Mobilizing values: Using perceptions of barachois ponds in Cape Breton to advance informed management

By

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Abstract

Barachois ponds or tidal lagoons are highly dynamic, incredibly productive, yet poorly understood wetlands across Nova Scotia, Canada. Defined by the partial or complete enclosure of a sand or gravel barrier forming a pond, they are saline when open to the sea, becoming fresh-water environments if fully enclosed. They form mosaic landscapes and are critical habitats, nesting sites, and feeding grounds for migrating shore birds and mammals. Barachois ponds are highly valued for their ecosystem services such as natural harbours, oyster aquaculture, and simple charm. Yet commonly applied environmental triggers for management, such as freshwater and saltwater for distinguishing between provincial and federal jurisdiction, become obscured in brackish water systems that shift constantly between stable states. Negative impacts to barachois ponds occur at the watershed scale, yet uncoordinated land-use policies across municipalities and First Nations Reserve lands exacerbate these impacts. To advance informed decision-making on the management of barachois ponds, perspectives from 33 participants across five stakeholder groups including academia, government, industry, local, and non-governmental organizations, are revealed using Q-methodology mixed-methods. Resulting in the unearthing of four dominant perspectives: The Leave-Them-Be Conservationists (1-LTBC); The Sustainable Developers (2-SD); The Management Reformists (3-MR); and The Science-Based Conservationists (4-SBC). Further analysis and interpretation of data and perspectives uncovered six key issues for reaching effective management of barachois pond ecosystems: 1) An adaptation of Wetland Ecological Services Protocol for Atlantic Canada (WESP-AC) is suggested for barachois ponds in Cape Breton; 2) To populate the provincial wetland inventory through the development of a comprehensive sub-classification system for barachois ponds; 3) To create robust social and cultural importance criteria for designating Wetlands of Special Significance and provide greater opportunities for input; 4) To require alteration approvals for barachois ponds be screened by more than minimum size requirements; 5) To coordinate integrated management at the watershed-scale by enacting land-use planning policies across relevant jurisdictions and promoting cross-sectoral communication; and lastly, 6) To increase environmental education initiatives around barachois ponds.

List of Acronyms Used

CB	Cape Breton
BDL	Bras d'Or Lake(s)
BLBR	Bras d'Or Lake Biosphere Reserve
CBRM	Cape Breton Regional Municipalities
CEPI	Collaborative Environmental Planning Initiative
DFL	Department of Lands and Forestry
IRM	Integrated Resource Management
MAB	Man and the Biosphere
MGA	Municipal Government Act
MPS	Municipal Planning Strategies
NNL	No Net Loss
NSE	Nova Scotia Environment
NS	Nova Scotia
NS WCP	Nova Scotia Wetland Conservation Policy
PPR	Public Perception Research
PSI	Provincial Statement of Interest
SAV	Submerged Aquatic Vegetation
SES	Social-Ecological Systems
UNESCO	United Nations Educational, Scientific and Cultural Organization
UINR	Unama'ki Institute of Natural Resources
WESP-AC	Wetland Ecological Services Protocol for Atlantic Canada
WSS	Wetlands of Special Significance

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CHAPTER 1. INTRODUCTION

Barachois ponds and tidal lagoons form a mosaic landscape ranging from tidal flat, to barrier pond, to dune, to beach, to fringent salt marsh vegetation, to coastal forest, providing microhabitats from one pond to the next owing to distinct salinity and temperature gradients within and between each pond or lagoon (de Wit, 2011; Esteves et al., 2008). Further, they are typically surrounded by salt marshes, creating a rich myriad of ecotones resulting in high biodiversity at the landscape level (de Wit, 2011; Hatcher, 2015). The formation of these saline, brackish and freshwater ponds creates unique and ephemeral ecosystems, constantly shifting configurations in space and time from natural processes (de Wit, 2011; Nixon, 2013).

Barachois ponds, along with tidal lagoons, are a subset of coastal saline ponds, a distinct class of wetlands in Nova Scotia in the Nova Scotia Wetland Conservation Policy (NS WCP) (Nova Scotia Environment (NSE), 2011). The NS WCP defines them broadly as "a small body of saline-to-brackish water, commonly found behind a barrier beach or bar formed of sand or cobble deposited by wave action. Receiving saline water from storm surge, sea spray, or periodic opening of inlet" (NSE, 2011, p.20). A widely known term that closely resembles a barachois pond is "coastal lagoon", defined as a "shallow water body separated from the ocean by a barrier, connected at least intermittently to the ocean by one or more restricted inlets, and usually oriented shoreparallel" (Kjerfve, 1994 p. 2). The defining features that distinguish coastal lagoons from barachois ponds are less clear, though Nichols and Allen (1981) describe a "pond" as occurring when longshore transport of sediment exceeds the capacity of river or tidal current to sustain an inlet, forcing closure from the sea. Each coastal pond is continually undergoing one of five phases, initiation, growth, establishment, breakdown and stranding or collapse (Taylor & Shaw, 2002). Their geological persistence is linked to rates of sea-level rise and filtering capacities in response to climate change and human activities such as land-use practices, water use and water diversion (Kjerfve 1994).

These wetlands provide a range of invaluable ecosystem services to humans and the natural world through fish supply, water supply, water filtration, climate regulation, flood control, coastal protection, recreational activities, tourism, natural harbours, shoreline protection from erosion, and much more (Finlayson, D'Cruiz, Davidson, 2005; Massachusetts Barrier Beach

Task Force, (MBBTF), 1994; Shaw et al., 2006; Taylor & Shaw, 2002). Given the range of values surrounding barachois ponds and coastal lagoons; from protection to development, it is critical to employ cross-sectoral and ecosystem-based approaches in wetland management decision-making processes, be they wetland conversion, irrigation and draining, land-clearing, development opportunities, conservation, livelihood practices, policy development, etc. (Finlayson et al., 2005).

Alarming decline of wetlands from development along the Bras d'Or Lakes (BDL) in Cape Breton, coupled with sea-level rise is hastening the degradation of barachois ponds faster than public policy can apply corrective measures (Bates, 2017; CEPI Steering Committee, 2013). Wetland policy is rightly informed by natural science, however, effective stakeholder involvement is also required to produce policy conditions that people will abide by (Grygoruk & Rannow, 2017). Therefore, it is critical to amass the full range of values and benefits provided by these wetlands in any decision-making analysis related to their protection (Ruiz-Frau, Edwards-Jones & Kaiser, 2011). The messaging surrounding conservation and adaptation must be easy to understand, relevant, and acceptable for all stakeholders (Grygoruk & Rannow, 2017). Therefore, gaining context-specific social research is imperative for understanding the meanings people associate with concepts related to marine conservation and barachois ponds (Hagan & Williams, 2016). Owing to their unmatched and dynamic nature, barachois ponds and coastal lagoons provide numerous critical ecosystem services, which are increasingly threatened in Cape Breton and around the world (Hatcher, 2015; Chapman, 2012; Kennish & Paerl, 2010).

1.1 Ecological significance of coastal lagoons

The ecological importance of coastal lagoons for supporting biodiversity is widely documented (Conde et al., 2015; Isacch, 2008; Parker, Westhead, Doherty, & Naug, 2007). Coastal lagoons are among the most productive ecosystems in the world pending an efficient trophic transfer (Chapman, 2012; Conde et al., 2015; de Wit, 2011; Kjerfve 1994; Pérez-Ruzafa & Marcos, 2012; Heritage Conservation and Recreation Service, 1979). These transitional marine-to-brackish-to-freshwater environments provide a diversity of benthic micro and macro fauna, marine vegetation, physical and chemical sedimentary characteristics, and on-shore hydric vegetation with an abundance of life encircling these habitats (Conde et al., 2015; de Wit, 2011;

Hatcher, 2015; Lamptey, 2011; Ontario Educational Communications Authority (TVO), 2018; Pérez-Ruzafa & Marcos, 2012). Located at the mouths of freshwater river systems where cooler freshwater mixes with semi-saline waters of the BDL, barachois ponds create unique estuarine habitats ideal for breeding fish (Hanam, 2000; Hipwell, 2001; Lambert, 2002; Parker et al., 2007). Some barachois ponds provide the richest fish breeding grounds in the entire watershed, often with a disproportionate number of rare of endangered species (Hanam, 2000; Hipwell, 2001).

Known as 'kidneys of the landscape', coastal lagoons and their tidal flats act as digesters for organic material, entrapping and recycling organic and inorganic material, contributing significantly to the detritus food chain, and providing invaluable habitats for countless invertebrates and benthic fauna (Conde et al., 2015; de Wit, 2011; Hatcher, 2015; Kennish, 2002; Kjerfve & Magill, 1989; Pérez-Ruzafa & Marcos, 2012; Tremblay, 2002). These invertebrates further contribute significantly to the food web from massive quantities of larvae (MBBTF, 1994). This is only enriched by the diverse habitats provided by coastal lagoons, such as open waters, submerged aquatic vegetation, unvegetated bottom sediments, tidal flats and creeks, and fringent wetlands (Kennish & Paerl, 2010).

Coastal lagoons and barachois ponds alike offer rich feeding grounds for resident and migratory waterfowl by providing marine plants, small benthic invertebrates and fish (De Wit, 2011; Pérez-Ruzafa & Marcos, 2012; Tremblay, 2002). The barriers that enclose barachois ponds are unmatched features central in supporting ecosystem services (Armah, 1993; Terwilliger & Wolflin, 2005). Isolated berms for instance, provide added protection to important migratory birds away from predators (MBBTF, 1994). Barachois ponds are also spawning and rearing habitats, known as nurseries for the BDL (Parker et al., 2007; Vieth, 1884). The watershed that drains into the Bras d'Or Lake is home to some of the largest concentration of breeding Bald Eagles in eastern North America (Erskine, 1992; Evans, 1999; Hipwell, 2001). These eagles are often present near barachois ponds owing to the availability of fish and vegetated barriers (Figure 1). This obviously notable abundance of ecosystem services provided by barachois ponds make these ecosystems highly valued by numerous stakeholder groups.

Figure 1. An eagle sits atop a nesting perch overlooking MacDougall Pond in Ben Eoin, Cape Breton

1.2 Social significance of barachois ponds in Cape Breton

While coastal barriers only account for 12% of the BDL shoreline, they are a highly visible and utilized landform, providing transportation, recreation, tourism, boating, real estate values, shoreline and infrastructure and natural harbour protection and anchorage from storms, waves and winds; thereby bearing great intrinsic coastal values (MBBTF, 1994; Shaw et al., 2006; Taylor & Shaw, 2002).

Mi'kmaq Ecological Knowledge (MEK) on the importance of barachois ponds in Unama'ki reveals the ponds are valued for fisheries services such as winter eel habitat and winter food access, for cultivating oysters, as spawning groups for trout, oysters, and gaspereau, and as important habitat for mackerel, smelt, perch, steelhead, flounder, salmon, stripped bass, shellfish, green crab, rock crab, and lobster. Further, these areas have been identified as Special Concern for turtles during July and August (Hatcher, 2015). As a result, mammals such as beaver, bobcat, fox, lynx, muskrat, and racoon frequent these areas for food. As such, they are valued greatly as ideal trapping grounds (personal communication, E. Johnson, July 2018). The ponds are also valued for their plant life, such as cat tails, reeds, eel grass, widgeon grasses and very important medicinal plants such as sweet grass and ginger root (Hatcher, 2015; personal communication, Participant C17, Local, July 2018).

Further MEK on the importance of barachois ponds demonstrates value for water filtration, as nutrient enrichment for Bras d'Or Lakes, and as shoreline erosion and storm protection (Hatcher, 2015). Valued culturally as natural harbours, for swimming and skating, and finally in some cases, for deeply rooted spiritual connections (Hatcher, 2015; personal communication, Participant C17, Local, July 2018). Given fish were often "herded" by the Mi'kmaq into small, slightly brackish "barrachois ponds" at the mouths of freshwater streams feeding into the lands, some Mi'kmaq gaspereau harvesters still actively upkeep and repair "their" ponds against erosion and siltation (Hipwell, 2001 p. 259; Lafford, 1997).

The Nova Scotia Department of Natural Resources, now called Department of Lands and Forestry, acknowledged barachois ponds and their barriers as being important salt water wetlands for protection against erosion (Hatcher, 2015; Nixon, 2013). Barachois ponds are also broadly valued for their capacity as reservoirs for fluvial sediments, for trapping inorganic sediments and organic matter as it filters down the watershed, and the subsequent prevention of elemental pollutants from entering the sea (Kjerfve, 1994; Lamptey, 2011). Barachois ponds and coastal lagoons are highly valued for their capacity to support fisheries for supporting high rates of primary and secondary production (Conde et al., 2015; De Wit, 2011; Hatcher, 2015; Hipwell, 2001; Kjerfve 1994; Pérez-Ruzafa & Marcos, 2012). Barachois ponds often enhance homeowners' properties by providing relatively calmer waters than those in the BDL and are commonplace among the Cape Breton land and sea-scape (Figure 2). Given the ecological and social significance of barachois ponds, it is critical to understand the underlying social ecological systems (SES) that threaten these coastal lagoons, both locally and regionally (Berkes & Seixas, 2005).

A. A deck overlooking a barachois pond. L. Ross

B. Ben Eoin Marina, former barachois pond. L. Ross

C. Dock at Lochmore Harbour, Big Pond. L. Ross

D. Barachois pond with property on the barrier. L. Ross

Figure 2. A collection of barachois ponds across the Bras d'Or Lakes, Cape Breton. L. Ross

1.3 Threats to barachois ponds

Numerous anthropogenic and regulatory threats currently face barachois ponds across Cape Breton and Nova Scotia (Environmental Design and Management (EDM) Ltd., 2008; Hydrological Systems Research Group, 2011). Barachois ponds are impacted at the watershed scale, meanwhile the BDL watershed has endured years of degradation (EDM, 2008; Hipwell, 2001; Naug, 2007; Parker et al., 2007). If unaddressed, these threats could have lasting impacts on the health of barachois ponds, and in turn, the valuable ecosystem services they provide (Kjerfve 1994; Sikora & Kjerfve, 1985). It is important to address threats to barachois ponds from a social-ecological perspective as coastal lagoons are inherently socio-ecological systems, bound by the consequences of human activities, whereby human activities are often linked with lagoonal ecology (Berkes & Seixas, 2005).

1.3.1 Anthropogenic threats facing barachois ponds in Cape Breton

Coastal lagoons have been severely altered or destroyed by eutrophic water conditions from nitrogen loading and faecal coliform, pollution, urbanization such as infilling, run-off, dredging of pond and barrier, modifications to the watershed causing altered hydrology, and anthropogenic climate change such as sea-level rise and invasive species (Figure 3) (Culbert & Raleigh, 2001; Butler et al., 1996; Esteves et al., 2008; Strain & Yeats, 2002).

Figure 3. Chapel Rd in Cape Breton, a paved barrier decreases natural passage of water.

Barachois ponds in the BDL are threatened by development in the watershed, both directly and indirectly through activities such as excavation and dredging of barriers, infilling ponds, shoreline hardening, construction, paving, increasing shorefront development from both developers and private land owners, land clearing, surface run-off, urbanization, agriculture, mining, as well as increased need for waste disposal (EDM, 2008; Hatcher, 2015). Barachois ponds with closed or partially closed inlet are much more susceptible to eutrophic conditions than otherwise more open systems (Kennish & Paerl, 2010; Hatcher, Imberger & Smith, 1987) (Figure 4).

Figure 4. Eutrophic conditions in one pond, while an adjacent pond is clean and healthy. Photo provided by L. Baechler.

Barrier beaches are experiencing higher rates of erosion from greater risk of flooding from heavy rain and storm events, negatively impacted water quality, and from the impacts of climate change through more frequent, more intense storms, sea-level rise (despite the BDL's relatively narrow tidal-range of 0.03 m - 0.34m), and increased temperatures (Bizikova & Hatcher, 2010; Culbert & Raleigh, 2001; Petrie, 1999; Shaw et al., 2006). While invasive species such as the European green crab and the MSX parasite are also wreaking havoc on the natural systems. The MSX parasite is an infectious disease that kills around 90% of the oysters it infects within four to five months (Cox, 2018). These issues create perplexing scenarios when advancing the management of barachois ponds and the BDL watershed.

To inform the design, planning, and implementation of coastal lagoonal management strategies for Cape Breton and Nova Scotia, decision-makers must use a social-ecological-systems (SES) lens to fortify resiliency against fluctuating social and ecological environments (Berkes, Seixas, 2005). Numerous lagoonal processes adhere to seasonal fluctuations, and are often subject to shocks and altered states and fit well within resilience thinking (Berkes &

Seixas, 2005). To adaptively manage for multiple unknown outcomes, decision-makers must operate using policies that are sensitive and flexible to change, able to incorporate both advancements in knowledge on barachois ponds and environmental data on such rapidly evolving social and ecological systems (Perry, Rosemary, Ommer, Barange & Werner, 2010). The health of barachois ponds is closely hinged to political and social mechanisms, such as the enabling of cross-sector communication effecting shared visions among all stakeholders, such as through space for political experimentation and respectful use of Traditional Ecological Knowledge, both qualities exhibited under the Bras d'Or Charter, and finally, through equity in resource sharing, such as recognizing the Bras d'Or Lakes as a single system (Seixas, 2002). It is therefore critical to understand the socio-political environments that govern the health of barachois ponds, so as not to work in a conservation "vacuum".

1.3.2 Regulatory threats facing barachois ponds in Nova Scotia

Currently, the regulatory structures in Nova Scotia under which barachois ponds are managed are not conducive to implementing integrated management of brackish water resources. Under the Nova Scotia Wetland Conservation Policy (NS WCP), waterbodies that exceed 2 m depth do not qualify as wetlands but instead are treated as watercourses. Therefore, points along barachois ponds that exceed 2 m are not technically protected as wetlands under the policy but are protected as a watercourse under the Nova Scotia *Environment Act*.

Meanwhile, wetlands on federal Crown lands are not protected under the NS WCP but are instead protected under the Canadian Federal Policy on Wetland Conservation. All other federal environmental protection laws such as the Canadian Environmental Assessment Act (CEAA), the Fisheries Act, the Species at Risk Act (SARA), and the Canadian Environmental Protection Act still apply (Hykin & Bendle, 2016). This separation of policies creates two issues for achieving integrated management of barachois ponds.

Firstly, a disjoint exists in how barachois ponds are defined, where the federal policy employs the use of the Canadian Wetland Classification System to delineate wetlands covered under the policy. Yet, this classification guide makes no explicit mention of barachois ponds; and thus, are not defined. Second, it can occur that one pond is delineated politically into provincial, federal, and First Nations jurisdiction depending on definitions used, and the location where the

pond occurs, adding further obstruction through use of different provincial policies for areas greater than 2 m in depth.

Many barachois ponds are situated within five municipalities in CB, including Cape Breton Regional Municipality (CBRM), Inverness, Richmond, Victoria, and the Town of Port Hawkesbury. Among the 15 Municipal Planning Strategies (MPS), limited or non-existing mandates are in place to work at the watershed scale through zoning bylaws, such as setbacks or buffers. While Cape Breton Regional Municipality (CBRM) emphasizes the importance of working at the watershed scale, the protection of public water supply is the central tenant linking environmental protection with municipal jurisdiction (CBRM, 2017). Further, many other barachois ponds are upon the five First Nations on Cape Breton: Eskasoni, We'koqma'q, Wagmatcook, Potlotek, and Membertou, which also do not enact coordinated land-use planning strategies when approving developments in the watershed (Figure 5).

