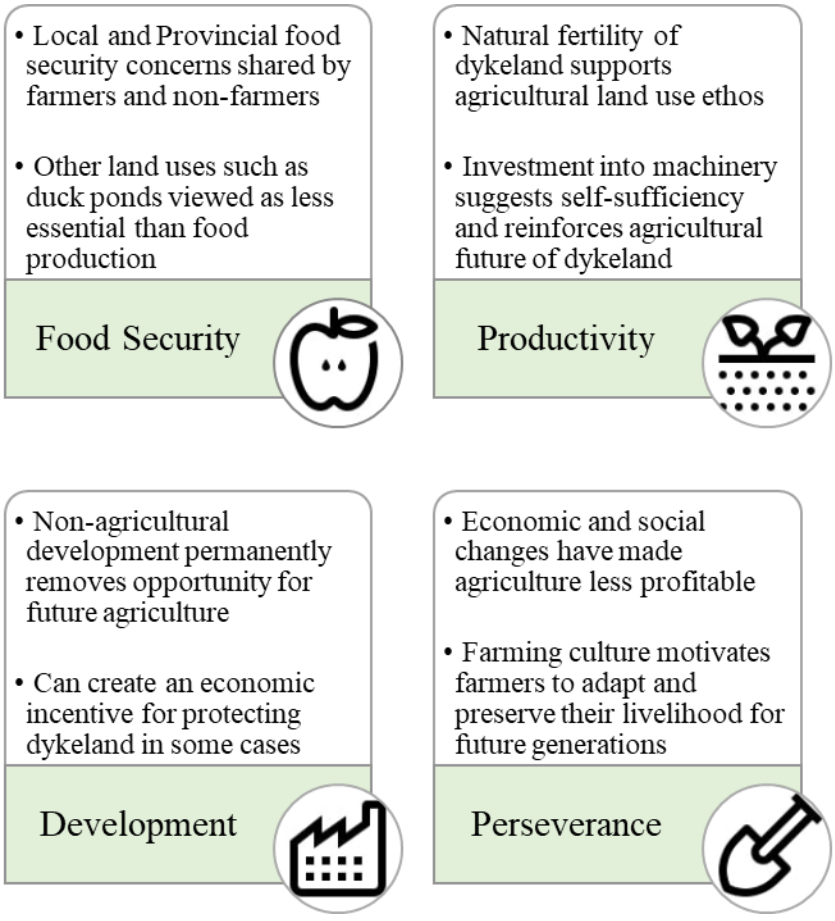

Figure 4.5 Agriculture theme summary

4.7 Summary of Landowner Narratives

Dykeland owners expressed a common concern for future climate change impacts, but had different views on the best adaptation approach. Risk perception was mediated by an understanding of local environmental factors including more static coastal systems and more dynamic river or marsh systems. Climate change impacts like sea level rise and erosion were viewed as slow-moving changes that are not yet encouraging proactive action. Dykes in contrast were viewed as a more stable and enduring part of the landscape, despite the widespread acknowledgment that they require maintenance and reinforcement. This hard-engineered approach was preferable for participants who adopted a *status quo* mentality, using the historical success of dykes and global examples as evidence of their effectiveness. Alternative strategies such as managed realignment were viewed by some participants as intended to divert water and would not support tidal marsh growth. Other landowners were neutral to the benefits of managed realignment but considered that issues of dyke cost and governance would eventually make it necessary in some areas. Managed realignment was viewed most optimistically by landowners who had knowledge of its implementation or process and stressed the inevitability of sea level rise.

Varying levels of risk perception and views on adaptation highlight the need for effective collaboration to promote good dykeland governance and planning. Landowners who were not involved in their marsh body still stressed the importance of a communitybased approach to adaptation. Landowners

largely described marsh bodies as effective for giving landowners a voice and representation for funding. This representation is even more crucial now for landowners who view the political influence of marsh bodies in decline from agricultural consolidation. Agricultural consolidation has led to a perceived reduction in funding for important agricultural work such as ditching. Some landowners viewed this disinvestment and the lack of a long-term plan as detrimental to the future potential of their land, community, or marsh body. Additionally, long-term planning was complicated by the fact that not all landowners share a long-term investment into their land and therefore have differing views on how to manage and protect them.