Figure 5. Map of Nova Scotia Mi'kmaq First Nations (Government of Nova Scotia, 2017).

The Government of Nova Scotia has not yet created a Provincial Statement of Interest enabling the integrated management of aquatic and terrestrial environments and natural resources across Municipal, Provincial, Federal, and Aboriginal governments. Yet these brackish water resources are multi-jurisdictional, spanning private and municipal, provincial, federal, and First Nations territory. Even the term "barachois pond" is fragmented in its interpretation among Nova Scotians and across policies (NSE, 2011; National Wetlands Working Group (NWWG), 1997). Effective integrated resource management (IRM) requires affording each municipality and the

Province with the authoritative capacity to adaptively implement setbacks or buffers on lands that surround watercourses when conserving ecosystem services (Expert Panel on Climate Change Adaptation and Resilience, 2018). Recognizing their authoritative limitations, the municipality of CBRM openly supports a collaborative agreement with the Province and Canada on the implementation of a watershed management plan (CBRM, 2017).

Despite positive strides from numerous organizations and institutions in Cape Breton to achieve watershed-scale management and governance from such groups as the Collaborative Environmental Planning Initiative (CEPI), Unama'ki Institute of Natural Resources (UINR), Unama'ki College, and many others, the regulatory frameworks under which barachois ponds are currently managed create significant complexities for reaching protection at the watershed scale (CEPI, 2011; Naug, 2007). This complexity, if not overcome, could threaten the future integrity of this brackish water resource.

1.4 Management Problem

While around 400 barachois ponds exist in Cape Breton, globally, coastal lagoons have experienced staggering declines from anthropogenic causes (Culbert & Raleigh, 2001; Kennish & Paerl, 2010). Owing to their prevalence along the shores of Cape Breton, an underlying mentality exists that if a barachois pond is lost to development, "there are many more just like it" (Hatcher, 2015, p. 4). In Nova Scotia and unmistakably in a regional context, this collection of tidal marsh ecosystems along the BDL in CB is unique, critical, and worthy of protection (United States Heritage Conservation and Recreation Services, 1979).

Two such means of establishing such protection of barachois ponds is through designation of Wetlands of Special Significance (WSS) under the NS WCP, and by triggering a provincial or federal Environmental Assessment (EA). WSS is a designation that affords greater protection against wetland alteration from development and human activities, while EA is a process that mandates best-practices against undue harm (Nova Scotia Environment, (NSE), 2011; Nova Scotia Environment and Labour, 2006). The size of a wetland is currently a key determinant in granting protection when authorizing an *Application to Alter a Wetland*, and with designating a wetland as a WSS (NSE, 2013). The NS WCP states that no wetlands of any type

under 100 m^2 may be designated as WSS (unless it is a salt marsh), nor do they require a permit to alter (NSE, 2013; NSE, 2011). Size is further used as a trigger within EA processes whereby only disruptions greater than two hectares or to two or more wetlands will trigger an EA (NSE, 2013; Province of Nova Scotia, 2017).

While much has been written recently regarding these ecosystems, significant knowledge gaps still exist in the inventory of barachois ponds in CB (Hatcher, 2015; Parker et al., 2007; Nixon, 2013; Petrie & Bugden, 2002; Rushton, 1974; Shaw et al., 2006, Taylor & Shaw, 2002). It is problematic to approve the alteration of barachois ponds when only 150 of the 400 barachois ponds in CB have undergone rapid-assessment. Size as a qualifier for protection may be inadequate given the lack of data on the precise characteristics of barachois ponds vital for the preservation of ecosystems services. The discrete values and benefits of a highly dynamic system are not reflected in size alone (Adamus, 2011). Size as a qualifier for protection, in the case of NS WCP, is more a means to balance regulatory efficiency with protection rather than an ecological axiom that 'larger is better'.

Barachois ponds are facing numerous ecological, anthropogenic, and regulatory threats with very limited human and financial capital to ensure their conservation, protection, and compliance. Collectively, these factors are diverting the possibility of reaching integrated management for barachois ponds and the Bras d'Or Lake watershed. The total loss and/ or partial destruction of barachois ponds have wider consequences for the Bras d'Or Lakes biosphere such as loss of productivity, spawning grounds, nursery areas, overwintering habitat, and fishing areas (Denny, 2013). Sea-level rise and increasing storms are furthering shoreward migration and disappearance of barrier beaches (Nixon, 2013). The ephemeral nature of these understudied ecosystems challenges their protection (Hatcher, 2015; Nixon, 2013). Without social research to complement the work undertaken by natural scientists on these ecosystems, it will be difficult for project managers to fulfill both social and ecological objectives without understanding the perspectives of the users of that ecosystem (Hagan & Williams, 2011).

1.5 Research Aims and Objectives

Multi-jurisdictional management of the Bras d'Or Lakes and barachois ponds requires multi-disciplinary research in ecosystem valuation that accounts both ecological and social values (Ruiz-Frau et al., 2011). Meaningful societal engagement to tease apart numerous values in marine conservation is increasingly needed to produce conservation strategies deemed acceptable by local communities, thereby reducing potential for conflicts (Christopoulou & Tsachalidis, 2004; Jefferson et al., 2015; Ruiz-Frau, et al., 2011). One study gathered residents' attitudes regarding a wildlife sanctuary to help inform the sanctuary's management strategy by accommodating local needs and perceptions (Allendorf, Aung & Songer, 2012). A follow-up study years later revealed that participants attitudes towards the sanctuary were significantly more positive, with instances of perceived conflicts having decreased, owing to their involvement and understanding of the decisions being made (Allendorf et al., 2012). Public perception research (PPR) in marine conservation promotes the use of multiple lenses in the pursuit of interdisciplinary, cross-sectoral research, with policy makers and decision-makers engaged at each stage of research and development (Jefferson et al., 2015). Another benefit of this type of research is that change in participants' understandings of the phenomenon tends to deepen during the PPR research process, creating ocean literate individuals who better understand their stake in marine conservation (Lotze, Guest, O'Leary, Tuda & Wallace, 2018; Lopes & Videira, 2013). Yet PPR is too nuanced to mobilize conservation actions alone and should therefore be a component of other larger marine conservation initiatives (Jefferson et al., 2015).

The use of Q-methodology is employed in this research to fill the gap between the pressing need for collaborative management at the watershed scale, and an absence of the technical data and resources required to delineate ecological and hydrological significance of barachois ponds. Instead, four dominant perspectives from five stakeholder groups concerning the management of barachois ponds are offered to inform managerial decision-making using Q-methodology, a mixed-methods design (Chapman, Tonts & Plummer, 2015). Stakeholder valuations of effective management strategies and pathways for action for reaching IRM emerged during this research.

The final intent of this study is to inform the designation of certain barachois ponds as WSS by informing decision-makers on their social and cultural significance using four dominant perspectives from five key stakeholders.

1.5.1 Central research question

1. How can understanding stakeholder perspectives of barachois ponds in Cape Breton advance informed decision-making on their management, under current regulatory frameworks?

1.5.2 Sub-questions

a. What are the dominant perspectives from key stakeholders regarding barachois ponds?
b. How can knowing these perspectives advance informed decision-making on barachois ponds management?

CHAPTER 2. BACKGROUND

This chapter provides the necessary context for understanding barachois ponds from a managerial perspective. Topics include the origin of the word barachois pond, its physical components and driving processes, the Bras d'Or Lake watershed, the Bras d'Or Lake as a social-ecological system, the regulatory framework under which barachois ponds are managed in Nova Scotia, the value of public perceptions in the context of marine management, and finally, the importance of establishing necessary and clear triggers for protection, as demonstrated through a case study on Big Pond RV Park in Cape Breton.

2.1 Overview of barachois ponds

2.1.1 The name

The term 'barachois' is Acadian in origin, with twelve spellings and pronunciations across Atlantic Canada including barrachois, barrisois, barasway, barrasway, barashwa… (Department of Butler, Chaisson, Daury, Dean, Dietz, MacKinnon, Steel, 1996). Four-hundred barachois ponds fringe the shores of the Bras d'Or Lake in Cape Breton, Nova Scotia (NS) accounting for 12% of the Bras d'Or shoreline (Taylor & Shaw, 2002). In the Mi'kmaq language, barachois ponds are named Pitu'wey (Hatcher, 2015). Other terms that refer to comparable ecosystems as barachois pond include freshwater barrier pond, coastal salt pond, tidal pond, tidal lagoon, barrier pond, saline lagoon, brackish lagoon, coastal brackish lagoon, coastal saline lagoon, barrier lagoon, barrier beach lagoon, and finally, coastal lagoon (Beer & Joyce, 2013; Butler et al., 1996; Metcalfe, 2013; NWWG, 1997; NSE, 2011; Tiner, 2017). The term "lagoon" however has two meanings (Barnes, 1980). First, "an area of salt or brackish water separated from the adjacent sea by a low-lying sand or shingle barrier", and second, "a stretch of water enclosed in a coral atoll" (Barnes, 1980, p. 20). When referring to the former definition, the term *coastal* lagoon is used (de Wit, 2011). These 400 coastal lagoons or barachois ponds are a defining feature of the estuarine Bras d'Or Lake and its watershed (Figure 6).

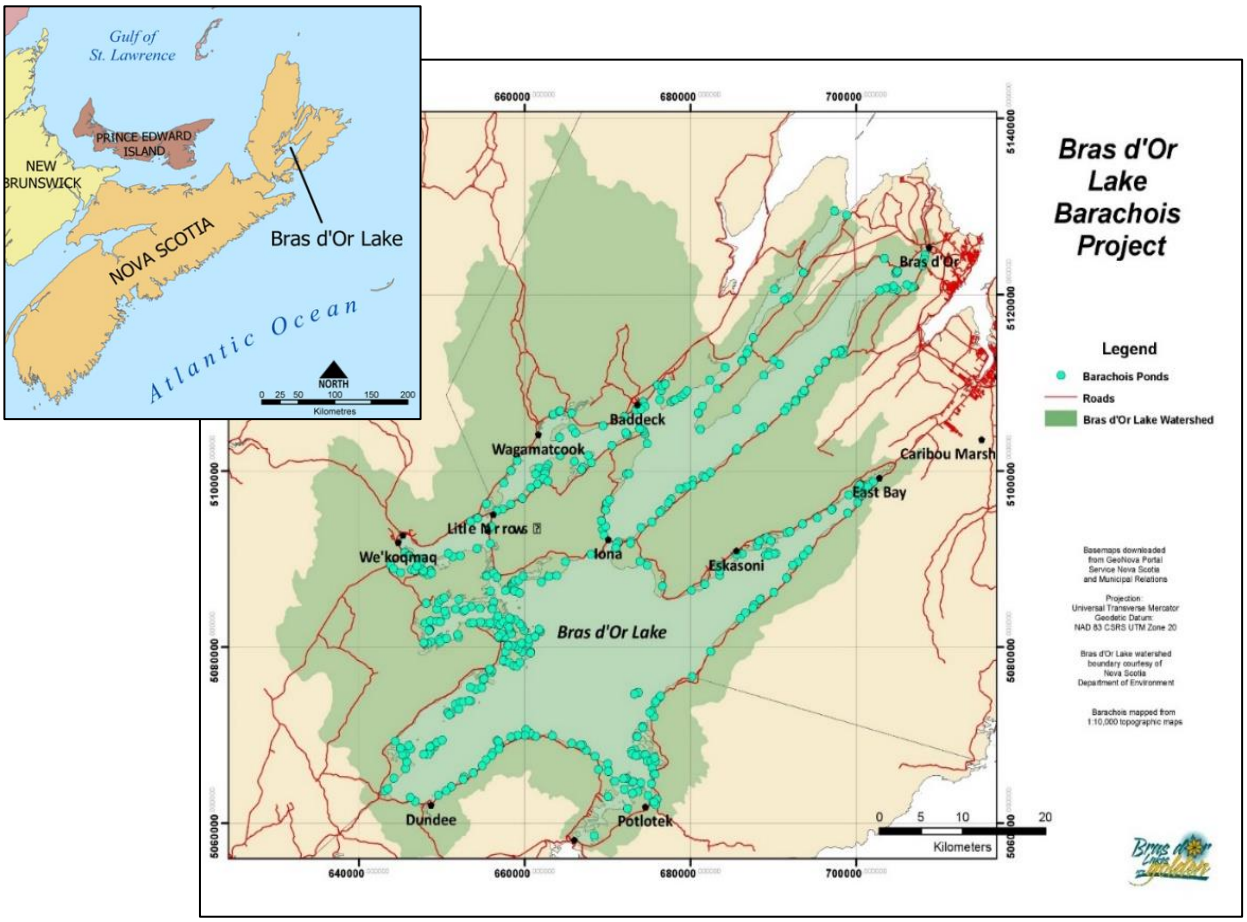

Figure 6. The Bras d'Or Lake watershed in Cape Breton, Nova Scotia, with the 400 barachois ponds along the shores of the BDL (Hatcher, 2018; Smaller map by Norman Einstein, May 12, 2005).

2.1.2 Physical components

The diversity of ecological components that comprise a barachois pond ecosystem are by in large what make them so unique; the pond or lagoon, the barriers, bars, berms, or spits, or trombolo, dune systems, back barrier, tidal flats, tidal creeks, tidal inlets, tidal deltas, and the fringent wetlands—often salt marshes (de Wit, 2011; Cornell et al., n.d.; Kennish, 2002; Parker et al., 2007; Shaw et al., 2006; Taylor & Shaw, 2002). Ecotones associated with barachois ponds include woods and fields to freshwater marshes and swamps, to brackish vegetation, to salt marshes and halophytes, to submerged aquatic vegetation (SAV) such as eelgrass (de Wit, 2011; Parker et al., 2007). Barachois ponds are considered both a "marine system" and a "terrestrial zone", occurring along the boundaries between freshwater and marine ecosystems (Davey, 2018;

Gaertner-Mazouni & de Wit, 2012). Well established barriers can host dune vegetation and numerous critical coastal flora such as Swamp Milkweed (*Asclepias incarnata*) (Baechler, 2014; Hatcher, 2015; Taylor & Shaw, 2002). Barrier beaches in the BDL can extend over 1 km in length, while beach-ridge plains generally under 350 m (Taylor & Shaw, 2002). Some barachois ponds are ideal habitats for eelgrass (*Zostera marina*), while others are valuable as trout habitats (CEPI, 2006; Parker et al., 2007; Smith & Rushton, 1964). The 400 barachois ponds across CB each demonstrate unique degrees of hydrodynamic heterogeneity, resulting in distinct variations in sediment types, salinities, temperatures, and water residence times between ponds (de Wit, 2011; Parker et al., 2007).

2.1.3 Driving processes

Barachois ponds are broadly influenced from marine waters through regular or periodic opening of their barrier, overtopping, sea spray and storm surge (NSE, 2011). Each pond is influenced by its configuration and geomorphology, exposure to wind, tides, seiche tides (wind and barometric tides), sedimentary budgets, depth, salinity, barrier and sedimentary characteristics, connectivity to marine waters, degree of freshwater inputs, water residence time, water quality, biological communities, as well as surrounding vegetation (Dodet, 2013; Kjerfve, 1994; Kjerfve, 1985; Hatcher, 2015; NWWG, 1997; Parker et al., 2007; Strain & Yeats, 2002; Taylor & Shaw, 2002). The dynamic and ephemeral nature of these systems is largely attributed to the barrier inlets' ability to close-over during storms, leading to a predominantly freshwater environment across a temporal scale (Chapman, 2012).

The processes affecting barachois ponds and their barriers within the Bras d'Or Lake differ slightly from those facing barriers on the Atlantic coast of Nova Scotia; reduced barrier heights are met with smaller tidal ranges, decreased wave energy, and longer intervals of winter ice (Shaw et al., 2006). The most influential characteristic however regulating the structure and function of coastal lagoonal biotic communities, is the degree of inlet opening to marine waters (Smakhtin, 2004).

Some coastal lagoons may even exhibit novel species, evolved through geographic isolation, qualified by the duration of a stable-state (de Wit, 2011). It is possible that certain

micro-organisms and small benthic fauna such as nematods, may be endemic to certain coastal lagoons (Esteves et al., 2008). While more research is required, the potentiality for geographic isolation exists (Esteves et al., 2008).

2.2 The Bras d'Or Lake watershed

The BDL watershed spans 3,500 km^2, with six major rivers draining 42% of the watershed (Hatcher, 2018; Arseneau, Arseneau & Rogers, 1977; Hipwell, 2001). Eleven sub-watersheds include St. Andrew's Channel, North Basin, East Bay, St. Peter's Inlet, West Bay, River Denys, McKinnon's Harbour, Whycocomagh Bay, St. Patrick's Channel, Middle & Baddeck Rivers, and Great Bras d'Or (UINR, 2007). The bays, inlets, and deep basins that characterize the BDL comprise 18% of the length of Nova Scotia's shoreline (UINR, 2007).

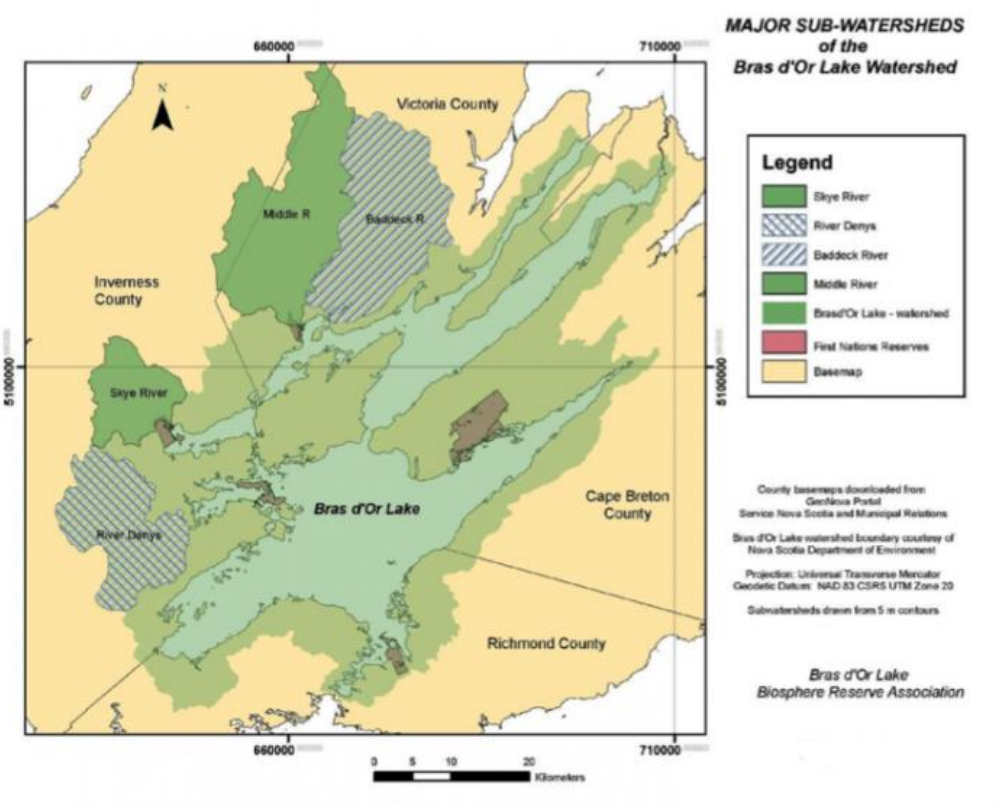

Figure 7. The Bras d'Or Lake Watershed (Bras d'Or Lake Biosphere Reserve Association, 2017).

The watershed is around one-third of Cape Breton Island, with Victoria County accounting for 39.4% of the watershed, Inverness County 27.9%, Cape Breton Regional Municipality 21.2%, and Richmond County 11.5% (EDM, 2008). In 2006, around 22,000 people

lived in the many small communities throughout the BDL watershed, most of which were located on the lakeshores (EDM, 2008). This did not include seasonal residents. All First Nations communities in CB have a unique association with the aquatic environments wherein they live alongside, such as provisioning critical resources, transportation, and spiritual connection throughout all seasons (UINR, 2007).

While these various land and water divisions align with the bio-regional politics governing the BDL, the freely exchanging water moving between land and sea divisions must not be overlooked in the decision-making process (Hipwell, 2011). Given the magnitude of collective interests, working towards the watershed as the management unit is a useful objective (Hipwell, 2001). Particularly when the watershed has endured ecological harm resulting from poor co-ordination between decision-makers permitting various land-use practices such as development and waste-water disposal (Hipwell, 2001). Bacterial contamination from sewage is the single greatest source of primary pollution, yet despite this, the lakes are still relatively pristine, with five of the eleven sub-watersheds not showing degraded water quality (UINR, 2007).

Despite this, the Bras d'Or Lake is a UNESCO Biosphere Reserve, recognized for the initiatives of the local stewards of the land, Indigenous and otherwise, to promote education and sustainability within the watershed (Hatcher, 2018). Yet, it is not solely anthropogenic threats that face barachois ponds in the Bras d'Or Lake and watershed.

2.2.1 The Bras d'Or Lake as a social-ecological system

Persistent efforts to improve conditions in the BDL have resulted in the Bras d'Or Lake and watersheds to achieve UNESCO Biosphere Reserve designation (2011) for exemplifying a "balanced relationship between humans and the biosphere." (CBD, 2008; Thyagrissen Consulting Limited, 2015). Part of the UNESCO's Man and the Biosphere Programme (MAB), the Bras d'Or Lake received designation for the upstanding ability to unite biodiversity conservation and socio-economic development with the well-being of ecosystems and communities alike which reside within the reserve (Convention on Biological Diversity (CBD), 2008). The BDL estuary is 31% of the Biosphere Reserve (Hatcher, 2018).

The Bras d'Or Lake is known as Pitu'paq in Mi'kmaw language (UINR, 2007). The Bras d'Or Lake is interchangeably pluralized as the Bras d'Or Lakes, referring to its two primary features; the North Basin and the Bras d'Or Lake connected by a 500 m wide opening called the Barra Strait, and sometimes referred to as the big lake and small lake (UINR, 2004). Despite this, the BDL is truly a single lake with the following four waterbodies considered as separate "lakes"; 1) Whycocomagh Bay, 2) St. Patrick's Channel, Baddeck Bay, 3) the Great Bras d'Or, St. Andrew's Channel, and 4) the Bras d'Or Lake, south of the Grand Narrows including West Bay, East Bay, and St. Peter's Inlet (Hipwell, 2001). Yet the BDL is an estuary, receiving tidal action from the 30-km, narrow and shallow Great Bras d'Or Channel resulting in approximately 72% ocean water composition (UMA Group, 1989; Petrie, 1999). The fact that such transitional ecosystems such as barachois ponds, occur along the shores of an inland sea, will undoubtedly add significant challenge in the creation of adequate mechanisms for achieving their protection.

2.3 Regulatory frameworks for barachois ponds in Nova Scotia

Under Section 103 of the *Environment Act*, the province of Nova Scotia owns all "watercourses", defined as the "bed" and "shore" of every natural water body as well as the water in them, including all rivers, streams, lakes, creeks, ponds, springs, lagoons, and groundwater (excluding non-natural water bodies) (Environment Act, 1994-95). Swamps, marshes and wetlands are not included in the definition of a watercourse, as they are a water resource (Nova Scotia Environment and Labour (NSEL), 2006**)**. The province's Nova Scotia Department of Environment is the lead agency for the fair management and allocation of water resources (NSEL, 2006). Under section 105 of the *Act*, the Minister has supervision over all water resources, watercourses, and water allocation. While the province does not hold jurisdiction over privately owned lands, the Minister may still regulate their use to fulfill their own supervisory duties. Examples include outlining the activities which trigger the requirement to notify or seek approval when altering a wetland or when triggering and EA (NSE, 2013; NSEL, 2006). The mean high-water mark is generally the cut-off between provincial and federal jurisdictions, with few exceptions (Lawyer's Insurance Association of Nova Scotia (LIANS), 2008). Given this definition however, salt marshes, coastal lagoons, ponds, barachois are all regulated under NSE, while mudflats, estuaries, and deeper coastal areas are federal jurisdiction.

Alteration permits for wetlands in Nova Scotia are directed by NSE based on two application streams: the simplified (<0.5 ha of 1 wetland type); and the standard: (a) alterations between 0.5-2 ha, b) alterations affecting >1 wetland type) (NSE, 2013). While three streams exist for triggering Environmental Assessments in Nova Scotia in relation to barachois ponds: First, if a wetland disturbance is >2 hectares, or if more than one wetland type is destroyed (Province of Nova Scotia, 2017). Second, "designated projects" listed under the *Canadian Environmental Assessment Act, 2012* would likewise trigger a federal EA (Province of Nova Scotia, 2017). Third, if the project takes place on First Nations reserve lands or with federal money, it would also trigger an EA (Aboriginal Affairs and Northern Development Canada (AANDC), 2014). AANDC has developed its own Environment Review Process to meet its *CEAA, 2012* legislation requirements (AANDC, 2014). All federal lands wetland practitioners make use of two central documents (CWS, 1996; NWWG, 1997). Yet, instances under provincial justification where a project does not trigger a federal or provincial EA, are much less clear (CEPI Steering Committee, 2014). Confusion ensued when the Ben Eoin marina site was purchased by a federal agency which shifted the requirements for EA, meaning the development was no longer subject to provincial legislation (CEPI Steering Committee, 2012, 2014). Further, despite loss of the valuable wetlands, minimum size requirements did not trigger the necessary protective mechanisms (CEPI Steering Committee, 2011b).

In addition to the provincial protection of wetlands through approval processes and Environmental Assessments, Municipal governments also have some capacity to manage against siltation, erosion and sea-level rise through the revision or updating of Municipal Planning Strategies (MPS), and the subsequent creation of land-use bylaws (Service Nova Scotia Municipal Relations (SNSMR), 2006). Whatever the revisions, according to the Municipal Government Act (MGA), MPS must be consistent with the six Provincial Statements of Interest (PSI). Defined in the MGA, they cover: (1) drinking water, (2) flood risk areas, (3) agricultural land, (4) infrastructure, (5) housing, and 6) development of the Nova Centre (Province of Nova Scotia; 2016; Service Nova Scotia and Municipal Relations, 2006). The MGA allows for the provision of new PSI where the Province deems a new Statement is necessary to protect its interests (SNSMR, 2006). Land-use bylaws created through MPS include conservation zones, overlays, vegetated buffers, setbacks, or special management zones (EDM, 2008; Rideout, 2012). Some municipalities enact water resource protection through septic setbacks of 30.5 m

from watercourses, 20 m vegetated buffers for forestry operations, and other buffers and setbacks ranging from 4 - 30.5 m across NS (Rideout, 2012). Nova Scotia does not yet have provincial policy on vegetated buffers or setbacks for land-use (Rideout, 2012).

Buffers and setbacks however are perceived as threatening to development, which has proven difficult for Municipal counsellors to willingly adopt the CEPI Bras d'Or Lake Development Standards and fully honour the Bras d'Or Charter (CEPI, 2018). Counsellors' concerns lay with the desires and wants of their constituents, no matter how informed or otherwise those values may be.

2.4 The value of public perceptions in the context of marine management

'*Perceptions*' can be defined as the "positive or negative evaluations of some aspect of conservation (e.g., governance, management, impacts on resources, costs and benefits), or the entire conservation initiative (Bennett, 2015). Perception is the interpretation given to awareness, a way of understanding and gaining insight (Admin, 2014). Differing slightly, a '*perspective*' refers to a point of view, a framework used to assess any given thing (Admin, 2014). While sound evidence must be used by decision-makers in the conservation of natural resources, it can be problematic to rely solely on evidence-based conservation (Bennett, 2015; Adams & Sandbrook, 2015).

In evidence-based conservation, certain types of knowledge, methods, and information are often prioritized such as a preference for quantitative data over more qualitative local and Indigenous knowledge (Adams & Sandbrook, 2013). When the intricacies of numerous social, political, and economic systems under which conservation practices operate are overlooked, such as use of gender-based analysis and integration of Indigenous Knowledge Systems, unsustainable conservation practices laden with social injustices begin to emerge (Adams & Sandbrook, 2013). Further, the cost and time associated with gathering quantitative and longitudinal data may also result in recommendations that are "too little too late" (Bennett, 2015, p. 584). It is therefore of great importance that decision-makers account for economic, non-economic, and cultural values when summing the values of the natural world (Stolton et al., 2015). Decision-makers must

recognize that values are central in shaping all that society does and should therefore be a central consideration in the decision-making process (Keeney, 1996).

A shift towards value-focused thinking demands progressive discussions between individuals, institutions, and Nations with differing levels of expertise, practices, and beliefs by using lived experience, diverse conservation philosophies, and empirical science to explore alternative viewpoints (Verschuuren & Brown, 2019; Keeney, 1996). Understanding the values surrounding barachois ponds will help inform the creation, evaluation, and prioritization of adaptation measures appropriate for local needs (Reid et al.,2014).

Today, barachois ponds are the center of a highly politicized municipal amendment that has captured the attention of many Cape Bretoners (Ayers, 2018(a)(b)(c)(d)(e); Conners, 2018(a)(b), Jala, 2018(a)(b)(c); Moffatt, 2018). In instances where projects do not trigger provincial or federal Environmental Assessments, or the need to meaningfully consult with First Nations people, tensions can run high as the promise of payoffs from successful developments can seemingly supersede the need for balanced decision-making.

2.4.1 Case Study: Big Pond RV Park

Big Pond RV Park is a 109-acre proposed development located in Big Pond Centre, rural Cape Breton. The 211-site RV and water park is hinged to Lochmore Harbour, a barachois pond locally known as “Big Pond” (pictured right) (Jala, 2018(a)(b)).

Figure 8. Lochmore Harbour by F. Baechler (n.d).

While many locals acknowledge that Big Pond is an essential barachois pond for protecting the health of the UNESCO Biosphere Reserve, most would agree it does not resemble the "floating oasis" that has come to represent the RV Park (Moffatt, 2018) (Figure 8,9).

Figure 9. Lochmore harbour and the proposed site of the water component of the Big Pond RV Park. (Jala, 2018b)

An initial application was submitted to CBRM for 541 RV sites. The 211 sites are regarded as Phase 1 of the project (Jala, 2018(b)(c)). Either phase requires an appeal to the Municipal Government Act for an amendment to the zoning bylaws (Jala, 2018(b)(c)). Numerous conflicts arose during public hearings held over the development, including disruption to pastoral tranquility, hazards to the neighbouring organic farm, the site's proximity to a grave yard, increased noise, dust, traffic, risk of fires, groundwater over-extraction, potential for septic leachate into the pond and groundwater, and potential for eutrophication given the pond's low flush rate (Ayers, 2018; Jala, 2018(a)(b)).

Lochmore Harbour barachois pond is mostly landlocked with a marshy shoreline of shallow mud, and a pond filled with eelgrass, crabs, mussels and oysters (Ayers, 2018; Moffatt, 2018). The proposed development requires the conversion of numerous acres of natural vegetation into RV sites, parking lots, tennis courts, and facilities (Moffatt, 2018). Despite all the concerns and potential for environmental alteration, an Environmental Assessment was not triggered given that the project will not adversely affect, alter, or destroy over two hectares of wetlands (equivalent to the size of four football fields) (Jala, 2018a). Further, a fish kill or large siltation event to the pond would trigger the Fisheries or Oceans Act, yet in this case, had not happened (Jala, 2018a).

CBRM Council was prepared to vote on the zoning amendment required for the project to proceed, when District 3 Councillor, Esmond "Blue" Marshall, whose district includes Eskasoni

First Nation, moved to have the motion tabled pending consultation with Indigenous communities (Conners, 2018(b)(c)). The *Municipal Government Act,* however, does not outline any responsibilities through the Municipality to consult with First Nations when considering zoning amendments at this stage (Conners, 2018c). The mandatory public participation process remained open to interpretation, however, and was used as an entry point for *anyone* looking to participate in deliberations (Conners, 2018c). Municipal Affairs Minister Derek Mombourquette said that, "Council has that flexibility to design that public participation process as they see fit" and can therefore expand the process to include First Nations consultation (Conners, 2018c). This case study presents an interesting and current example of the complexities involved when managing barachois ponds.

If conservation and protection of barachois ponds are to succeed, they need to generate enthusiastic support from all stakeholders and local communities (Bernbaum, 2017). While it is necessary to collect data relating to water quality, water chemistry, water circulation, rates of water exchange, water residence time data, and the physical, chemical, geological, biological and ecological components of the lagoonal system, expanding this collection to include deeply held spiritual, cultural, and aesthetic values is conducive to generating enduring support from the people (Bernbaum, 2017; Kjerfve 1994). Lacking this level of demonstrated public support, elected officials will cease to offer on-going funding essential for sustaining conservation initiatives, regardless of existing operative policies, designated protected areas, or even UN Biosphere Reserve designations (Bernbaum, 2017).

To address these issues and inform management, Q-methodology was used to reveal the dominant social perspectives surrounding barachois ponds and to substantiate each narrative quantitatively using factor analysis (Curry, Barry & McClenaghan, 2013).

CHAPTER 3. METHODS

3.1 Q-Methodology

The data for this study were generated using Q-methodology and semi-structured interviews (Ellis, Barry & Robinson, 2007). Q-methodology operationalizes both quantitative and qualitative research to systematically study human subjectivity around values and beliefs by generating patterns of perspectives using factor analysis; transforming subjective perspectives into quantifiable data (Baker, 2006; Hagan & Williams, 2016; Webler, Danielson & Tuler, 2009). Q-methodology is increasingly employed in conservation management, where the requirement to draw upon science-based evidence meets the need to include public perception research (Dasgupta & Vira, 2005; Lotze et al., 2018; Webler et al., 2009).

Six steps for undertaking Q-methodology include (1) defining the concourse, (2) developing the Q-Sample (Q-set), (3) selecting the Q-Participants (P set), (4) administering the Q-sort, (5) conducting semi-structured interviews, (6) and finally, analysis and interpretation of quantitative and qualitative data (Brown, 1993; Hagan & Williams, 2016; Van Exel & de Graaf, 2005). Q-methodology results in the unearthing of dominant perspectives called factors, an output of Q-methodology (Ellis et al., 2007). Each participant loads significantly under one or more perspective or factor as a result of the factor solution, according to how closely their views or Q-sort aligned with the 'true' perspective (Webler et al., 2009).

3.1.1 Steps I & II: Defining the concourse and Developing the Q-Sample

The concourse represents all possible statements said or known about any given topic, in this case, barachois ponds. Building the concourse is the most important step in employing Q-methodology (Hagan & Williams, 2016; Van Exel & de Graaf, 2005). Omitting a single perspective can create a deficient portrayal of that subject, precluding the statements' potential contribution to the creation of dominant perspectives or factors.

An extensive literature review was conducted to generate the concourse, firstly by searching the term 'barachois pond', then 'coastal saline pond', then 'coastal lagoon', and

finally, ‘tidal lagoon’. All statements and opinions concerning barachois ponds and similar marine environments were recorded along with source information. The resulting 85 statements that formed the concourse were inductively grouped into overarching themes (Webler et al., 2009; Lynch, Adler & Howard, 2014). Five main themes were identified: management, benefits, threats, development, and descriptive.

The final Q-Sample or Q-set was developed using the most salient statements within each category. A total of 52 statements representative of the larger concourse were chosen for the final Q-set (Webler et al., 2009). The final Q-set was tested by a knowledgeable wetland specialist for clarity and coherence. Their feedback was recorded, and statements were adapted accordingly. Each statement was randomly numbered and printed on laminated cards. The cards were placed on a sorting board containing 52 squares in a quasi-normal distribution with 11 columns and 8 rows (Figure 10). ‘Strongly agree’ is represented by +5, while ‘Strongly disagree’ is represented by -5. Neutral statements are represented by 0. The remaining ranks (+4, +3, +2, +1, -1, -2, -3, -4) represent a gradient of agreeance ranging from ‘strongly agree’ to ‘strongly disagree’.

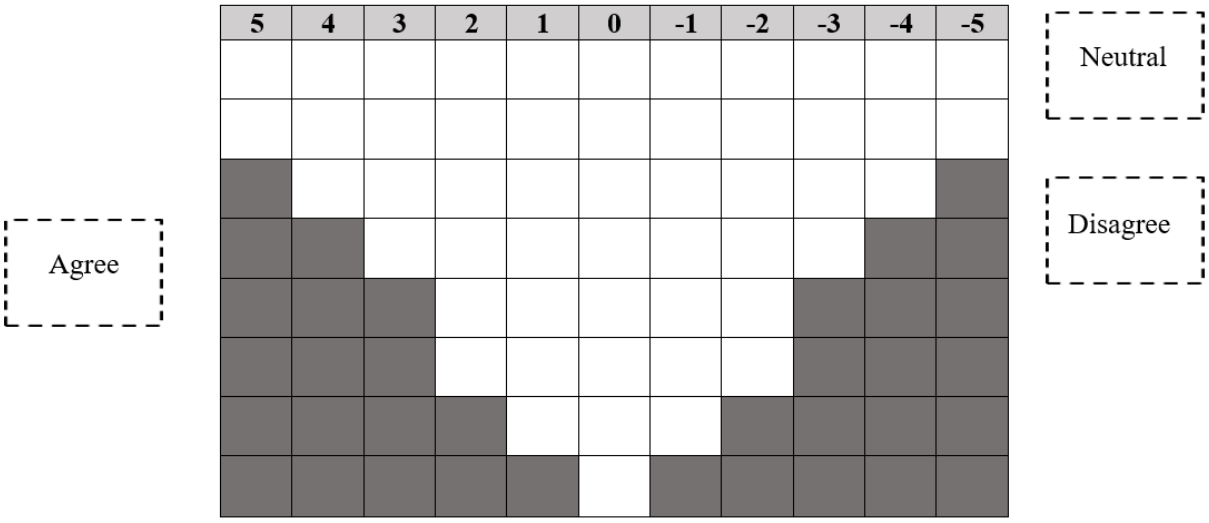

Figure 10. Quasi-normal distribution sorting board. One white square for each statement. Participants ‘pre-sorted’ each statement by reading them, and placing in either three piles (agree, disagree, neutral) before sorting each pile onto board.

3.1.2 Steps III: Selecting the Q-Participants

The Q-Participants or P-set were then identified. These are relevant, well-informed stakeholders whose perspectives would inform the management of barachois ponds (Webler et

al., 2009). Five stakeholder groups were identified that included government (federal, provincial, municipal), academia, non-governmental organizations, industry and locals (defined by anyone living in Cape Breton, either full-time or seasonally). Typically, around five or six individuals per stakeholder group were selected for their theoretical relevance and well-informed opinions surrounding barachois ponds (Brown, 1980). In total, 33 individuals partook in the Q-sort exercise. A strongpoint of Q-methodology is the relatively low number of participants required to generate statistically meaningful results, given that each participant's Q-sort produces extensive information (Barry & Proops, 1999; Hagan & Williams, 2016).