Values help to further explain these different levels of investment or attachment between landowners toward dykeland. Many participants viewed their land through a historical or cultural lens, including generational agricultural usage and Acadian heritage. In this way, the past informs the present and future because it places a sense of responsibility to continue the legacy left behind by others. In the present day, dykelands are enjoyed recreationally by some landowners for recreation and tourism, while introducing risk or nuisance for some farmers. Recreation produced different emotions for landowners and helps to explain how dykelands are experienced differently on an individual basis. For example, marsh restoration for some landowners were viewed as aesthetically pleasing, while others favoured the perceived natural environment of agricultural dykelands. The awareness of this agricultural ecosystem among landowners in

contrast to the services of wetlands suggest that dykeland ecosystems have more inherent value that necessitate their protection.

Agriculture was viewed as an extension of this natural dykeland ecosystem by providing services for both animals and humans. Landowners regardless of farming experience showed appreciation for food production on dykelands to maintain food security and independence in the context of a global pandemic. The natural fertility of dykeland, as well as investment in agricultural equipment, further reinforces agricultural land use on dykeland. Other land uses such as residential and commercial development were described as damaging for agriculture and society in the long-term. Some landowners viewed nearby development as an opportunity to secure additional funding and attention for dyke infrastructure protecting their land. This is just one example of farmers adapting to the environmental, economic, and social pressures they face. Their perseverance through these obstacles position them as proactive and resourceful managers of their land, who have forged a culture out of their profession that could ensure its continuation for future generations of dykeland farmers. This dykeland narrative reveals the dynamic trade-offs inherent in managed realignment (Figure 4.6).

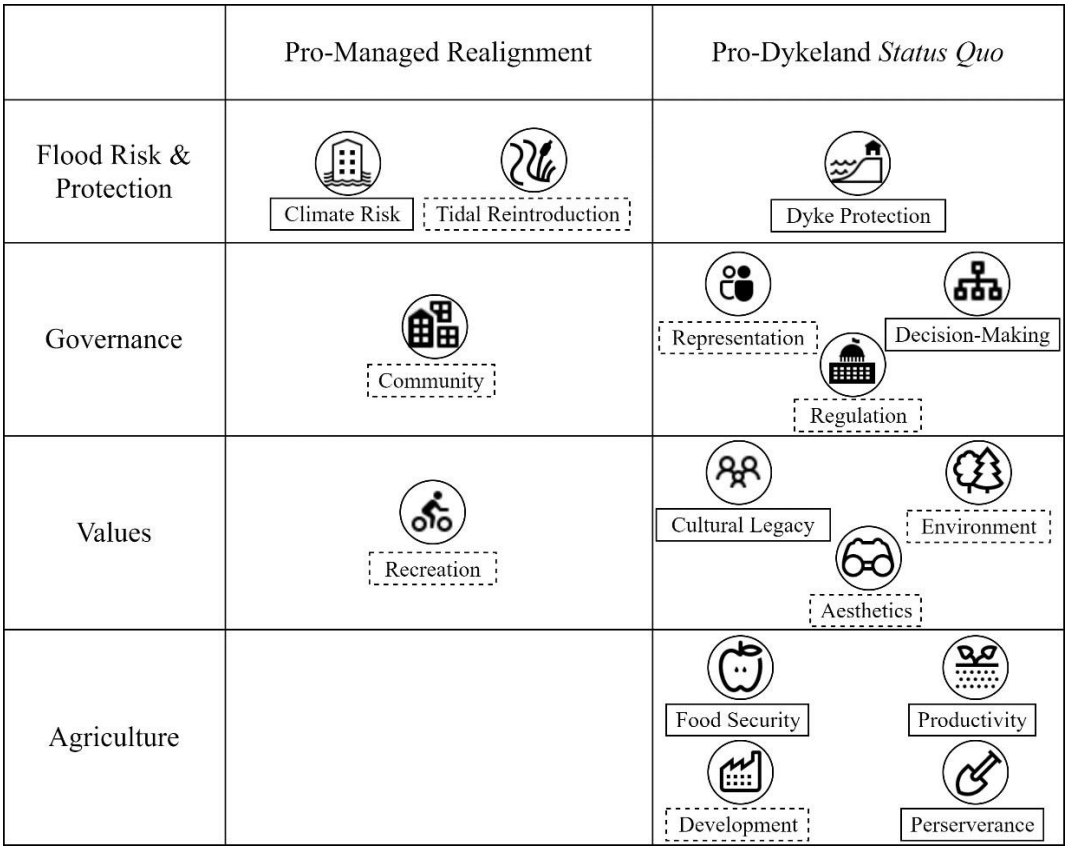

Figure 4.6 Summary of landowner narratives on managed realignment. Filled theme outlines indicate unified participant discourse whereas dashed lines represent a more varied discourse.