3.1.3. Step IV & V: Administering the Q-sort and Conducting semi structured interviews

The Q-sorts were administered in person, one participant at a time, at a location of their choice. The exercise began with each Q participant signing the research consent form and providing their own conceptualized definition of barachois ponds. The deck of 52 numbered statements was shuffled and handed to the participant.

Q-sort instructions were given orally by the researcher, who firstly instructed the participant to carefully read each statement while asking themselves whether they *agreed* or *disagreed* with the statement or were *neutral*, described as "don't know/ don't care". The participant was encouraged to seek clarification on any statement(s) that was unclear. They began by sorting each statement into three piles; agree, disagree, and neutral, until all 52 statements were read and sorted. The final number of cards within each pile was recorded by the researcher (Hagan & Williams, 2016; Brown, 1998).

The participant was next asked to sort the 'agree' pile by choosing two statements with which they agreed with most (+5), then three statements (+4), until all statements in the agree pile were sorted. The participant was then asked to do the same for the 'disagree' pile, choosing two statements with which they disagreed with most (-5), then three statements (-4), until all statements in the disagree pile were sorted. They were then asked to prioritize eight statements within the neutral pile that held little to no meaning, and sort them under the neutral column (0). The remaining statements were ascribed as representing a gradient of agreeance relative to their most and least agree i.e. +3, +2, +1, -1, -2, -3 (Hagan & Williams, 2016).

Once the final statement was sorted, participants were asked to confirm their sort was complete, being given the opportunity to rearrange statements if required. A photo of the Q-sort was taken as record, followed by a semi-structured interview consisting of four follow-up questions regarding their extreme perspectives (+5, +4, -5, -4) (Appendix 1) (Hagan & Williams, 2016).

3.1.4 Step VI: Analysis and Interpretation

The data were analyzed using free online software, PQMethod 2.11 (Watts & Stenner, 2012). The software produced a correlation matrix representing the degree of (dis)similarities among participants' perspectives (Curry et al., 2013). Factor analysis was subsequently performed on the correlation matrix using principal component analysis (PCA) and Varimax factor rotation (Curry et al., 2013). Varimax creates factor solutions by maximizing the amount of explained variance, on as few factors as possible (Webler et al., 2009). Dominant perspectives emerged through careful analysis of the factor solutions (Webler et al., 2009; Stephenson, 1965). The extent to which individual Q-sorts exemplify a factor is known as a factor loading (Watts & Stenner, 2012; Webler et al., 2009). Participants with similar perspectives on the topic will load significantly on the same factor (Curry et al., 2013).

Correlation between individual Q-sorts and shared factors were considered significant if a factor loading exceeded ±0.36, or $2.58*(1/\sqrt{N})$ where N represents the total number of participants interviewed (Hagan & Williams, 2016). However, using 0.36 as the significant loading factor yielded an unsatisfactorily high number of confounding sorts, participants who loaded significantly in more than one factor. To reduce the number of confounding sorts by increasing the level of significance, a significant factor loading of 0.5 was used (McKeown & Thomas, 2013; Watts & Stenner, 2012). Despite this increase, 7/33 were still confounding sorts. The fewer confounding sorts in a factor solution, signifies that participants possess heterogeneous perspectives (Webler et al., 2009).

When selecting an appropriate factor solution, attention was given to the composite reliability of a factor, meaning how many participants exemplified it. The more participants that define a factor, the higher the reliability (Hagan & Williams, 2016; Dasgupta & Vira, 2005). A factor solution was viable when each factor presented was defined by a minimum of five

participants, resulting in a factor reliability of 95% (Hagan & Williams, 2016; du Plessis, 2005). As well, the explained variance of each factor must have exceeded 10% (Watts & Stenner, 2012).

Using distinguishing statements was important when interpreting a factor's narrative; statements ranked statistically different from all other perspectives (*/**), as well as those that were distinguishing and extreme (+5*, +4**, -5**, -4*), followed by all other extreme statements (+5, +4, -5, -4) (Watts & Stenner, 2012). PQ Method software generates an 'X' beside the z-scores of the participants who loaded significantly under a factor (0.5≤) (Appendix 2). The semi-structured interviews of participants who loaded significantly under a given factor were also used as supplementary material to bolster that perspective's narrative (Webler et al., 2009). Consensus statements were excluded from contributing to the factor's narrative, as these statements have null significance given that they are ranked similarly across all perspectives (Watts & Stenner, 2012).

3.2 Limitations

Certain limitations are worthy of pointing out regarding use of Q-methodology for answering the central and sub research questions. First, many participants when asked to self-identify with one of the five stakeholder groups, admitted they commonly identified with numerous stakeholder groups at any given time. One individual simply would not participate, refusing to be constrained to "one box" (they provided an enriching account of barachois ponds off-record instead). To address this, including their stakeholder affiliation along with their perspective builds a richer case for understanding that perspective and that participant.

Second, participants were asked to sort their "most agree" pile, followed by their "least agree" pile, followed by "neutral" followed by placing the remainder of the statements wherever they were most appropriate. Often each side of the Q-sort board was interpreted as absolutely disagree or absolutely agree (evidenced by placing statements under the negative or the positive value). This made certain participants uneasy when they were forced to place statements that they very weakly or neutrally agreed or disagreed about, in the "opposing side". This was eased by explaining that the two "sides" were not absolute, that the +/- 1, 2, and 3 represented a

gradient of agreeance ranging from most to least with complete neutrality in the middle. For this reason, the 2 and 1 values are not used to support significant findings in this study.

Third, the use of double negatives in many of the statements was a weakness in the creation of the statements, though moderately unavoidable. Despite this, effort was made to ensure there was an even distribution of "negative" and "positive" statements. Participants were frequently puzzled however when ranking negatively-oriented statements with which they disagreed. As such, to infer clear results, instances where all four perspectives disagreed with a negative statement, the 'double-negative' was interpreted as a 'positive' when construing the implications of the result (Figure 11).

ID	**The original text:**				
10	In general, the construction and maintenance of infrastructure (roads, wharves) **does not** greatly impact barachois ponds.	**-3**	**-1***	**-2**	**-3**

ID	**Corrected to a positive for clarity:**				
10	In general, the construction and maintenance of infrastructure (roads, wharves) greatly impacts barachois ponds.	3	1*	2	3

ID	**The original text:**				
13	Climate change e.g. sea-level rise, storm intensity, ocean acidification, invasive species, **are not** imminent threats to barachois ecosystems.	**-4**	**-1****	**-3**	**-5**

ID	**Corrected to a positive for clarity:**				
13	Climate change e.g. sea-level rise, storm intensity, ocean acidification, invasive species, are imminent threats to barachois ecosystems.	4	1**	3	5

Figure 11. Correction of double negatives for ease of interpretation and analysis.

CHAPTER 4. RESULTS

Each participant was asked to define the term ‘barachois pond’ according to their own conceptualization in advance of the Q-sort exercise. The results are shown in a word cloud (Figure 12). The size of each word denotes the relative frequency with which that word was used across all definitions by all participants.

Figure 12. A word cloud depicting the definitions of ‘barachois pond’ provided by participants before starting the Q-sort exercise.

4.1 Dominant Perspectives

Four perspectives were revealed from the factor solution and Q-methodology process accounting for 72% of the study variance. Specifically, Perspective 1) the ‘leave-them-be conservationists’ (LTBC) accounted for 22%, 2) the ‘sustainable developers’ (SD) were 12%), 3) the ‘management reformists’ (MR) were 20%, and lastly, 4) the ‘science-based conservationists’ (SBC) accounted for 18%. Each of the four perspectives is presented with explicit reference to the statement ID on which the perception is founded (Table 1). Distinguishing statements are those ranked significantly different from any other perspective ($p<0.05$, $p<0.01$). Inversely, consensus statements were ranked significantly similarly across all perspectives ($p<0.05$,

p<0.01). Factor arrays of +5 equate to 'very strongly agree' while -5 equates to 'very strongly disagree', with 0 equating total neutrality. Excerpts from the semi-structured interview questions following the Q-sort exercise were further used to support the perspective's narrative, interjecting voices from participants whose response loaded significantly under that perspective. Taken together, the four resulting factors (perspectives) from the final factor solution explained 72% of the variance, 22%, 12%, 20%, and 18% respectively.

Table 1. Factor array for each statement. Factor 1) Leave-them-be conservationists (1-LTBC), 2) Sustainable developers (2-SD), 3) Management reformists (3-MR), 4) Science-based conservationists (4-SBC). Distinguishing statements are shown under factor arrays (* = p<0.05; ** = p<0.01)
Consensus statements are shown far right (* = p<0.05; ** = p<0.01)

	Statement and ID number	**Factor Arrays**				**Consensus Statements**
		1 (LTBC)	**2 (SD)**	**3 (MR)**	**4 (SBC)**	
1	Barachois ponds are important year-round fishing grounds for trout, eels, gaspereau.	1	-1**	1	1	
2	Dredging artificial openings in barachois ponds to purify water conditions in ponds that support oyster leases is a valid reason for their alteration.	-3**	2*	-1*	0*	
3	Barrier beaches that define Barachois ponds are important ecosystems in their own right.	4	3	4	4	*
4	Barachois ponds are vital for maintaining local biodiversity e.g. muskrat, otters, birds, loons.	4	5	4	5	**
5	Barachois ponds are very threatened by pollutants such as pesticides, herbicides, fertilizers.	3	-1	1	3	
6	Barachois ponds are very threatened by oil and other chemicals enter the ponds by surface run-off from roads.	2	0	0	1	
7	Building or maintaining artificial openings in barachois ponds is an important method for managing water levels to avoid flooding.	-2	-2	-1	-1	
8	Dredging artificial openings in barachois for recreational purposes is not a valid reason to alter barachois ponds.	5**	2	2	0*	
9	Building or maintaining artificial openings in barachois ponds is necessary for managing algal blooms or reducing nutrient levels in Barachois.	-1	-1	-2*	0	
10	In general, the construction and maintenance of infrastructure (roads, wharves) does not greatly impact barachois ponds.	-3	-1*	-2	-3	
11	Industrialization, e.g. fish plants, energy projects, negatively impact barachois health.	1	1	0	0	

12	Residential or recreational coastal development within 100 – 200 meters negatively impacts barachois health.	1	1	1	2	**
13	Climate change e.g. sea-level rise, storm intensity, ocean acidification, invasive species, are not imminent threats to Barachois ecosystems.	-4	-1**	-3	-5	
14	Barachois ponds promote salt marsh wetlands by facilitating hydrophytic vegetation, e.g. plants that are adapted for life in saturated soils such salt water cordgrass, sedges and rushes.	2	3	3	2	*
15	Barachois ponds do not demonstrate fluctuating hydrology from year to year, e.g. water depth, flow patterns, duration and frequency of flooding.	-2	-2	-2	-4*	
16	Upland owners should be consulted when the development of barachois ponds is being considered.	0	1	2	0	**
17	Barachois ponds including barriers, do not protect against flooding.	-1	2**	-2	-2	
18	Most barachois ponds should be classified as wetlands of special significance for they support rare species at risk e.g. migratory birds and waterfowl.	4	3	2	3	**
19	Barachois should be classified as wetlands of special significance for having high social / cultural importance.	5	0	1	4	
20	Barachois ponds are significant features that add value to the landscape (aesthetic/ economic).	2**	5	3	4	
21	Barachois ponds detract from the landscape. They are a nuisance.	-5	-3	-4	-5	
22	Infrastructure around barachois ponds detract from the ‘naturality’ of the landscape, lessening its overall worth.	0	-2*	-1	-1	
23	Barachois are mainstays for recreational activities, e.g. boating, ice-hockey, bird watching, walking, swimming, kayaking.	1	0	0	2	
24	Fishing is only valuable in barachois ponds whose channels are wide enough to allow sea water to enter.	-1	0	-1	-2*	
25	An inventory of the diverse barachois pond habitats and their associated species composition is lacking.	2	2	3*	1	
26	The management of barachois ponds is uncoordinated.	0	2	5**	0	
27	Unmanaged growth is an important driver of negative environmental impacts on barachois ponds.	2	3	2	2	*
28	Barachois ponds are an important part of my cultural and or personal identity.	0	0	0	1	

29	Freshwater barrier [barachois] ponds provide unique learning opportunities, e.g. how a dune, rocky shore, salt marsh or estuary may affect life in the pond.	2	4*	2	2	
30	There is adequate policy and / or legislation protecting barachois ecosystems.	-2*	-4	-5	-1*	
31	The size of a barachois pond is an important determinant in its value and worth.	-1	2**	-3	-2	
32	The water in barachois ponds is stagnant and/ or full of undesirable marine plants / algae.	-2	-4	-3	-4	**
33	Protecting naturally occurring barachois ponds is not critical as they can be artificially constructed, even matching ecosystem function.	-4	-5	-4	-3	**
34	In general, the majority of barachois ponds change form notably from year to year from wind storms and storm surges.	0	0	2	1	*
35	The requirement to conduct Environmental Impact Assessments (EIA) prior to dredging barachois channels creates unnecessary setbacks for development.	-4	-2*	-4	-3	
36	Small barachois ponds (<100 m^2) ought not to be protected as they are not as ecologically valuable are larger ones.	-3	-1**	-2	-3	
37	Most people do not know what barachois ponds are (it could be they may know they exist but would not necessarily identify them as barachois).	1	4	4	1	
38	Barachois ponds do not hold as much value if they have been altered by a single storm event.	-2	-3	-3	-2	*
39	Barachois ponds are not ideal environments for aquaculture development.	1	-2	1	-2	
40	Barachois ponds have been negatively affected by lowered investments in wastewater treatment facilities.	0	1	0	-1	*
41	Lack of regulated tourism poses negative consequences related to illegal fishing activities in the barachois ponds.	-1	-3**	0	0	
42	Incompatibilities between professional and recreational fishing are negatively affecting fish, shellfish, and bait resources.	-1	-1	0	0	*
43	Fishing in barachois ponds has local economic and social importance and is even perceived as additional income for some families.	0	1	1	2	*
44	Many barachois ponds should be filled in and developed to support a variety of regional economic developments.	-5	-5	-5	-4	*
45	Barachois ponds have immense scientific value for they are essentially a mesocosm for the greater ocean.	3	1	1	3	
46	Conservation and protection efforts impede development efforts around barachois ponds.	-2	1**	-2	-1	

47	Barachois ponds hold untapped potential for economic development.	-3**	0	-1	-1
48	We do not know enough about the barachois ecosystems to effectively manage them.	1	-4**	5**	1
49	Barachois ponds are commonly used for illegal dumping of garbage.	0	-3*	-1	-1
50	It is important that all barachois ponds are valued equally, as each offer something different and unique worth protecting.	3	-2**	0**	3
51	More stakeholders ought to recognize the value of barachois ponds through outreach initiatives (e.g. environmental education programs, development of infrastructure).	3	4	3	5
52	Certain barachois ponds in Cape Breton hold potential for tidal lagoon power generation.	-1	0	-1	-2**

4.1.1 Perspective 1- the Leave-Them-Be Conservationists

The leave-them-be conservationists (1-LTBC) agree very strongly that dredging artificial openings for recreational purposes is not a valid reason to alter ponds, while moderately disagreeing that purifying water conditions to support oyster leases is a valid reason for altering barachois ponds (Statement ID #s 8 and 2). One participant said, "we should try to maintain them as they are… to get a better understanding of them" (Participant A3, 1-LTBC, Academia). The 1-LTBC disagree very strongly that barachois ponds are a nuisance that detract from the landscape (Statement ID # 21) yet agree the least that barachois ponds are significant features that add aesthetic or economic value to the landscape (Statement ID # 20). One participant noted,

> *The natural ecosystems were here first and have precedence… While they can be undesirable, that's a necessary part of ecosystem function. (Participant A6, 1-LTBC, Academia).*

The members of this group disagree, more than any other perspective, that barachois ponds hold untapped potential for economic development (Statement ID # 47). One participant advised,

> *Take only that which you need. To take more is to be wasteful and greedy…in some instances, it's not a matter of physically taking what you need, but if you're creating development that takes away the potential of that ecosystem to provide, then you're*

taking more than you need. (Participant D22, 1-LTBC, NGO)

The 1-LTBC agree very strongly that barachois ponds should be classified as WSS for having high social and cultural importance (Statement ID # 19). One participant noted that, "I work mostly with Mi'kmaq at this time, and I know they're culturally significant for the Mi'kmaw" (Participant D20, 1-LTBC, Academia). The 1-LTBC strongly agree that impacts of climate change, e.g. sea-level rise, storms, ocean acidification and invasive species pose imminent threats for barachois ponds (Statement ID # 13). Two participants noted,

> *The relationship between climate change and the natural maintenance of the barachois needs to be incorporated into planning and management. (Participant D20, 1-LTBC, NGO)*

> *I've seen barachois changing hydrology, but climate change is going to exacerbate this. Climate change is the biggest threat to barachois ponds. (Participant A6, 1-LTBC, Academia)*

The 1-LTBC weakly disagree that there is adequate policy and / or legislation protecting barachois ecosystems (Statement ID # 30). To that note, this perspective strongly disagrees that the requirement to conduct Environmental Impact Assessments (EIA) prior to dredging barachois channels creates unnecessary setbacks for development (Statement ID # 35). Two participants expressed that,

> *Class 1 [Nova Scotia Environmental Assessment] is a very light study, it's a scan. When you talk about coastal development, it should be a Class 2. It should be aggressive. (Participant B14, 1-LTBC, Industry)*

> *I think you can have development hand-in-hand with ecological protection. It's a fine balance achieved from EIA to make sure we're not going to do things wrong. (Participant A6, 1-LTBC, Academia)*

4.1.2 Perspective 2- the Sustainable Developers

The sustainable developers (2-SD) strongly agree, more than any other perspective, that enough is known about barachois ecosystems to effectively manage them (Statement ID # 48).

This group strongly disagrees that there is adequate policy/legislation protecting barachois ecosystems (Statement ID # 30). One participant suggests that,

> *A holistic approach is the way to go when making decisions. The [current] policy and legislation don't allow you to do that. [In this context] adequate does not mean a lack-of, it means appropriate. You can have a ton of legislation that is hopelessly inadequate. It must be adequate for the time and place that we're in now. (Participant A1, 2-SD, Academia)*

Members of this group feel that climate change does not pose an imminent threat to barachois ponds (Statement ID # 13). The 2-SD agree more than any other perspective that barachois ponds, including their barriers, do not protect against flooding (Statement ID # 17). One participant noted, "it might be wrong to say they protect against flooding, but they are buffer areas; They absorb water and prevent it from eroding the land nearby" (Participant C15, Local). The 2-SD agree very strongly that barachois ponds are significant features that add aesthetic or economic value to the landscape (Statement ID # 20). One participant said,

> *They're significant and add value. They're not unique [to Nova Scotia], but I think the ones we have here are very special. Tropical lagoons are much less friendly and pleasant because of predators and unpleasant smell, not places you want to go swimming. But most places here you can go swimming. (Participant A1, 2-SD, Academia)*

This group is the only perspective that (weakly) disagrees that all barachois ponds should be valued equally (Statement ID # 50). One participant noted, "you can have a special environment but there are degrees of specialness… so, this kind of activity we're going to allow, but on a case-by-case analysis" (Participant A1, 2-SD, Academia). This group is the only perspective that (weakly) agrees that the size of a barachois pond is an important determinant in its value and worth (Statement ID # 31), and disagrees the least that small (<100 m^2) barachois ponds ought not to be protected for they are not as ecologically valuable are larger ones (Statement ID # 36). One participant noted,

> *Some small wetlands can be very interesting, but in most cases, the larger it is the more interesting it is… the more potential it has for organisms like plants and animals that make these environments unique and special. (Participant B9, 2-SD, Industry)*

Members of this group very weakly agree that the construction and maintenance of infrastructure (roads, wharves) greatly impacts barachois ponds (10). The 2-SD disagree, more

than any perspective, that infrastructure around barachois ponds detracts from the 'naturality' of the landscape and lessens its overall worth (Statement ID # 22). This group is the only group that (very weakly) agrees that conservation and protection efforts impede development efforts in the barachois ponds (Statement ID # 46). One participant proposed,

> *You want good examples of [barachois ponds] that haven't already been compromised and that have demonstrated some stability to carry on into the future. Not much point in protecting something that's going to be gone due to factors that are completely beyond our control in ten years time. (Participant A1, 2-SD, Academia)*

This group is the only perspective that weakly agrees that dredging artificial openings to purify water for oyster leases is a valid reason for alteration (Statement ID # 2). Members of this group strongly agree that most people do not know what barachois ponds are, and that more stakeholders ought to recognize the value of barachois ponds through outreach initiatives (e.g. environmental education programs, development of infrastructure) (Statement ID # 37 and 51). Two participants noted that,

> *Most homeowners and landowners don't know what a barachois pond does. They don't realize it's an incubator for a variety of little eggs and insects and things that are critical in the ecosystem, that it provides a unique nesting site for birds. (Participant C16, 2-SD, Local)*

> *Education is better than enforcement. [An individual] needs to come to the understanding of that barachois… It's a kind of education… but there needs to be an entertainment piece. A story that has these nuggets of values, protocols and appropriate behaviors but not finger wagging. (Participant A1, 2-SD, Academia)*

The 2-SD strongly agree, more than any other perspective, that barachois ponds provide unique learning opportunities, e.g. how a dune, rocky shore, salt marsh or estuary may affect life in the pond (29). One participant said,

> *People don't appreciate that beaches are moving all the time… or how algae weeds are being managed by being tumbled across the sand, tumbled across the coarseness of the rocks. Those dynamics change which vegetation can and can't grow. (Participant C16, 2-SD, Local)*

This group is the only perspective that weakly disagrees that barachois ponds provide year-round fishing grounds for trout, eels and gaspereau (Statement ID # 1).

4.1.3 Perspective 3- the Management Reformists

The management reformists (3-MR) disagree very strongly that there is adequate policy or legislation protecting barachois ecosystems (Statement ID # 30). One participant said,

> *Technically [barachois ponds] fit under the wetlands policy, but they aren't really treated as wetlands, so they don't really fit. They really do need their own policy. Most managers don't know how to deal with them. (Participant D24, 3-MR, NGO)*

This group agrees very strongly that the management of barachois ponds is uncoordinated (Statement ID # 26). One participant stated that, "we need a body that looks after the four municipalities and five First Nations that can coordinate and set guidelines, and get those guidelines out" (Participant D23, 3-MR, NGO). While another two participants said,

> *Over the last couple of years studying barachois and interacting with people and the issues… related to management, nobody is clear about how they're managed or who's responsible for them. How does that affect them? You see development on some of the barrier beaches, either people building on them or altering, opening somehow, and not knowing what the rules are. And even wanting to find out, and not being able to know. Asking authorities, and they wouldn't know. Finding out whose responsible for the permitting, finding out what's allowed, what's not allowed, nobody is really sure. (Participant D24, 3-MR, NGO)*

> *[We need] a funding mechanism that gives each municipality the ability to focus more on the environment and have a multi-layer approach to environmental protection… Not just leaving it all in the hands of the province but actually empowering the municipalities with some authority. (Participant E30, 3-MR, Government)*

The 3-MR agree very strongly, and by far the most, that not enough is known about barachois ecosystems to effectively manage them (Statement ID # 48). One participant pondered,

> *Everyone says how important they are, but how do you quantify it? We lost something when that marina went in. We gained other things (economic), but we lost a barachois without an understanding of what processes it gave us with respect to the lake. And the loss of one barachois may not be a bad thing… but consider the cumulative effects of*

these losses. What happens when we lose 50 of them? (Participant D23, 3-MR, NGO)

Members of this group agree, along with 'the sustainable developer', that most people do not know what barachois ponds are (Statement ID # 37). One participant noted,

> *People don't know much about them because they don't know their importance… we also don't know much of their hidden value. If you do not know the hidden value, the importance fades. (Participant A7, 3-MR, Academia)*

The MR agree most that an inventory of the diverse barachois habitats and their associated species composition is lacking (Statement ID # 25). One participant said,

> *It's an easy thing to inventory but… they're not included in the NS wetland inventory. The GIS layer is publicly available, it includes salt marshes, but ponds are considered DFO purview, it falls into a grey area. Easily identifiable, at least coastal lagoons, barachois are identifiable from air photos. So, easiest thing to include as an inventory. You can get that number, identify what they are, look at size and area distribution, location, adjacent landscape features, record how many are connected to the watershed and how many have connections to the ocean when the photos were taken. Ecolgoical, demographic, geographical, morphology stuff. Mapping barachois is a low-hanging fruit that would allow us to manage them. (Participant E33, 3-MR, Government)*

The 3-MR is the only group neutral that all barachois ponds should be valued equally (Statement ID # 50). Two participants said,

> *To say that one [barachois pond] is more valuable than another is not fair. One might have a bigger economic, productivity, recreational value, but each one has its own place in the system (Participant A8, 3-MR, 4-SBC, Academia)*

> *I think promoting the value of conservation from an ecological standpoint is great. But to get people to buy in, you need to have the dollars and cents connected to it… conservation does have an economic benefit, but it's not often perceived as a value. (Participant E31, 3-MR, Government)*

The 3-MR disagree more than any other perspective that size is an important determinant of worth of barachois ponds (Statement ID # 31). Members of this group weakly disagree that building or maintaining artificial openings in barachois ponds is necessary for managing nutrient levels (Statement ID # 9), and disagree very weakly that dredging artificial openings in barachois barriers for purifying water conditions to support oyster leases is a valid reason for alteration

(Statement ID # 2). One participant noted, "they're ignored in terms of those kinds of studies. If you don't know how something works… you don't know what kind of effects changing this-or-that would have" (Participant A5, 3-MR, Academia).

This group, along with LTBC, strongly disagree that the requirement to conduct Environmental Impact Assessments (EIA) prior to dredging barachois channels creates unnecessary setbacks for development (Statement ID # 35).

4.1.4 Perspective 4- the Science-Based Conservationists

The science-based conservationists (4-SBC) strongly agree that barachois ponds demonstrate fluctuating hydrology from year to year, e.g. water depth, flow patterns, duration and frequency of flooding (Statement ID # 15). One participant commented,

> *The majority of them change notably… more so in the last couple of years. They're breaking through more often, changing openings a lot. In fact, that's why we've had more boats in here than last year, because a lot of barachois have closed-off, and people had been keeping their boats in them. (Participant C18, 4-SBC, Local)*

This perspective strongly agrees that barachois ponds should be classified as wetlands of special significance for having high social and cultural importance (Statement ID # 19). One participant said,

> *There is a lot of traditional medicine in [barachois] that is untapped… that we've lost over time. That needs to be looked at. They are very unique ecosystems and I'm sure there's medicines in there that we've lost, yet they play a significant role in our history. (Participant D26, 4-SBC, NGO)*

The 4-SBC agree very strongly that the impacts of climate change, e.g. sea-level rise, storm intensity, ocean acidification, and invasive species are imminent threats to barachois ecosystems (Statement ID # 13). Members of the 4-SBC disagree the least that there is adequate policy protecting barachois ponds (Statement ID # 30). This perspective strongly agrees that barachois ponds are significant features that add aesthetic or economic value to the landscape (Statement ID # 20) and strongly disagrees that barachois ponds are a nuisance and detract from the landscape (Statement ID # 21). One participant said,

> *Part of the reason we as humans take advantage of barachois systems is because the broader community doesn't recognize the value of barachois. They feel the water is stagnant or undesirable… but without [barachois ponds], the Bras d'Or wouldn't have existed for the past 700 years. In essence they offer more value to humans from an environmentally supportive way, rather than an economically supportive way. (Participant E29, 1-LTBC, 4-SBC, Government).*

The 4-SBC agree very strongly that more stakeholders ought to recognize the value of barachois ponds through outreach initiatives, e.g. environmental education programs, development of infrastructure (Statement ID # 51). One local said,

> *I believe people are inherently good… They do things unknowing the damage they're doing, and if they were educated on the matter, they wouldn't do a lot of those things anymore. They're valuable, and education is key. (Participant C19, 4-SBC, Local)*

Despite this, the 4-SBC is the group is neutral that dredging barachois for recreational purposes is not a valid reason for barachois alteration (Statement ID # 8), and neutral that dredging to purify water in oyster leases is a valid reason for barachois alteration (Statement ID # 2). This group disagrees the most that fishing is only valuable in barachois whose channels are wide enough to allow sea water to enter (Statement ID # 24). Rather, one participant referred to barachois ponds as "nurseries… places where some species absolutely depend on." (Participant C19, Local). Another participant reported,

> *Barachois were used extensively for eel fisheries until the stocks dropped from intense pressures on the system. Used for winter fishing smelt, trout, gaspereau… the whole gamut of the smaller, migratory species. (Participant C18, 4-SBC, Local).*

4.2 Consensus Statements

Consensus statements refers to statements that were all ranked similarly across all four perspectives ($p<0.01$**, $p<0.05$*). Consensus statements are non-significant, in that they are not accounted in the creation of any perspective given that all participants felt equally about each statement. Consensus statements are important as they serve as a starting point for consensus-building (Hermelingmeier, Nicholas, 2017). Therefore, the most salient consensus statements are highlighted below while the remainder are listed in Appendix 3.

- ❖ All perspectives strongly or very strongly agreed that barachois ponds are vital for maintaining local biodiversity e.g. muskrat, otters, birds, loons, invertebrates (Statement ID # 4/**).

- ❖ Most perspectives strongly agreed that the barrier beaches that define barachois ponds are important ecosystems in their own right (Statement ID # 3/*), with the 'sustainable developers' only moderately agreeing.

- ❖ Most perspectives strongly agreed that protecting naturally occurring barachois ponds is critical, as they cannot be artificially reconstructed to match ecosystem function (Statement ID # 33/**), with the 'sustainable developers' very strongly agreeing.

- ❖ Most perspectives moderately agreed that barachois ponds promote salt marsh wetlands by facilitating hydrophytic vegetation (Statement ID # 14/*), with the 'leave-them-be conservationists' and the 'science-based conservationists' only weakly agreeing.

- ❖ Most perspectives disagreed very strongly that many barachois ponds should be filled-in and developed to support a variety of regional economic developments (Statement ID # 44/*).

- ❖ Most perspectives weakly agreed that that unmanaged growth is an important driver of negative environmental impacts on barachois ponds (Statement ID # 27/*), with the 'sustainable developers' moderately agreeing.

- ❖ Most perspectives very weakly agreed that residential or recreational coastal development within 100 – 200 meters of barachois negatively impacts barachois health (Statement ID # 12/**).

- ❖ Most perspectives were neutral or agreed very weakly that upland owners should be consulted when the development of barachois ponds is being considered, with the 'management reformists' weakly agreeing (Statement ID # 16/**).

- ❖ Each perspective moderately and weakly disagreed that barachois ponds do not hold as much value if they have been altered by a single storm event (Statement ID # 38/*).

4.3 Confounding Sorts

A confounding sort refers to an instance where one participant will load significantly under more than one perspective, thus weakening the heterogeneity of the perspective (Watts &

Stenner, 2012) (Appendix 2). This study resulted in 6 out of 33 confounding sorts despite increasing the significant loading factor from the proposed 0.36 to 0.5 (Hagan & Williams, 2016; Watts & Stenner, 2012). Of the six participants who loaded significantly into two perspectives; three participants from Government, Industry, and NGO loaded significantly into perspectives 1-LTBC and 3-MR; two participants from Academia and Government into perspectives 1-LTBC and 4-SBC; and one participant from Academia into perspectives 3-MR and 4-SBC. Insights from confounding sorts were not used in the creation of perspectives. However, they were used to support the significance of the study's overall findings.

4.4 Key issues identified

This extension of the results chapter reveals six key issues drawn through comprehensive linkages across the four perspectives, the qualitative semi-structured interviews that followed each Q-sort, the factor solution data, as well as perspectives from consensus statements and confounding sorts. In addition to the rich account of insights for informing the management of barachois ponds, key issues are substantiated using extreme, distinguishing, noteworthy, and significant consensus statements. While consensus statements and confounding sorts were not useable in the interpretation of the four perspectives (Watts & Stenner, 2012), they played a key role in shaping the overall importance of this study and as such, have been included as contributing greatly to supporting key issues identified.

Given that the study produced confounding sorts, and because certain participant's responses only marginally loaded significantly into one perspective over another, it was less relevant to draw significant conclusions by explicitly analyzing the similarities and discrepancies across the four perspectives. After all, no single perspective is weighted any more heavily than another, and it is further unlikely that a participant would align exclusively with one perspective, and not also with components of another. The four perspectives therefore serve to illustrate four principal paradigms for understanding barachois ponds, recognizing that stakeholders could relate to more than one perspective. Extreme, distinguishing, noteworthy, and/or significant consensus statements by the 33 participants were used as evidence to support management advice. To inform the management of barachois ponds, knowledge and insights from the four perspectives as well as supporting data for substantiating them are presented in 6 tables, each representing a

key issue. Each table comprises the Statement and Statement IDs, how that statement was perceived and by what perspective, and how the statement supports that key issue (Table 2, 3, 4, 5, 6, 7). Note that where certain statements were used repeatedly across key issues, they were interpreted differently, enabling the creation of six distinct key issues.

Table 2. Key Issue- Wetland Ecological Services Protocol (WESP) and barachois ponds

Wetland Ecological Services Protocol (WESP) and barachois ponds *Description: The WESP for Atlantic Canada may not be adequately capturing barachois pond, particularly along the Bras d'Or Lakes with its narrow tidal range. An adaptation of WESP-AC arises from the need to ensure the functions and benefits of barachois ponds are being fairly assessed.*		
Statement and Statement ID #	**Who felt what?**	**Significance to this discussion**
Barachois ponds promote salt marsh wetlands by facilitating hydrophytic vegetation, e.g. plants that are adapted for life in saturated soils such as salt-water cordgrass, sedges and rushes. **(14)**	Consensus statement ($p<0.01$). Both the 2-SD and the 3-MR moderately agreed.	*I see them as important barriers for shoreline and the promotion of other ecosystems like salt marshes. You don't see any salt marsh habitat for awhile and you come along to a barachois, and then the whole inner surface of the pond is a salt marsh. And the only reason it exists there is because of that barrier beach out front stopping the wave action from destroying the salt marsh habitat. So physically, it provides a place for salt marsh plants to live. Build it and they will come. (Participant A5, 3-MR, Academia)*
There is adequate policy and / or legislation protecting barachois ecosystems. **(30)**	The 3-MR very strongly disagreed. The 2-SD strongly disagreed.	*What's really problematic is when you know a holistic approach, one that considers all interacting aspects of the environment, is the best way to go when making this decision… and the policy and legislation doesn't allow you to do that. (Participant A1, 2-SD, Academia)*
Protecting naturally occurring barachois ponds is not critical as they can be artificially constructed, even matching ecosystem function. **(33)**	Consensus statement ($p<0.01$). The 2-SD very strongly disagreed. The 1-LTBC and the 3-MR strongly disagreed.	*No, we can't duplicate them, they're not in a steady state. Someone could create a pond, a duplicate of what we thought the conditions were in another pond. When we talk about restoring, it comes down to some professional telling another professional what he has to duplicate. And since we don't fully understand all the interactions in the barachois pond, it's impossible to say, "here's what you have to duplicate…". (Participant C16, 2-SD, Local)*

	The 4-SBC moderately disagreed.	

Table 3. Key issue- Inventory and sub-classification of barachois ponds

Inventory and sub-classification of barachois ponds *Description: There is a need to document and inventory the numerous key characteristics of coastal saline ponds, such as through a sub-classification system.*		
Statement and Statement ID #	**Who felt what?**	**Significance to this discussion**
Barrier beaches that define Barachois ponds are important ecosystems in their own right. **(3)**	Consensus statement ($p<0.01$). The 1-LTBC, the 3-MR, and the 4-SBC all strongly agreed.	*[Barrier beach ecosystems] provide a unique habitat, but that also serves to protect shorelines from erosion. The value is in those functions. (Participant E28, 1-LTBC, 3-MR, Government)*
Climate change e.g. sea-level rise, storm intensity, ocean acidification, invasive species, are not imminent threats to Barachois ecosystems. **(13)**	The 4-SBC very strongly disagreed. The 1-LTBC strongly disagreed. The 3-MR moderately disagreed.	*Climate change is upon us. There's no denying it. It's here. We have a pretty good idea of what climate change is going to do. And with sea-level rise in some places, it will actually eliminate barachois. They'll just flood over, and they'll be gone. So, it's critical to start looking at whether there are things we can do. (Participant C19, 4-SBC, Local)* *Barrier beaches are critical with climate change coming. Storm surge protection is absolutely associated with the barachois, holding all kinds of water back. (Participant E33, 3-MR, Government)* *…a perfect example on TV down on the mainland* (Davie, 2018; Palmeter, 2018). *They had their barrier beach open 30 m wide after a storm, and they wanted the province to come and fix it. Climate change creates a big opening, salt water flies into freshwater lake and freshwater lake drains, and they want Natural Resources to come in and fix it. Thankfully province is saying we're not going to be doing anything. If you're having a problem, move your house. If you want to live right on the water's edge, be prepared for all kinds of eventualities. (Participant A5, 3-MR, Academia)*
An inventory of the diverse barachois pond habitats and their associated	The 3-MR moderately agreed.	*I think its hard to separate out the line where you go from beach and dune to barachois pond to salt marsh… the line is quite blurred. We don't know enough about these systems*

species composition is lacking. **(25)**		*individually. For example, the salt marshes; we're going to protect them as Wetlands of Special Significance, whereas the barachois pond beside it— go ahead and fill it in. Needs a better understanding of each coastal habitat type, coastal wetland habitat type, form, and function, and how they interact with one another. (Participant B13, 1-LTBC, 3-MR, Industry)*
There is adequate policy and / or legislation protecting barachois ecosystems. **(30)**	The 4-MR very strongly disagreed. The 2-SD strongly disagreed.	*If your policy and legislation don't allow some mechanism for considering case-by-case assessments, if it's all just black and white, for example, this is a marine wetland and therefore it's always protected no matter where it is and how big it is, well that's inadequate legislation and policy. (Participant A1, 2-SD, Academia)*
The size of a barachois pond is an important determinant in its value and worth. **(31)**	The 3-MR moderately disagreed. Meanwhile the 2-SD weakly agreed.	*Is the [barachois pond] important as a nursery? As a sediment basin? As a bioreactor? As a coastal wetland? As shoreline protection? All these things would have to be factored in, not just size. (Participant B10 3-MR, Industry)*
Protecting naturally occurring barachois ponds is not critical as they can be artificially constructed, even matching ecosystem function. **(33)**	Consensus statement ($p<0.01$). The 2-SD very strongly disagreed. The 1-LTBC and the 3-MR strongly disagreed. The 4-SBC moderately disagreed.	*They can be transient in nature making them very fragile. There can be differences in chemical conditions from pond to pond, one is not substituted with another very readily. (Participant A6, 1-LTBC, Academia)*
We do not know enough about the barachois ecosystems to effectively manage them. **(48)**	The 3-MR very strongly agreed. Meanwhile the 2-SD strongly disagreed.	*There's far more that we don't know, than we do know. And we're trying to manage, protect, restore, and create [barachois ponds], and I don't think we know enough. Despite successes, we've had some not so successful ones, as we don't know enough about them. Manage and restore barachois ponds...? How do we do that? Knowledge gaps around species, actual form and function, role in ecosystem— we know there's key plants and animals that depend upon [similar wetland types], do we know the same for ponds? Do we even know what's there? Are there differences between barachois in Bras d'Or vs. Bay of*