Chapter 5
Discussion

This research used interviews with dykeland owners to understand more about their views on managed realignment as a climate change adaptation strategy within the social context of marsh bodies. After a contextualized thematic analysis, four major themes were identified including flood risk/protection, governance, values, and agriculture. Sub-themes were identified and expanded upon to highlight the most important components. To gain a more complete picture of how landowners view managed realignment strategies, integrating these themes illustrated the underlying factors influencing views on managed realignment. Implications of the research are now explored and compared with relevant literature for decision-makers and researchers to use in future work.

5.1 Implications

This research explored three research questions to understand how flood risk, social dynamics, and ultimately managed realignment is perceived among dykeland landowners. Based on the analysis, there are a number of factors that affect how landowners perceive managed realignment and its usefulness in the physical and institutional context of Nova Scotia. This complexity reinforces the assertion made by Myatt-Bell et al. (2002) that perception of managed realignment should be studied on a case-by-case basis. While the relatively smaller sample size in this study limits the applicability of the results, the use of in-depth interviews helps illustrate the broader motives behind views on

managed realignment. Understanding these motives have revealed implications based on the research questions that could improve collaboration with landowners in the future.

5.1.1 Flood Risk Perception

Despite the almost unanimous view that climate change will exacerbate flood risk, participants varied in how they described the effects of impacts like sea level rise and erosion. This variability was partly the result of place-specific environmental factors like wind on exposed coastal dykeland and river flooding on more inland dykeland. These different hazards influenced perception of both risk and adaptation, supporting the need for understanding climate change in its geographical context (Hulme, 2008). This also reinforces Adger et al. (2013) in their assertion that climate risk perception is mediated by local knowledge and cultural norms. Magnan (2014) suggests that incorporating this local environmental knowledge into risk communication could give communities the confidence necessary to drive long-term change necessary for climate change adaptation. Additionally, further understanding the relationship between people and place would enable a culturally sensitive understanding of climate risk perception (Barnes and Dove, 2015).

Participants were also sometimes inaccurate or otherwise uncertain in describing flood risk impacts. For example, the removal of upland trees has been found to have limited effect on flooding in Truro despite some participants in the same area claiming it does (CBCL Limited, 2017). On the other hand, some participants, especially farmers, were quite accurate in their projected sea level

rise estimates, even using exact values. This suggests that future outreach by trusted partners like the NSDA may be effective in conveying flood risk to landowners.

The historical success of dykes led to complacency about future flood impacts among some landowners. This complacent view of flood risk could reinforce the *status quo* mentality among participants. This 'techno-fix' mentality that hard-engineering can fix the issue of flooding is a common barrier among stakeholders and decision-makers (Fazey et al., 2015). Needham and Hanley (2019) suggest that views of managed realignment schemes among local Scottish residents were supported by doubt or concern about existing flood defenses. One way to communicate flood vulnerability is to present visualizations of flood impacts including computer models and context-specific displays (Burch et al., 2010). Roness and Daigle (2012) showed that focusing on local flood impacts for the Tantramar dykes in New Brunswick was a more effective and personal communication strategy. Communicating both the vulnerability of some dykes along with the buffer capacity of restored wetlands could support a more realistic view of climate change impacts.

5.1.2 Community/Marsh Body Dynamics

Overall, the social dynamics within dykelands help explain some of the opportunities and barriers to effective collaboration. Landowners who were not aware of their status as a marsh body member still expressed the desire for a collective approach to dykeland planning and decision-making. Managed realignment in particular was viewed as more effective when coordinated among

landowners instead of a piecemeal approach. Community buy-in is crucial as individual landowners wanted everyone to contribute equally. Additionally, this fosters a sense of communal responsibility of dykeland that is based on a common understanding of their unique significance. This community-based mindset that favours local decision-making over government support has persisted since the Acadians, whose self-governance was unique in the global context of agricultural reclamation (Johnston, 2007).