		Fundy? Or other two coasts? (Participant B13, 1-LTBC, 3-MR, Industry) *There's a lack of information on barachois, leading to lack of management because we don't have the information. (Participant B10 3-MR, Industry)* *If we want to understand their significance to the landscape, their ecological significance, we need to know how many there are, how much area they cover, what the physical, chemical parameters are, how frequently are they open to the ocean? What are the typical salinities? What are temporal dynamics of the water quality? Nuisance algae? High nitrogen- high phosphorus system, low phosphorus - low nitrogen, what are typical chemical constituents in the pond? The whole food chain? What's there? Benthic invertebrates, zooplankton, fish species typical of these? Does that change when there's strong freshwater connection vs. ocean connection? What are the birds that use it and others? Assess one as particularly more beneficial, comparing a cross section of ones, coming up with classification approach; small, medium, large, fresh or ocean connected. Classifying, stratifying your sample, having a range of those. Vegetation, how much salt marsh is typically associated with them? It's an open book for learning. We know nothing very systematic about their ecology. Wouldn't be that expensive. (Participant E33, 3-MR, Government)*
It is important that all barachois ponds are valued equally, as each offer something different and unique worth protecting. **(50)**	The 1-LTBC and 4-SBC both moderately agreed. Meanwhile, the 2-SD weakly disagreed.	*Because each one is unique, how do you say that one is more unique? One could be slightly more unique, or one might be similar to another classification, but that doesn't make it any less important. They're all there, all valued equally, study them all to the same degree. (Participant A3, 1-LTBC, Academia)* *There's value in all ecosystems. But we have to put up buildings and structures and houses, and so we choose areas where the impact will be minimal in a perfect world. Developing this classification system would allow us to do this. (Participant D20, 1-LTBC, NGO)* *I don't think we have to keep all 400+ barachois in a pristine state around here. I think we'd be smart to have a good classification of barachois ponds. Not even the most rabid conservationist thinks all of the Scotian Shelf needs to be*

		protected… They're saying we need a network of marine protected areas representative of different types of shelf environment. You'd say the same here. We need to categorize and classify our barachois ponds, and make sure essential attributes embodied in barachois ponds aren't lost because we've allowed people to do things in these special environments. (Participant A1, 2-SD, Academia)

Table 4. Key Issue- Wetlands of Special Significance—Social and cultural importance

Wetlands of Special Significance—Social and cultural importance *Description: Indicators are put forward for establishing social and cultural significance criteria for designating barachois ponds as Wetlands of Special Significance under the provincial and federal wetland policy*		
Statement and Statement ID #	**Who felt what**	**Significance to this discussion**
Barachois should be classified as wetlands of special significance for having high social / cultural importance. **(19)**	The 1-LTBC very strongly agreed. The 4-SBC strongly agreed.	*I think when and how Westerners believe that what they're doing is right… they should approach the appropriate people in our communities that have knowledge of these areas… and why we have place names significant to all these areas and what they mean. When you approach other elders or knowledge keepers about these place names, you'll see the significance of why it's called this. And when you have that understanding, you have an appreciation for what's there. Science is able to go in and say yes, this is all there, but if they approached our people, then they'd understand that, sure these things are there… but do you know how to use them? That's the difference between the western way of thinking and our way of thinking. (Participant D22, 1-LTBC, NGO)* *As a microcosm, a [barachois pond] is unique. In some cases, the salinity is much higher. What causes these species to thrive in those ponds? How did they come to exist in this threshold environment that, on this side you don't survive, but on this side the salinity or temperature is just right? Natural design—What does environment and evolution show us..? We can bio-mimic that design. When we mistreat them, we miss those opportunities to learn about biomimicry when observing how the natural system does what it does. (Participant B14, 1-LTBC, Industry)* *Because they are very unique ecosystems, I'm sure there's medicines in there that we've lost yet play a significant role in our history. (Participant D26, 1-LTBC, NGO)*

		I think they are beautiful, very sheltered. Certainly, in the evening when there's no wind, barachois pond are very calm. And Cape Breton is very windy place, so you appreciate the place where the water is more often calm. Not thinking about financial or economic value. Obviously, they do have that potential economic value… But I think of it as having a more intrinsic value, whether it has economic value or not. (Participant E32, 1-LTBC, 4-SBC, Government)
Barachois ponds are significant features that add value to the landscape (aesthetic/ economic). **(20)**	The 2-SD very strongly agreed. The 4-SBC strongly agreed. The 3-MR moderately agreed.	*Physically, [a barachois pond] provides a place for salt marsh plants to live. I consider that part of a natural economy as opposed to dollars and cents. I certainly appreciate them aesthetically. I love looking at them. I love seeing them as I drive by or if I'm sailing. (Participant A5, 3-MR, Academia)*
There is adequate policy and / or legislation protecting barachois ecosystems. **(30)**	The 3-MR very strongly disagreed. The 2-SD strongly disagreed.	*In terms of [Statement ID #] 30, and the policy regulation side of things, we have more policy and certainly a lot more regulatory protection in place for wetlands… but we've singled out salt marshes as Wetlands of Special Significance among all of the wetlands. But given the connection and place in landscape that the barachois ponds have, I think they should have similar-to-salt marsh level of protection. Because they are a rarity. They only occur in certain parts of our province and along our perimeter. (Participant B13, 1-LTBC, 3-MR, Industry)*

Table 5. Key Issue- Altering barachois ponds

Altering barachois ponds *Description: The decision to alter a barachois pond should be informed by more than size alone.*		
Statement and Statement ID #	**Who felt what**	**Significance to this discussion**
Dredging artificial openings in barachois ponds to purify water conditions in ponds that support oyster leases is a valid reason for their alteration. **(2)**	The 1-LTBC moderately disagreed. Meanwhile the 2-SD weakly agreed.	*If you're changing the opening, you're changing the system itself. Whatever is in there has evolved or developed or sorted itself according to those conditions. If you change those conditions quickly, you affect the ecology of that. If you did dredge, you're fundamentally changing the hydrology and ecology. (Participant E28, 1-LTBC, 3-MR, Government)*

Dredging artificial openings in barachois for recreational purposes is not a valid reason to alter barachois ponds. **(8)**	The 1-LTBC very strongly agreed. The 4-SBC were neutral.	*If you don't understand the ecological value or role of these systems, then it's hard to justify or rationalize why they should be altered. (Participant E28, 1-LTBC, 3-MR, Government)*
Building or maintaining artificial openings in barachois ponds is necessary for managing algal blooms or reducing nutrient levels in Barachois. **(9)**	The 3-MR weakly disagreed.	*We build or maintain artificial openings because we're trying to protect systems in natural function, but the best thing we can be doing is getting out of their way. The more we're doing to manipulate or manage [barachois ponds], the more we're altering them. I think as much as possible, step aside and let them function as naturally as possible given sea-level rise and climate change. The more we can get out of the way, the less we must do, the better. The moment we decide to build or maintain an opening for X, Y, Z, we're taking over an ongoing, potentially long-term activity and expense. If we just look at the system, in this case why we have algal blooms and high nutrient levels, let's address that. Opening up the barrier is a band-aid solution. We should deal with the root cause of the blooms and nutrient levels. Let the barachois pond do its thing naturally. (Participant B13, 1-LTBC, 3-MR, Industry)*
In general, the construction and maintenance of infrastructure (roads, wharves) does not greatly impact barachois ponds. **(10)**	The 1-LTBC and 4-SBC moderately disagreed.	*They need to be protected. Because you can destroy them, and they'll never be the same. And it took a long time for nature to create them, and there definitely needs to be some sort of protection around them. They're a unique ecosystem; plant, animals, bugs—everything is interconnected within that small ecosystem. And if something is altered, it can affect the whole chain, and disrupt it. (Participant D26, 4-SBC, NGO)*
Climate change e.g. sea-level rise, storm intensity, ocean acidification, invasive species, are not imminent threats to Barachois ecosystems. **(13)**	The 4-SBC very strongly disagreed. The 1-LTBC strongly disagreed. The 3-MR moderately disagreed.	*We should be encouraging people to build away from barachois ponds, and the shoreline in general. (Participant E32, 1-LTBC, 4-SBC, Government)*
There is adequate policy and / or legislation	The 3-MR very strongly disagreed.	*The solution is to improve our policy and legislation. When I mentioned the need for protocol, I meant you can have a rule*

protecting barachois ecosystems. **(30)**	The 2-SD strongly disagreed.	*that says you will do 'this', but if you don't have mechanisms to accomplish that… then there is not much use in having the rule. (Participant A1, 2-SD, Academia)*
The size of a barachois pond is an important determinant in its value and worth **(31)**	The 3-MR moderately disagreed. Meanwhile the 2-SD weakly agreed.	*As a rule, we tend to look at our own values on it… can we fish in it, can we put a boat in it? When in reality, big things aren't necessarily more valuable than small things. There are things living there that have a role in the system, even though we don't know that role. Bigger isn't necessarily better. To say one is more valuable than another, it's not fair. One might have a bigger economic, productivity, recreational value, but each one has its own place in the system. (Participant A8, 3-MR, 4-SBC, Academia)*
The requirement to conduct Environmental Impact Assessments (EIA) prior to dredging barachois channels creates unnecessary setbacks for development. **(35)**	The 1-LTBC and the 3-MR strongly agreed. The 4-SBC moderately agreed.	*[The EA process] is there so you don't make bad choices. Every developer always has a timeline 6-12 months ahead of where they should be. Clients hand in a design and ask, when can we have the permit? Doesn't work quite that way. You don't want to rush, or have cost overruns… You're better off spending more time in the design and assessment phase. Once that things start, it's hard to control the costs, it can grow exponentially. It's always been a fallback for 'pseudo economic development junk theory'; jobs are the most important. Well, they're not. Food, habitat, being alive, is more important than some developer's plan. In most cases, it needs to be more rigorous. (Participant B14, 1-LTBC, Industry)*
Many barachois ponds should be filled in and developed to support a variety of regional economic developments. **(44)**	Consensus statement ($p<0.05$). The 1-LTBC, 2-SD, 3-MR all very strongly agreed. The 4-SBC strongly agreed.	*Seems to me, we had an issue with an RV park proposed on, or right next to a barachois. And there didn't seem to be anything stopping them except for their own investors falling through, because the community did not want that to happen. Without any policy or anything, they protested. At least the public is trying to protect the environment, even if the policy makers are failing us. (Participant D27, 1-LTBC, NGO)*

Table 6. Key Issue- Coordinating integrated management

Coordinating integrated management *Description: Integrated management at the watershed scale is necessary for effectively managing barachois pond ecosystems, to maximize the benefits valued across multiple jurisdictions.*		
Statement and Statement ID #	**Who felt what**	**Significance to this discussion**

Barachois ponds are vital for maintaining local biodiversity e.g. muskrat, otters, birds, loons. **(4)**	Consensus statement ($p<0.01$). The 2-SD and the 4-SBC very strongly agreed. The 1-LTBC and the 3-MR strongly agreed.	*It looks like an explosion of life whenever you look at those places, but without those studies, you never really know. It would appear, but without the proper studies we don't really know. (Participant D27, 1-LTBC, NGO)*
Most barachois ponds should be classified as wetlands of special significance for they support rare species at risk e.g. migratory birds and waterfowl. **(18)**	Consensus statement ($p<0.01$). The 1-LTBC strongly agreed. The 2-SD and the 4-SBC moderately agreed.	*I think it's important we protect [barachois ponds] for rare and migratory species. Little tiny bumps in their flow of patterns can have major downstream bumps. I think it's important to keep little treasures like that safe. (Participant B14, 1-LTBC, Industry)* *Some [barachois ponds] should be classified as Wetlands of Special Significance as they are interesting points of transitions for birds. (Participant E9, 2-SD, Industry)*
The management of barachois ponds is uncoordinated. **(26)**	The 3-MR very strongly agreed.	*You can't effectively manage that which you only have limited information on. (Participant B10 3-MR, Industry)* *Everyone is operating in silos. No one is talking. (Participant B10 3-MR, Industry)* *For the municipality, they're limited by what they can regulate environmentally because of the provincial Municipal Government Act. But there are some things they can do, like development setbacks and riparian buffers along the stream. The province is really the one who has the responsibility to protect the environment, and a lot of times, development like this would trigger provincial Environmental Assessments, but if it's under size… Because the municipality doesn't have the expertise on staff because that's not what they normally deal with, a lot of things go unregulated because it doesn't meet the provincial criteria for an assessment, but there's no one looking at it from an environmental perspective from the Planning and Development Department. (Participant E30, 3-MR, Government)* *The municipality is on the CEPI group. But I think until we can have an agreement collectively with all the municipalities on how best to manage, it's difficult for one municipality to potentially take the lead, when subsequent municipalities are not following suit. It often falls to municipalities that have*

		land-use bylaws in place, so not all of the ones that are around the BDL currently have those in place. The CBRM is one of the few that actually has land-use restrictions in place. So we're often perceived as being more regulatory or difficult than other jurisdictions on the island. So, we could champion this and take the lead, but I know we're struggling day-to-day to get the regular permits issued for developments, that then to subsequently take on another level of enforcement with limited staff resources… Not to say we don't see it as valuable, we just don't have the resources. We would like to see more of a collaborative approach, but until that collaborative approach is reached and implemented across the board, I think it's not something that we're willing to stand up and champion. But we do see the lack of regulatory framework in place, and we are restricted somewhat with our role under the Municipal Government Act. Not saying we couldn't implement setbacks from a water body, but I think until we get some sort of across the board consensus, it's not something we're in the framework or mindset to champion. Definitely we would want the First Nations communities and all other regulatory entities to have a similar perspective, so that we're working from the same "song book", all looking at development in these areas similarly. (Participant E31, 3-MR, Government)
Unmanaged growth is an important driver of negative environmental impacts on barachois ponds. **(27)**	Consensus statement ($p<0.05$). The 3-MR moderately agreed.	*In my experience in Nova Scotia, in the majority of cases, there is a lack of planning around coastal development and coastal growth. Talking about zoning and legislation in general, at the provincial level. I have seen certain housing development happening too close to lagoon or ocean, or too much of it for particular area, that you see negative impacts. So, [Statement ID #] 27 rang true. It just seems like we allow unmanaged growth. Even though we can say it's managed because there might be some zoning or some regulation, it's inadequate zoning or regulations. So, in that way, it's unmanaged. (Participant D21, no perspective, NGO)*
There is adequate policy and / or legislation protecting barachois ecosystems. **(30)**	The 3-MR <u>very</u> strongly disagreed. The 2-SD strongly disagreed.	*I think it really does need a separate policy, something that looks at [barachois ponds] as unique, because nothing right now quite covers them. Some have more permanent opening to BDL, which makes them more of a federal thing. Whereas some are completely enclosed which would make it more provincial… and then that could change! I think it should be treated in general like any aquatic bodies, so there's a mix of*

		federal and provincial, and they both have their influence. But there needs to be a coordinator. As long as it's clear who's responsible, and which provincial department is responsible, i.e. Department of Environment and/ or Lands and Forestry. (Participant D24, 3-MR, NGO) *[Barachois ponds] are managed in between inland and ocean environments. Is it where the uplands meet ocean, where provincial meets federal. Multiple levels of categories make it complex but interesting. In the mess is where interesting solutions are created. (Participant E9, 2-SD, Industry)*

Table 7. Key Issue- Education Stakeholders

Educating stakeholders *Description: There is a disparity between the importance of barachois pond ecosystems and people's understandings of their importance.*		
Statement and Statement ID #	**Who felt what**	**Significance to this discussion**
Barachois ponds are significant features that add value to the landscape (aesthetic/ economic). **(20)**	The 2-SD very strongly agreed. The 4-SBC strongly agreed. The 3-MR moderately agreed.	*Now that I know what they are, I see them all the time and I appreciate them a lot for adding aesthetic value to the landscape. (Participant C15, 2-SD, Local)*
Barachois ponds detract from the landscape. They are a nuisance. **(21)**	The 1-LTBC and the 4-SBC very strongly disagreed. The 3-MR strongly disagreed. The 2-SD moderately disagreed.	*How can anyone think they detract from landscape? It's a unique feature! It's its own little unique mini ecosystem. How does that detract? I think it adds. (Participant E3, 1-LTBC, Academia)* *While they can be undesirable, that's necessary and part of ecosystem function… Part of education. (Participant A6, 1-LTBC, Academia)* *People have negative feeling about these wetlands; "worthless swamps" as opposed to attractive beaches. It's a matter of people changing through learning more about the contributions they make to the environment and how valuable they are. (Participant E31, 3-MR, Government)*
Freshwater barrier [barachois] ponds provide unique	The 2-SD strongly agreed.	*Ponds are vital habitats that have food and animals. A lot of people go to the beach and think, don't swim on that side, it's*

learning opportunities, e.g. how a dune, rocky shore, salt marsh or estuary may affect life in the pond. **(29)**		*gross, swim on that side, it's fresh. But ponds are warmer, muddier, more turbid. When you open people's eyes to their ecological value, you can see them switch in their mind, valuing the pond as a habitat more. (Participant C15, 2-SD, Local)*
Most people do not know what barachois ponds are (it could be they may know they exist but would not necessarily identify them as barachois). **(37)**	The 2-SD and the 3-MR strongly agreed.	*Most people don't know about barachois, even me who am educated in wetlands. (Participant E9, 2-SD, Industry)*
More stakeholders ought to recognize the value of barachois ponds through outreach initiatives (e.g. environmental education programs, development of infrastructure). **(51)**	The 4-SBC very strongly agreed. The 2-SD strongly agreed. The 1-LTBC and the 3-MR moderately agreed.	*The biggest thing is education. You can make all kinds of policies and "shoulds" and "shouldn'ts". But unless someone informs people on what [barachois ponds] are and how valuable they are to the systems, I don't think anything will happen. (Participant C18, 4-SBC, Local)* *I really believe that education is the key to a lot of things, and that most people are inherently good. They do things unknowing the damage they're doing, and if they were educated, they wouldn't do a lot of those things anymore. (Participant C19, 4-SBC, Local)* *I worked in pubic education with Bras d'Or Watch… we're excited when our sites include a barrier pond because it does include all those different habitats. People get jazzed about finding a lot of different things in a concentrated area. [Barachois ponds] have a lot of potential as a public-education marine habitat area. (Participant C15, 2-SD, Local)* *[Barachois ponds] would be an area where the concept of Two-Eyed Seeing would be beneficial. Our people have always used the land for survival. (Participant D22, 1-LTBC, NGO)* *I see them as handy subaquatic ecosystems, perfect for students to learn how things interact with each other, how the physical and biological world are dependent on each other. They're right on the shoreline too, so you don't have to travel off coast. (Participant A5, 3-MR, Academia)*

		Development of cottages has in the past around Bras d'Or has not been favorable for protection of barachois. People are more cognizant that that's what they want to protect. Educational programs would only benefit that. (Participant A6, 1-LTBC, Academia)

CHAPTER 5. DISCUSSION

The previous tables outlined six key issues surrounding the management of barachois ponds revealed from the perspectives of 33 participants from industry, academia, government, locals and NGOs. In brief, the key issues were; the tidal Wetland Ecological Services Protocol for Atlantic Canada (WESP-AC) is not adequately capturing the functions and benefits of barachois ponds along the Bras d'Or Lakes; that barachois ponds should be inventoried under the Provincial Landscape Viewer using a more comprehensive classification system based on essential characteristics; that because barachois ponds are so closely associated with salt marshes, the criteria for designating barachois ponds as Wetlands of Special Significance using social and cultural importance must employ more inclusive and culturally respectful mechanisms for submission to ensure maximum protection of salt marshes and barachois ponds alike; that the conditions for requiring a permit to alter barachois ponds must be triggered by more than minimum size requirements alone— this, synergized by the creation of a comprehensive classification system for barachois ponds in the provincial wetland inventory; that jurisdictional authority over common resources such as fresh, brackish, and marine systems must manage resources at the watershed-scale, with greater opportunities and incentives for communication and planning between municipalities, First Nations, provincial and federal departments; and lastly, that more investments ought to be made into educating the public, government officials, and developers of the ecological and social benefits afforded by barachois ponds.