Given the rarity of this landowner governance globally, marsh bodies could offer an opportunity to collaborate on managed realignment proposals. Agricultural consolidation has clearly disrupted marsh bodies by reducing their perceived political representation. In the process, it may have also unified some concerned farmers, which could lead to mobilization around certain issues as indicated by Sherren et al. (2016). Recent history has shown that advocacy groups such as Friends of the Dykelands, which formed in response to *Bishop-Beckwith v Town of Wolfville, 1996* and is still an active charity today, could mobilize in the event that dykeland values are threatened. However, it should be noted that a distinction was made by participants between non-agricultural development, which the Friends of the Dykelands advocated against, and land use change like managed realignment. This indicates that non-agricultural development and managed realignment are not viewed equally and shows some promise in educating wetlands as a beneficial land use alternative when appropriate.

Despite their perceived decline in representation, the main purposes of marsh bodies according to participants are to secure necessary funding and provide a voice for landowners. Paradoxically, fewer landowners in a marsh body may provide more of a voice on managed realignment by allowing more space for contrasting views to be shared. Participating marsh body members did not agree on the current level of conformity in marsh bodies today, with some responses indicating internal power differentials and others suggesting mutual agreement on major issues. This variability between marsh bodies suggests that a generalized approach to outreach will not be effective, especially given the abundance of trade-offs and values that complicate participation (Few et al., 2007). Instead, Few et al. (2007) promote a more flexible collaboration process where decision-makers go beyond consultation and instead allow genuine participation among stakeholders in designing adaptation projects. In the context of marsh bodies, authentic collaboration on managed realignment that supports and respects their representation and self-governance is suggested to help counter the perceived decline in representation and political influence due to consolidation.

5.1.3 Managed Realignment

Barriers to managed realignment largely came in the form of values that would be affected by its implementation. For example, landowners' awareness of current dykeland ecosystems and their benefits is shared by other farmers of reclaimed land in Europe with a strong conservation ethos for habitat behind dykes (Parrot and Burningham, 2008). While Goeldner-Gianella (2007) showed

unfamiliarity with reclaimed ecosystems among local French residents, the landowners of this study showed strong support for and knowledge of current dykeland ecosystems. Aesthetic and recreational value related to bird-watching and built heritage were major motivators for participants without farming experience who still wanted to protect their local environment. This is consistent with Chen et al. (2020) in their suggestion that built heritage and wildlife are valued by Bay of Fundy dykeland residents.

In contrast to the dykeland environment, the tidal marsh environment was viewed more skeptically, possibly because of its scarcity as suggested by Sherren et al. (2016). Participants generally did not value tidal marsh or recall key benefits such as wave attenuation, despite efforts to educate people about the value of salt marshes in Nova Scotia (Bowron et al., 1999; Rahman et al., 2021). Future efforts to spread knowledge of tidal marsh in Nova Scotia should avoid a unilateral strategy and instead meet landowners where they are by considering the scales of investment at which they operate. For example, advertising ecosystem services such as carbon sequestration may not be as effective for landowners who are more worried about acute flood impacts or may otherwise dispute the need for sequestration altogether. Instead, it is important to directly associate tidal marsh with flood protection in a real-life scenario, as demonstrated by one concerned participant who described giving a tour of his vulnerable dykes to officials during high tide. This strategy is similar to strategies in Canada and Australia that prompts individuals to document king tides as a way to visualize future sea level rise (Coulter, 2018). Given the large

tidal fluctuations in the Bay of Fundy, this could be an effective addition to wetland education by providing a visible display of tidal marsh benefits in action.

The discourse related to historical and cultural values on dykelands was more pronounced in this study compared to much of the managed realignment literature. The Mi'kmaq and colonial Acadian setting that reclamation first occurred in is unique compared to the more historic dyking traditions found in Europe. Participants described Acadians as 'geniuses' who built the land with hard work, evoking a rich imagination among participants of what that history may have looked like. The respect for and interest in dykeland history suggests a more tangible attachment to their landscape's past, as described by the poet Douglas Lochhead speaking of reclaimed land along the Bay of Fundy:

> here, right where my foot takes
> weight, what Acadian sweated and
> froze in the ever-wind to make these
> dykes? There is a sense of history
> here and all across this marsh
> (Lochhead, 1980).

This imagining of history indicates a nostalgia for past landscapes, which help people make sense of current and future landscape changes (Lowenthal, 1975). Ultimately, this suggests that values associated with long-term uses of dykeland will be difficult to ignore while planning for any adaptation that could potentially disrupt them. However, opportunities to share or simply recognize these values

may build trust and create a common understanding of the land upon which to collaborate from.

Other values considered in the study were related to dykeland agriculture and came from participants with and without a farming background. The findings suggest that farmers in particular were highly driven by their value system. For example, there was never any mention of financial compensation for land acquired for managed realignment, albeit possibly due to the lack of a formalized governmental scheme promoted by European counterparts (Roca and Villares, 2012). This may suggest that money is not a major source of motivation for some farmers who instead derive value from their land through farming it. These values echo Aggestam (2014) in their assertion that views on restoration are driven by environmental values and proper land use ethics (Aggestam, 2014). Additionally, this reinforces Sherren et al. (2016) in their characterization of dykeland farming as paramount to the dykeland culture.

Chapter 6

Conclusions

This research sought to understand how landowners view flood risk and managed realignment within the geographic and social context of dykeland marsh bodies. Given the self-regulation of marsh bodies, landowners play an elevated role in adapting Nova Scotia's dykelands to climate change. Through the interview responses of twelve participants, major themes including flood risk/protection, governance, values, and agriculture were identified. These themes were used to construct a narrative of dykeland ownership to help inform future outreach on managed realignment with landowners.

Despite the consensus that dykelands are vulnerable to sea level rise flooding, participants viewed dykes and dyke reinforcement as an effective approach while recognizing their need for costly maintenance. This gap can be explained partly by a dependence on dykes for protecting valuable assets, a preference for immediate solutions to flooding, and values related to dykeland environment and cultural legacy. Support for alternatives such as managed realignment were most common among participants with a long-term mentality about their land and who were familiar with its uses given the inevitable impacts of climate change. Marsh bodies were not shown to influence views on managed realignment, but were instead viewed as declining in their economic and political influence. Instead, farmers were driven by the values gained from farming including environmental conservation of dykeland ecosystems and historical or generational continuation of agriculture. Despite the multiple threats they face,

farmers shared an optimistic view of protecting and passing down these values in the hope that dykeland agriculture can survive in the future.

This research was limited by a few factors including the COVID-19 pandemic. While the phone interview method may have added convenience and even comfort among some participants, the loss of verbal cues from a face-to-face interview made speaking on the phone less engaging and informative. Despite a mostly representative sample of dykeland owners, the lack of participation from landowners in Hants, Digby, and Yarmouth Counties indicate an incomplete spatial gap in participation. Additionally, missing voices from the Mi'kmaq perspective limited the perceptions of dykelands to a more Western settler worldview.

Future work could explore the use of managed realignment to deliver cultural ecosystem services given the recent restoration supported by Mi'kmaq groups and others. Incorporating these relational values with views on climate change adaptation has shown to help understand the context surrounding restoration perception (Parsons et al., 2019). Further, using this lens to investigate the full historical evolution of dykelands to today could identify how colonialism has created a dependence on hard engineering. Lastly, applying different qualitative methods, including surveys that incorporate these initial findings, could provide a more complete understanding of flood risk and managed realignment among dykeland landowners.

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Appendix A: Interview Questions and Prompts

Q 1. How did you come to own your land?

Q 2. What are some of the things you currently use the land for?

- How have these uses changed since you've owned the land?

Q 3. How has your land changed since you've owned it?

- Has this changed your approach in how you manage the land?

Q 4. Do you think your land is at risk of flooding?

Q 5. How well do you think the dykes in your area protect the land from flooding?

Q 6. What do you think should be done, if anything, to protect your land for the future?

- What are the best options for protecting your land in the long-term?

Q 7. Dyke realignment is a process where a dyke line is intentionally set back closer inland. This is done in order to restore tidal influence and support new marsh habitat. The new marsh can act as a natural buffer to sea level rise and storm surge flooding. This strategy has recently been used in Cumberland County, Nova Scotia. Are you familiar with these kinds of ideas?

- What do you think about these ideas?