5.1 Wetland Ecological Services Protocol (WESP) and barachois ponds

The Wetland Ecological Services Protocol (WESP) contains a regionalized manual for Atlantic Canada; WESP-AC (Adamus, 2018ab). WESP is a rapid assessment protocol manual used throughout the United States and Canada by wetland practitioners for monitoring and assessing wetland ecological condition based on demonstrable functions and benefits, for comparing relative ecosystem services across all wetland types, and for comparing ecosystem services before and after a restoration, enhancement or loss (Adamus, 2018b). WESP-AC prides itself as a rapid assessment tool operational over the span of 1-3 hours using both aerial photo interpretation and on-site assessments. WESP scores nine wetland attributes across all wetland

types during each assessment, including Storm surge interception, Water purification, Organic nutrient export, Fish habitat, Waterbird habitat, Songbird and raptor habitat, Biodiversity maintenance, Wetland stability, and Public use or recognition; the latter is not considered a function but still measured as a benefit (Adamus, 2016).

WESP-AC has a manual for tidal and non-tidal wetlands, that necessarily distinguish the pertinence of field questions related to the wetlands' functions and benefits as attributable to fresh or saltwater systems (Adamus, 2018ab). The questions used in the tidal WESP-AC manual for scoring relative wetland function, are heavily reliant on the presence of distinct tidal zones creating a high marsh zone (personal communication, Participant D24, 3-MR, NGO, July 2018). Yet within the Bras d'Or Lake, often there are no distinct high and low marsh zones, or they are very narrow and overlapping. For instance, where *Spartina alterniflora* and *Spartina patens* typically occur successively in a tidal wetland from wet to dry respectively, in the BDL they can occur intermixed or one may be absent entirely (Mitsch & Gosselink, 2015; personal communication, Participant D24, 3-MR, NGO, July 2018). Does this suggest that the surrounding marsh is not a salt marsh? Local ecologists are inclined to disagree. The salt marshes found along the Bras d'Or Lake are no "less functioning" than other markedly tidal salt marshes because they do not show tidal zones— they are merely different, existing along the shores of a complex estuarine lake system instead of open sea (personal communication, Participant D24, 3-MR, NGO, July 2018; personal communication, J. Higgins, September 2018). Further, while WESP-AC is not designed to identify wetland type, many of the tidal questions are salt marsh-centric, creating odds when assessing freshwater barachois ponds that are tidally influenced (personal communication, Participant D24, 3-MR, NGO, July 2018).

No monitoring protocol is perfect. And no definition of wetland health, intactness, or ecological condition is unanimously accepted (Adamus, 2016; Fennessey, Jacobs & Kentula, 2004). It is however accepted that no single wetland may operate at high for all functions, particularly when certain benefits such as public-use typically trump other functions such as high biodiversity (Adamus, 2016; Fennessey et al., 2004). It is further recognized that high-functioning wetlands are not always healthy and intact and vise versa (Adamus, 2016; Adamus, 2018b). A wetland that demonstrates a function under the WESP protocol does not inherently mean the wetland will be scored highly for that function. For example, a wetland that has a demonstrated capacity to remove nitrate will not necessarily be valued for such unless it is

exposed to significant levels of nitrate, or one that has a demonstrably low function for water storage may still be valued high for that function if the wetland is located above the homes in the watershed (Adamus, 2016). The degree and sorts of values a wetland can provide are a direct reflection of the wetland's *opportunity* to provide that function (Adamus, 2016). When speaking to the ecological condition of a wetland, therefore, the individual functions must be stated (Adamus, 2016).

5.1.1 Challenges of addressing this issue

The WESP-AC's scoring system and indicators are put forward to adequately describe the relative effectiveness of wetland functional performance. Yet the WESP-AC manual outlines numerous limitations for effectively answering all relevant questions related to wetlands assessment (Adamus, 2018b). For instance, and the most relevant to barachois ponds, the functional effectiveness of a wetland is measured against that of all other wetland types across the region using standardized criteria (Adamus, 2018b). In other words, the resulting scores are not a direct measurement of the true functional effectiveness of any given wetland, but of the cumulative and relative effectiveness of the 72-120 non-tidal sites and 19-43 tidal sites that fed into the algorithms that calibrated overall scores from each Atlantic Maritime province (Adamus, 2018a; Adamus, 2018b).

While barachois ponds are classified as tidal marsh lagoons under the Canadian Wetland Classification System, the tidal range in Bras d'Or Lake is generally too insignificant to ascribe a high score to values of any given wetland function when compared with other tidal wetlands across the region (Petrie & Bugden, 2002; Shaw et al., 2006). Further, only one barachois pond in Cape Breton was used to regionally calibrate the values of wetland functions. Since many of the questions outlined in the tidal WESP-AC rely on pronounced tidal gradients, local wetland ecologists in the BDL are opting to use non-tidal WESP to assess barachois ponds, relying less on demonstrating measurable tidal gradients to validate wetland function. The validity of the assessment of barachois ponds is then affected, when barachois ponds consistently fail to yield high scores as compared with other, more pronouncedly tidal wetlands (personal communication, Participant D24, 3-MR, NGO, July 2018).

Non-tidal questions in the WESP-AC give practitioners the ability to account for numerous different wetland types in the calculations as opposed to being constrained by the narrow definition of tidal wetland. Yet the non-tidal manual still falls short for effectively assessing barachois ponds given their nature as a (fresh to brackish to saline to shallow to deep) pond having different wetland patches associated with them. In some respects, barachois ponds could even be considered a water course with fringing wetlands. Given that all perspectives within this study felt that barachois ponds promote salt marsh wetlands by facilitating hydrophytic vegetation, it is not clear whether tidal WESP-AC adequately captures salt marshes that fringe barachois ponds along the Bras d'Or Lake (Statement ID # 14**).

5.1.2 Opportunities for addressing the issue

If tidal WESP-AC does not adequately capture the functions and benefits of barachois ponds, then it is not an adequate policy for barachois ponds, a concern echoed by the strong and very strong feelings towards Statement ID # 30. WESP-AC as a tool to inform decisions regarding wetland avoidance, minimisation and replacement, particularly if not capturing all functions, is inadequate given consensus Statement ID # 33** revealing that all perspectives felt strongly and very strongly that barachois ponds could not readily be restored, and that they should be preserved in their natural state. This emphasizes the importance of ensuring an assessment protocol that adequately and confidently captures functions and benefits, given that restoration and replacement are highly undesired outcomes.

Yet, opposing views between three perspectives were also revealed, whereby two perspectives moderately agreed that all barachois ponds should be valued equally, another felt they should not. Valued "equally" in this context, however, could refer to equality across all wetland types, as opposed to equality across all barachois ponds (Statement ID # 50). Therefore, in supporting the sentiments of the 2-SD that not all barachois ponds should be valued equally, while supporting the 1-LTBC and the 4-SBC that all barachois ponds should be valued equally during a functional assessment, an adaptation of the tidal WESP-AC as a method for assessing barachois pond function is recommended.

5.1.3 Recommendations

To satisfy the varied perspectives and simply recommend a hybrid between tidal and non-tidal manual, would require the re-normalization and re-calibration of all raw scores from wetlands included in the statistical sample for the Maritimes, as well as the identification of many new reference sites and indicators more reflective of barachois ponds (Adamus, 2018b). Hardly reasonable given the specificity of the problem at hand. Therefore, an alternative regionalized approach for quickly and effectively determining the unique functions and benefits provided by each barachois pond, particularly in Cape Breton, is necessary.

Tidal WESP-AC is usable for the rapid assessment of barachois ponds in Cape Breton but requires more explanation and clarification as to how exactly these questions should be answered for these environments both in Nova Scotia more broadly but specifically along the Bras d'Or Lakes.

Ultimately, a separate adaptation of WESP-AC tidal and non-tidal should be developed specifically for the functional assessment of coastal saline ponds in Nova Scotia and along the Bras d'Or. The next key issue identified; enacting an inventory and sub-classification systems for barachois ponds, if implemented, would help streamline functional assessments of barachois ponds.

5.2 Inventory and sub-classification of barachois ponds

A wetland inventory houses essential information necessary for wetland management such as wetland size, location, type, condition, flora, fauna, soils, hydrology, physical and chemical soil and water properties, as well as assessment and monitoring protocols (de Groot, Stuip, Finlayson & Davidson, 2006; Government of Canada (GOC), 1991). Inventories are important for documenting monitoring data on the ecological character of wetlands, pressures, values and risks associated with alterations (de Groot et al., 2006; GOC, 1991). Currently, Nova Scotia Department of Lands and Forestry collects and houses the provincial landscape data including coastal ponds and makes it available to the Department of Nova Scotia Environment for

management and enforcement decisions (personal communication, Participant E33, 3-MR, Government, July 2018).

Given that only a fraction of barachois ponds in NS have been rapidly assessed, and are excluded from the provincial wetland inventory, documenting and cataloguing the remainder of barachois ponds would be a significant step toward understanding these ecosystems in greater depth thereby addressing Statement ID #48; i.e., "we do not know enough about barachois ponds to effectively manage them". Meanwhile, having enough knowledge and understanding of barachois ponds enables wetland practitioners and regulatory agencies to be able to further delineate coastal saline ponds into sub-classes, by employing the knowledge that is already known on key characteristics (Statement ID # 48). The consensus Statement ID # 3* shows the importance of accounting barrier beaches as distinct entities when inventorying and sub-classifying barachois ponds, begging the need to capture functions and benefits deriving from landforms specific to barachois ponds.

Moving forward, the narrowed valuation of barachois ponds still faces slight contention between the three perspectives. While the 2-SD disagreed that all barachois should be valued equally, an inventory, and particularly a sub-class system would provide practitioners that ability to assess barachois ponds in greater detail, designating significance accordingly to the health of key demonstrable characteristics (Statement ID # 50). Meanwhile, the 1-LTBC and the 4-SBC who agreed that all barachois ponds should be valued equally, may not appreciate a sub-classification system for it necessarily involves selective valuation as opposed to blanket valuation (Statement ID # 50). An inventory and sub-classification system would simply provide other means for valuing these ecosystems. Another slight contention was revealed by Statement ID # 31, whereby the 3-MR disagreed that size is important for determining barachois pond value and worth. This was in opposition to the 2-SD, who agreed that size is important for determining value and worth of barachois ponds. An inventory would satisfy the 3-MR by providing alternative means for valuing barachois ponds. Meanwhile an inventory and sub-classification of coastal saline ponds would not insult the 2-SD's sentiments regarding size.

The province uses size as a principal determinant for establishing wetland value (<100 m^2 or >2 ha) (NSE, 2011; NSE, 2013). Yet in many cases, the threshold under which a wetland's characteristic ceases to be effective is unknown (Adamus, 2016). While scientists suggest that

size may influence function in a greater-than-linear fashion, only four functions in the WESP use size as an indicator of function; Waterbird Feeding, Waterbird Nesting, Songbirds-Raptor-Mammals, and Pollinators (Adamus, 2016). Given that climate change is an imminent threat, as revealed by Statement ID # 13, it is essential to document and inventory barachois ponds to create a baseline for future climate change impact assessments and scenario building. Lastly, the consensus Statement ID # 33** on the need to protect naturally occurring barachois ponds over alternatives, justifies the need for understanding how the key characteristics of barachois ponds captured under a sub-class system, support the functions and benefits provided by barachois ponds.

A recent shift in government regulations towards assessing wetland function over form has permitted a more rigorous assessment process for proposed developmental impacts, watershed planning, biodiversity assessments, wetland evaluations, and scouting potential restoration sites (Tiner, 2017). Despite acknowledging this, barachois ponds appear to consistently fall between jurisdictional and regulatory boundaries as a transitionary (brackish) water resource, and therefore warrant a distinct method for assessing their function and benefits (Hatcher, 2015).

Given that wetland inventories in Canada are based on visible wetland characteristics such as vegetation and standing water, they do not typically account for small, ephemeral systems such as barachois ponds (Hanson et al., 2008). Yet it is important to recognize the different forms and functions related to barachois ponds, for each may be subject to unique stressors or vulnerable to differing stressors at varying degrees (Fennessey et al., 2004). For example, it is critical to better understand the key characteristics of barachois ponds which are supportive of salt marsh ecosystems, as salt marshes are inevitably designated as WSS and often fringe the perimeter of barachois ponds (Hatcher, 2015; NSE, 2011).

5.2.1 Challenges to addressing this issue

If size as a sole qualifier for protection is maintained, situations may arise where the last pond containing a given characteristic becomes developed, going unrecognized under the current, generalized sub-classification system of tidal lagoons and barachois ponds. This becomes exacerbated by a functional assessment tool that may not be adequately capturing the

benefits of barachois ponds. While the classification of barachois ponds had gained momentum in 2013-14, shifts in departmental leadership, loss of funding and subsequent shift in management priorities for many of the involved organizations, halted the significant progress achieved by project practitioners. This included plans to collaborate across Maritime groups on the creation of a unified protocol for assessing coastal saline ponds (Hatcher, 2015; Personal communication, L. Young, November 2018). With barachois ponds under the purview of multiple jurisdictions such as provincial, federal, and First Nations, depending on how they are addressed, it is unsurprising that they are absent as a layer in the provincial wetlands landscape viewer. This, however, does not negate the need for capturing barachois ponds in an inventory using a sub-classification system.

The Canadian Wetland Classification Guide uses three hierarchical levels to classify wetlands: class, form, and type (Canadian Wildlife Service (CWS), 1996). However, the only wetland classification that most closely resembles coastal saline pond is *class* of marsh, *form* of tidal marsh, and *subform* of tidal lagoon marsh (NWWG, 1997). However, by virtue of the term "coastal saline pond", barachois ponds are inadvertently distanced away from tidal marshes… a step backwards in the pursuit of their conservation and protection.

5.2.2 Opportunities for addressing the issue

Populating a baseline inventory for barachois ponds is a critical step towards informing decision-making surrounding these ecosystems and providing evidence-based information for deciding on barachois ponds (de Groot et al., 2006; GOC, 1991). The time and financial costs required for completion of a barachois pond inventory may be large in the short term. However, having a baseline for monitoring environmental conditions, functions and benefits will be invaluable in the long-term, as climate change alters the sea and land interface (GOC, 1991; Fennessey et al., 2004). Further, understanding form and function of barachois ponds can lead to new knowledge and discoveries around prized salt marshes.

5.2.3 Recommendations

While coastal saline ponds as a class of wetlands in the NS WCP are delineated into barachois ponds and tidal lagoons, owing to key characteristics it is critical to establish a sub-classification scheme of coastal saline ponds that truly and effectively captures the sensitivity of each pond against development. As such, a sub-class system would be operative in tandem with a comprehensive inventory of barachois ponds.

At present, certain barachois ponds may not achieve status as WSS as they fail to meet the habitat requirements for classification as a "wetland" owing to their morphology such as rocky shoreline, barren sandy soils, and other unsuitable substrates for supporting wetland vegetation (personal communication, H. Higgins, September 2018). This is further exacerbated by instances where the "pond" or "lagoon" are technically defined as watercourses under the *Environment Act* owing to their depth greater than 2 m, shifting the requirements for alteration approvals to the Watercourse Alteration Program (Nova Scotia Environment, 2015). There are no establishments for Watercourse of Significance. Therefore, once again, barachois ponds fall through the jurisdictional means for attaining protection.

An inventory is an important tool in conjunction with Nova Scotia's No Net Loss (NNL) policy outlined in both the provincial and federal wetland conservation policy, whereby barachois ponds would be designated as avoid, replace, or compensate, based on numerous features (Austen & Hanson, 2007; de Groot et al., 2006). A sub-classification system for coastal saline ponds that recognizes the nuances of the diverse characteristics of each pond can be used to map their relative sensitivity against developmental impacts. Identifying and documenting the myriad of significant characteristics exhibited by each pond, and accounting for those within the alteration approval process, could avert certain barachois ponds from succumbing to negative impacts of undue alteration approvals.

The incorporation of a sub-class system into the development of an inventory of barachois ponds is critical, while recognizing the inefficiency of having multiple assessment protocols for every wetland class in the region (Fennessey et al., 2004). Identifying reference sites that are representative of an unimpacted state for each sub-class is critical for establishing benchmarks for achieving model ecological condition of each sub-class (Fennessey et al., 2004). The United States Environmental Protection Agency's Environmental Monitoring and Assessment Program

has a “rule of thumb” that 50 sites per class are needed to increase the adequacy of your sample (Fennessey et al., 2004).

To serve the needs of land and coastal managers, a sub-classification should be 1) flexible and adaptative, 2) professionally credible through experimental validation, 3) translatable into plain language, 4) logical, consistent, and objectively quantifiable, and 5) easily documentable, retrievable for decision-makers (Mader, 1991; Tiner, 2017). Additionally, owing to the importance of hydrology for defining wetlands and the myriad of functions and benefits they provide, hydrology should be described with explicit detail, addressing the void of detailed hydrological assessments of the diverse ecotones exhibited by barachois ponds across Nova Scotia (de Wit, 2011; Kjerfve, 1994; Tiner, 2017). Potential key parameters for inclusion in a sub-classification system of coastal saline ponds were suggested by numerous participants during the semi-structured interviews that followed the Q-sorts. They were;

> **(1)** Turnover time; Hours- days/ days- weeks/ weeks- months/ months- years (Note: Always average residence times to avoid skew from pulse events) (personal communication, Participant A1, 2-SD, Academia, July 2018).
> **(2)** Water source; Tidal input from inlets, overwash or spray, surface water inputs, groundwater inputs, area of watershed that drains into pond (personal communication, Participant A1, 2-SD, Academia; personal communication, Participant B10, 3-MR, Industry, July 2018; personal communication, Participant D23, 3-MR, NGO, July 2018).
> **(3)** Inlet characteristics; Width, depth, water velocity (personal communication, Participant A1, 2-SD, Academia; personal communication, Participant B10, 3-MR, Industry; personal communication, Participant D23, 3-MR, NGO). (Tip: Hard to typify or characterize with less than three sample sites (personal communication, Participant D23, 3-MR, NGO, July 2018)
> **(4)** Salinity; Salinity in defining types the ranges of biotic and abiotic characteristics (personal communication, Participant A1, 2-SD, Academia; personal communication, Participant B10, 3-MR, Industry; personal communication, Participant D23, 3-MR, NGO, July 2018).
> **(5)** Barrier characteristics; Height, width, composite, vegetation, closed/ open (personal communication, Participant A1, 2-SD, Academia; personal communication, Participant D20, 1-LTBC, NGO, July 2018).