Q 8. A marsh body can be defined as a body of marshland owners that is incorporated according to the Agricultural Marshland Conservation Act. According to the Act, some powers of a marsh body may include buying or selling marshland property and maintaining works such as dykes and ditches. Are you familiar with what a marsh body is?

- Do you identify as a member of a marsh body?
- What are some functions of the marsh body that you think are most important?
- What is the biggest issue that the marsh body as a whole is facing?

Q 9. What are some things you hope to see for your land in the future?

- What kinds of potential do you see for your dykeland?

Appendix B: Recruitment letter

Dear Sir or Madam:

You are being invited to participate in a research project titled "The Future of Nova Scotia's Dykelands: Understanding the Landowners' Perspective." This research is part of other ongoing projects including the Natural Sciences and Engineering Research Council of Canada (NSERC) ResNET Project (https://www.nsercresnet.ca/landscape-1---bay-offundy.html).

The security of Nova Scotia's coastline is a priority for many of us. Dykelands, or drained marshlands, are important to Nova Scotia's agricultural, economic, and cultural livelihoods. Decisions are being made about how to protect dykelands and their communities in the future. I am reaching out to property owners within dykeland areas for their input on issues related to dykeland protection.

As part of my masters degree at Saint Mary's University, I am looking into how landowners consider climate change impacts like flooding. Specifically, I'd like to learn from landowners like yourself about how you manage your land, your potential flooding concerns, and your long-term goals for managing and protecting your land. Your input on these topics may help inform planners about your views on different approaches to protect dykelands.

My personal interest in the dykelands is rooted in my Acadian heritage. Acadians were the original French settlers that dyked and farmed the marsh in Atlantic Canada. As an Acadian descendant from Louisiana, I have become fascinated with the dykelands' history and what they have to offer today. I am equally interested to learn from the people who own, work, or otherwise share my interest for these dykeland landscapes.

Would you be willing to talk about these topics in an informal interview? The interview will be roughly 30 to 60 minutes long and can be held over the phone or over a virtual platform like Zoom, whichever is more comfortable for you. If you are interested in participating or have questions related to this project, please call Brandon Champagne (902-700-6945) or (brandon.champagne@smu.ca). For any additional questions you may also contact my supervisor, Dr. Danika van Proosdij (902-420-5738) or (dvanproo@smu.ca). If you know anyone else who may be interested, feel free to share this invitation with them.

Saint Mary's University's Office of Research Ethics has granted ethics clearance for this project. If you have any questions or concerns about ethical matters, you may contact the Chair of the Saint Mary's University Research Ethics Board at ethics@smu.ca or 902-420-5728. The Research Ethics Board file number is: 20-121

Thank you in advance for your consideration.

Brandon Champagne

Appendix C: Saltwire Digital Advertising Campaign

PANEL ON
RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Brandon Champagne

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **16 January 2020**

Appendix E

INFORMED CONSENT FORM

The Future of Nova Scotia's Dykelands: Understanding the Landowners' Perspective

SMU REB File # 20-121

Brandon Champagne, Danika van Proosdij, Ph.D., and Kate Sherren, Ph.D. Department of Geography and Environmental Studies Saint Mary's University, 923 Robie Street, Halifax, NS B3H 3C3 Phone: 902-700-6945; Brandon.champagne@smu.ca

You have been invited to participate in a research project titled "The Future of Nova Scotia's Dykelands: Understanding the Landowners' Perspective". As part of my masters degree at Saint Mary's University, I am conducting this research under the supervision of Dr. Danika van Proosdij. Your participation in this research is entirely voluntary.

Purpose of the Research: This research project explores how dykeland landowners in Nova Scotia view environmental impacts of climate change such as flooding. The research also hopes to understand how landowners view ideas of how to adapt to these impacts. Planners are currently making decisions about protecting dykeland communities, which will include the participation of local stakeholders. An initial understanding of how some dykeland landowners view these topics will lead to more effective collaboration with planners and researchers working to protect dykelands and their communities.

Eligibility: Any person 25 years or older who owns land registered within a marsh body by the Nova Scotia Department of Agriculture is considered eligible for participation. If you are unsure whether your land meets this criteria, please contact Brandon Champagne for more information.

What You Will Be Asked to Do: You will be asked to participate in a one-on-one interview about the impacts of flooding and your thoughts on potential solutions. Topics will include your approach in managing your land, your views on flooding and environmental change, and your participation in the marsh body. The interview will be open-ended, meaning that I may ask follow-up questions based on your responses. Due to COVID-19 guidelines, interviews will take place either on the

phone or over a virtual platform like Zoom Pro between September and November of 2020. I predict it will take between 30 and 60 minutes to finish the interview.

Potential Benefits: The research findings will help improve collaboration between stakeholders and planners working to protect dykeland communities. As an added bonus, participants may learn about or become more aware of efforts to protect dykelands and their communities.

Possible Risks: While this research is considered minimal risk, there is a chance you experience negative reactions from questions about yourself or your history of owning land. However, I have tailored interview questions to avoid intimidation. You may also withdraw from the project at any time. Additionally, because confidentiality cannot be guaranteed, there is a minimal risk that your participation will be known to others. However, your name and information will be kept anonymous throughout the research and I will not share your involvement with anyone at any time.

Information Gathered: In addition to your interview responses, I will collect identifiable information such as your name, phone number, and email/mailing address. I will only use this information to correspond with you during the study and will not share it with anyone at any time. During the interview I will record the audio to provide a more accurate account of our conversation. I will transcribe the recording using the Descript software. The interview audio and transcripts are kept confidential from Descript, but are shared with Google Cloud Speech-to-Text, Rev, and Amazon AWS for safe transcription and secure storage. Descript protects data using encryption over HTTPS, which is the industry standard for online security. Note that Descript's servers are located in the United States, meaning that your data will be stored in another country. For more information, visit https://www.descript.com/security.
Should you decide on a virtual platform for the interview, I will create and share a password for the interview call in order to ensure privacy. Zoom Pro uses features such as encryption to protect its users. More details can be found at https://zoom.us/docs/en-us/privacy-andsecurity.html.

Confidentiality: I will make every effort to protect the confidentiality of your participation in the research as well as the information you provide. You will be assigned a random participant number throughout the research in order to protect your identity in reports, presentations, and publications. This will also ensure that any identifiable information you provide is kept separate from your interview responses at all times. After the interview, I will safely store your data on an

encrypted flash drive in a locked box. After my research is complete, I will transfer the interview transcript to my supervisor on an encrypted flash drive, where it will be kept safe in a locked office. It may only be shared with her research assistants for future reference and will not be included in future research or publications. All other data will be destroyed at that time, including interview recordings.

Dissemination of Research Findings: Because this research is part of my masters degree, I will write a thesis report that sums up my research findings. The report will be made publicly available online once it is submitted and accepted by Saint Mary's University. I will provide you the link to access this document once it is available, which will be around June 2021. Additionally, the research findings may be presented at various research conferences, workshops, or publications.

Compensation: While there is no monetary incentive for participating, compensation will be given if you have incurred a cost related to the project. The most likely scenario would be if you must pay an additional fee for interviewing over the phone. In this case, you would be compensated in cash through mail. Note that a toll-free number can be made available if necessary.

Voluntary Participation: Your participation in this research is completely voluntary and you may choose to stop participating at any time. If you wish to do so, simply notify me that you would like to withdraw from the study. This decision will not affect your standing with the research team or Saint Mary's University. If you decide to withdraw, all information collected from you will be destroyed. It would be helpful for me if you plan on withdrawing to notify me before I begin the writing process around January 2021. If you have any questions about the project or the risks involved with participating, contact me at Brandon.champagne@smu.ca (902-700-6945) or my supervisor at dvanproo@smu.ca (902-420-5738).

Research participant rights and protection: The Saint Mary's University Research Ethics Board has reviewed this research with the guidance of the TCPS 2 based on three core principles: Respect for Persons, Concern for Welfare and Justice. If you have any questions or concerns at any time about ethical matters or would like to discuss your rights as a research participant, please contact ethics@smu.ca or 902-420-5728.

Consent:

Do you understand what this study is about, appreciate the risks and benefits, and that by consenting to agree to take part in this research study, you do not waive any rights to legal recourse in the event of research-related harm?

Do you understand that your participation is voluntary and that you can end your participation at any time without penalty?

Have you had adequate time to think about the research study and have you had the opportunity to ask questions?

Please keep one copy of this form for your own records.