(6) Biological characteristics; Fish species, invertebrates, benthos, zooplankton, submerged aquatic vegetation, fringent vegetation, halophytes (personal communication, Participant B10, 3-MR, Industry, July 2018; personal communication, Participant D23, 3-MR, NGO, July 2018; personal communication, Participant E33, 3-MR, Government, July 2018).

(7) Sediment chemistry; Hydric soils, nutrients, metals, bacteria, pharmaceuticals (personal communication, Participant B10 3-MR, Industry, July 2018).

(8) Pond characteristics; Depth, length and width, salinity at center point, secchi depth, pH, temperature, size of watershed (personal communication, Participant D23, 3-MR, NGO, July 2018).

(9) Historical/existing use, ease of public access, supports a fishery, size and dynamics of 'the feature' relative to shoreline processes (personal communication, J. Higgins, September 2018)

(10) Significance to the Mi'kmaq people (personal communication, Participant C19, 4-SBC, Local, July 2018)

These suggestions align with other classification types actively used across the United States, such as biological, physical, chemical, hydrogeomorphological, vegetation, hydrology, soil substrate, landscape position, landform (shape of wetland), and artificial (Tiner, 2017). In general, the use of ecological factors such as hydrology, soils, biota, and landscape setting form the basis for indicators used to define wetlands (Fennessey et al., 2004). Of particular note, is stability and sensitivity. Taylor and Shaw (2002) present a conceptual model for coastal barrier evolution for gauging shoreline stability. They have classified coastal barriers into five phases, 1- Initiation, 2- Growth, 3- Establishment, 4- Breakdown, 5- Stranding/collapse (Taylor & Shaw, 2002). Each phase denotes a level of stability against time and natural processes. Similarly, Shaw et al. (2006) divide shoreline types into sensitivity grades, contingent on the probability of succumbing to change from sea-level rise.

5.3 Wetlands of Special Significance— Social and cultural importance

The term 'value' implies a core belief, a principle, a preference for something or some state, the importance of something for itself or other, or a measure of something such as the number of

functions and benefits a barachois demonstrates (Kumar et al., 2017). Wetland of Special Significance is a designation for wetlands that "exemplify" or are "characteristic" of each wetland type and that are "strategic" or "essential" for meeting goals and objectives of the wetlands program (GOC, 1991). For a barachois pond to achieve status as Wetlands of Special Significance in the Nova Scotia Wetland Conservation Policy would require that it be: demonstrably associated with a salt marsh, be within a Wildlife Management Area, Provincial Park, Nature Reserve, Wilderness Area or other provincially protected area, be an intact restored wetland, be designated as a protected water area, or be known to support Species-At-Risk (NSE, 2011). Other considerations in NS are given to barachois ponds that support significant species assemblages, that support high wildlife biodiversity, that hold significant hydrologic value, or that have high social or cultural importance (NSE, 2011). The Federal Policy on Wetland Conservation similarly mentions designation as Wetlands of Significance to Canadians by which wetlands are designated through supporting water quantity and quality, habitat, wildlife, endangered species, human use, recreation, education and research, uniqueness, quantity, and more (GOC, 1991).

The tidal WESP-AC has a Public Use and Recognition indicator and serves as the only readily operative framework for wetland practitioners to assess social and cultural significance. Public Use or Recognition is identified as “the potential and/or actual ability for the wetland to support non-consumptive uses such as birding, education, or research, and/or sustainable consumptive uses such as hay harvesting or fishing” (Adamus, 2018b, p.50). Indicators of Public Use or Recognition include conservation investment, consumptive uses of provisioning services, mitigation investment, % visited daily by people, % never visited by people, sustained scientific use, and visibility (Adamus, 2018b).

Neither federal or provincial policies, however, possess tangible mechanisms for wetland practitioners looking to designate WSS using cultural or social significance, apart from the aforementioned WESP-AC. And less so are opportunities for formal public submissions.

5.3.1 Challenges for addressing this issue

Wetlands can only be designated as WSS given the availability of evidence for supporting that decision made by a wetland practitioner. Yet the current criteria for social and

cultural significance under the WESP-AC manuals are rarely applied in NS when designating salt marshes as WSS, much less barachois ponds (personal communication, J. Higgins, September 2018). A culturally diverse, consented-upon set of criteria and mechanisms for gathering, documenting, and interpreting social and cultural significance from individuals and groups, is absent for wetland practitioners in NS. Considering the breadth and depth of reasons barachois ponds are held in high regard as outlined in the results chapter and summary of key issues, the absence of inclusive and pro-active mechanisms for designating barachois ponds as provincial WSS is a disservice for reaching effective salt marshes conservation measures, and further restricts opportunities for generating meaningful environmental citizenry around critical resources.

5.3.2 Opportunities for addressing the issue

All 400+ barachois ponds have already been mapped along the Bras d'Or Lakes (Hatcher, 2015). Further, Mi'kmaq Ecological Knowledge studies have been undertaken surrounding barachois ponds, and numerous other sources exist that put forward social and cultural significance values for wetlands (Denny, 2013, Kumar et al., 2017; Pritchard, Ali & Papayannis, 2016). Yet the province requires the classification, delineation, and functional assessment of wetlands habitats as evidence for assigning WSS (personal communication, J. Higgins, September 2018). Establishing a set of criteria for assigning social and cultural significance that considered public input would enrich the protection and conservation of barachois ponds, and wetlands more broadly in Nova Scotia.

5.3.3 Recommendations

Invigorating WESP-AC with more robust Public Use and Recognition criteria would again require the re-calibrate and re-normalize of scores. While this seems overly unnecessary given the scope of the issue and therefore not feasible, social and cultural benefits should, at minimum, be captured in an inventory of barachois ponds. With relatively fragmented means for capturing social and cultural significance amongst wetland practitioners, admittedly less

opportunities for public participation exist within inventory mapping mechanisms that support WSS designation.

The province is receptive to working with traditional knowledge holders on identifying plant or animal species that have a high importance to First Nations peoples, but that are not listed as species of concern on any provincial or federal list (personal communication, J. Higgins, September 2018). A Mi'kmaq Ecological Knowledge study prepared by Mainland Mi'kmaq Developments Inc., outlined four criteria used to assess the significance of potential project impacts from a liquid natural gas project on Mi'kmaq use of the land and resources. They were, 1) Uniqueness of the land, 2) Culture or spiritual meaning of land or resource, 3) Nature of Mi'kmaq use of land or resource, and 4) Mi'kmaq constitutionally protected rights in relation to land or resource. The study also further breaks down Mi'kmaq land and resource use activities into five groupings (Mainland Mi'kmaq Developments (MMD) Inc., 2015a). 1) Kill/hunting, 2) Burial and birth, 3) Ceremonial, 4) Gathering food/medicinal, and 5) Occupation and habitation (MMD Inc., 2015b).

The Ramsar Convention also has guidelines for rapid cultural inventories for wetlands (Pritchard et al., 2016). Rapid cultural inventories are a scalable method for identifying, documenting, and making available information on the social significance of held values and practices affiliated with particular wetlands (Pritchard et al., 2016). Establishing a social inventory for wetlands in Nova Scotia would improve conservation and wise-use by enabling cultural significance of attributable ecological factors to be accounted for in the approval of WSS or an alteration. Protecting cultural heritage leads to more inclusive wetland management, while increasing public awareness and support for these ecosystems and their unique ecosystem services (Pritchard et al., 2016). Pritchard et al. (2016) identified an extensive list of social and cultural indicators with detailed elaborations on each one. A broad list, however, of indicators is shown in Table 8.

Table 8. Suggestions for social and cultural significance criteria for barachois ponds in Nova Scotia.

Social and cultural indicator	Reference
(1) Recreation and Tourism	(Ramsar Convention, 2012)

(2) Inspirational and Artistic	(Mallarach, Comas & de Armas, 2012; Ramsar Convention, 2012)
(3) Scientific & Educational	(Ramsar Convention, 2012)
(4) Habitation	(Ramsar Culture Working Group, 2008)
(5) Primary uses of wetland resources	(Ramsar Culture Working Group, 2008)
(6) Secondary use of wetland resources	(Ramsar Culture Working Group, 2008)
(7) Knowledge, Belief systems, and Social practices	(IUCN, 2012; Ramsar Culture Working Group, 2008)
(5) Cultural and Spiritual values	(IUCN, 2012; Mallarach, Comas & de Armas, 2012)
(6) Health and Recreation values	(IUCN, 2012)
(7) Aesthetic-perceptive or Scenic	(Mallarach, Comas & de Armas, 2012)
(10) Social: Historical, Ethnological and Governance	(Mallarach, Comas & de Armas, 2012)
(11) Oral and linguistic	(Mallarach, Comas & de Armas, 2012)
(12)Religious	(Mallarach, Comas & de Armas, 2012)

The inventory and sub-classification system of barachois ponds, along with the creation of more robust social and cultural significance criteria, will all contribute greatly to evolving the wetland alteration approval process.

5.4 Altering barachois ponds

Dredging barachois ponds, either mechanically or manually, is often undertaken to widen inlet for recreation, to purify water conditions or to oxygenate pond (Smakhtin, 2004). The primary environmental impacts of dredging, or the underwater excavation of sediment, include changes to the natural sedimentary processes, disturbances to and ultimately loss of benthos and invertebrates, as well as the modification of substrates that these organisms rely upon (James et al., 1999; Lamptey, 2011). Dredging can impact microbenthic organisms via compaction, burial or smothering from siltation of dredged material (Goldberg, 1989; Lamptey, 2011). Further, the

impacts of dredging encompass the dredged sites as well as the material dumping sites (Hall, 1994).

Contrastingly, new habitats may be created within the slopes and mounds of the dredged area (Lamptey, 2011). Given the above impacts, it is unsurprising that certain stakeholders could feel apprehensive regarding uncontrolled dredging of barachois ponds. During the 2013-14 rapid assessments of barachois ponds along the BDL, it was evidenced that water turnover times and exchange parameters are central in determining the ecological functioning of any given pond, specifically instances of marine water influx into a predominantly freshwater environment (Hatcher, 2015; Hatcher et al., 1987; Kjerfve & Magill, 1989; Smakhtin; 2004). The opening and closing of a barachois pond, an essential element to its existence, is the most important factor in determining the ponds' inherent ecology (Smakhtin, 2004). Therefore, limitless approval by NSE to alter any wetland under 100 m^2 without notification is concerning, given that small size does not inevitably equate to insignificance in ecological value.

5.4.1 Challenges to addressing this issue

While *Section 66, Approval and Notification Procedure Regulations* under the Nova Scotia *Environment Act* require approvals or notifications for activities that alter a watercourse, water resource, or wetland (Environment Act, 1994-95), the activities which require approvals or notifications listed under *Division 1- Water,* are caveated with exemptions that state: A person is exempt from the requirement to obtain an approval or provide notification in respect to activities (b) using seawater and (c) using brackish water from an intertidal zone of a river estuary (Environment Act, 1994-95). These exemptions seem inadequate for the protection of barachois ponds… Further, if the pond is deeper in size, and considered a watercourse, it is subject to different alteration approval processes than would a wetland, creating further regulatory obscurity (NSE, 2015).

Meanwhile, employing size as a valid trigger for protection elicited slight contention between two perspectives (Statement ID # 31), with some perspectives merely appreciating the regulatory efficiency, while acknowledging the uncertainties around the dependability of this approach. Another slight contention was between the 1-LTBC, that weakly disagreed that

dredging barriers to purify water conditions in oyster lease ponds is a valid reason for alteration, while the 2-SD moderately agreed that altering ponds to support oyster leases is valid (Statement ID # 2). Interestingly, during a barachois monitoring and site visit with Participant A1, 2-SD, Academia, the inlet had been evidently dredged in the week since Participant A1 had last been. Seeing people collecting data on their shorefront, the homeowner came down and briefly exchanged pleasantries and intentions with Participant A1 (us collecting data/ they, knowing the inlet was dredged).

> *One of the mechanisms [to improve our policy and legislation] is enforcement. That individual raking mussels, they shouldn't have been doing that. It's not a problem, no one saw them, and this isn't something [the Province] would take them to court for. It would need to be a much more egregious change before [the Province] got involved. And so, that person must decide in their head and heart… "those mussels are serving an important purpose there, and I should think twice about ripping them out and casting them off". Now at least acknowledging there's a trade-off, "A few mussels which we have no shortage of to increase the ventilation of the oyster pond that's in danger of choking.". Maybe they should be a hero! So that's what I meant about protocol. How is that person supposed to behave in the context of an existing policy that says, "you may not go out in the subtidal zone in front of your property and remove or alter the seabed… That's not within your set of rights or privileges". Apart from the policy, it would be helpful for that individual to have a protocol that shows some species you can never tamper with but that it's ok to keep this place ventilated if you don't use machinery. Maybe machinery is the issue. (Participant A1, 2-SD, Academia)*

5.4.2 Opportunities for addressing the issue

While differing perspectives exist between what is 'right' and 'wrong' when it comes to dredging barachois ponds, the consensus statement that barachois ponds are important ecosystems, highly regarded in the face of development (Statement ID # 44*), demonstrates that their outstanding values must be accounted for when authorizing alteration permits. Further, the consensus statement which shows that all perspectives agree that EIA processes are not burdensome to progress (Statement ID # 35), is positive for demonstrating that all stakeholders are receptive to the necessary regulatory requirements imposed when protecting barachois ponds.

Using areal indicators such as size of damage (<100 m^2 or >2 ha) when assessing the impacts of dredging and other alterations to barachois ponds, may not be adequate given the multivariate yet often ambiguous negative impacts from dredging lagoons, such as restructured

benthic communities and reformed sedimentary and chemical processes (Lamptey, 2011; NSE, 2011; NSE, 2013). *Section 110* of the Nova Scotia *Environment Act* allows the Governor in Council to make regulations respecting the infilling or alteration of wetlands, swamps, marshes, ravines or gulches, and the prevalence of this issue is only going to increase.

With unconsolidated cliff/shore erosion retreating on average 0.34 m/a (1973-2001), exceeding 1 m/a in areas with high wave action, there will be ample sediment budget for building beaches and infilling lagoons (Shaw et al., 2006). "Whether to dredge?" will be a question that arises as more and more ponds undergo infilling, shoreline hardening, construction, paving, shorefront development on public and private land, and increased need for waste disposal—simultaneously (Hatcher, 2015). Given the array of functions and benefits potentially going uncaptured, accounting for the perspectives revealed in this study regarding dredging activities is a significant starting approach for their valuation.

5.4.3 Recommendations

To combat the numerous unplanned instances of inlet and barachois pond alteration that are clearly taking place, something akin to a decision tree when seeking approval for dredging barachois barriers should be enacted for home owners and developers. While best management practices for development have been released, creating an online decision-tool platform whereby all relevant values are input as options, providing an interesting pre-planning tool (CBCL, 2014; EDM, 2008; UINR, 2011).

Aligning with the sub-classification system, developers and homeowners looking to modify their property should be aware of undertaking activities near barachois ponds with barriers in phase 4 or 5, as they are least stable, and ergo are the most sensitive to human activities (Taylor & Shaw, 2002). According to the study undertaken by Taylor and Shaw (2002), almost 44% of large coastal barriers were in Phase 4, necessitating the need for greater awareness around these barriers.

While it is acknowledged that that construction and maintenance do indeed impact barachois ponds (Statement ID # 10), the consensus statement that shows all perspectives very weakly agree that residential or recreational coastal development within 100 – 200 meters

negatively impacts barachois health (Statement ID # 12**), demonstrates a concern for best practices implemented during construction. For instance, it is important to record alterations in water circulation, in the distribution of sediment grain size, and changes in water quality including dissolved oxygen levels, temperature, turbidity, and pollutants (MBBF, 1994).

Figure 13 puts forward a planning tool for ranking hazards in accordance with risk levels, for instance, of key characteristics in the face of change and land-use impacts, etc. Figure 14 presents a social-environmental-economic cost-benefit analysis (CBA) tool for generating the true costs and benefits of a project or action. Using the hazard risk matrix and the social-ecological system CBA, in conjunction with a sub-classification and social and cultural inventory of barachois ponds, would provide significant added value to the process.

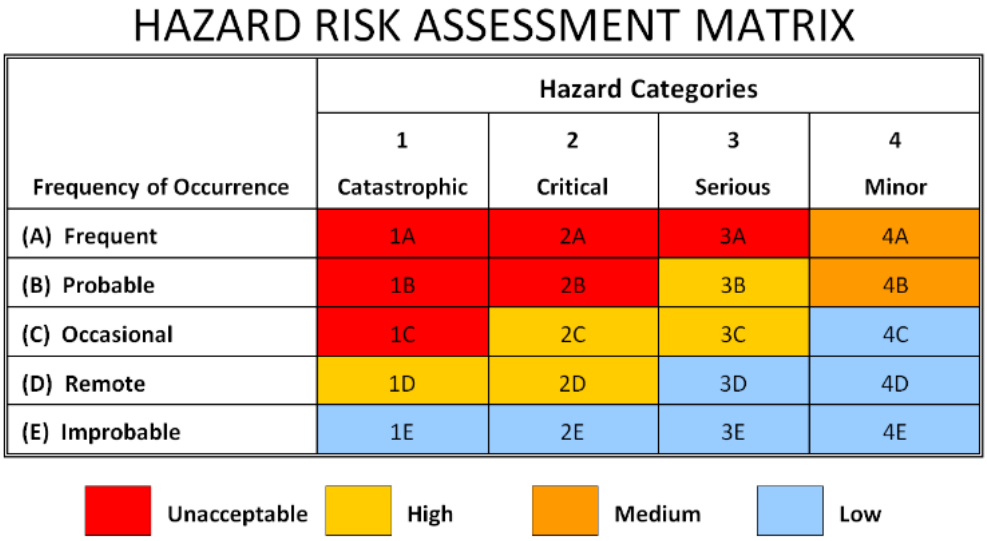

Figure 13. Hazard Risk Assessment Matrix. (1) Complete system loss, or irreversible environmental damage; (2) Major system damage, or reversible severe environmental damage; (3) System damage, or mitigatable environmental damage; (4) Minor system damage, or minimal environmental damage (Safety Management Services Inc., 2017).

When evaluating the costs-benefits analysis of state-change in a social-ecological system (SES) such as coastal lagoons, the use of unconventional yet well-adjusted economic tools ought to be used (Costanza, 2006; Berkes & Seixas, 2005). Using an SES CBA to evaluate changes to barachois pond's ecological state from development can better inform future strategies for building resilience such as: (1) learning to live with change and uncertainty; (2) maintaining diversity for resilience as insurance for the provision of key characteristics which facilitate adaptive renewal following a shock or disturbance; (3) drawing significantly from local and

traditional knowledge bases, experiences, and understandings, and (4) creating opportunities for self-organization through supporting mechanisms for social capital and collective action, and for integrating conflicting users into one conversation to enable a social, user-driven conflict management process for approving environmental alterations (Costanza, 2006; Berkes & Seixas, 2005; Hartwick & Olewiler, 1999). Considering SES CBA extends beyond the benefits of employing a social CBA, to include environmental considerations as well, leading to increased adaptive resilience within brackish water resource management (Costanza, 2006). The categorization of the accounted costs and benefits must be considered, therefore understanding the range of possible values is key (Costanza, 2006). Failing to account a broad spectrum of costs and benefits results in decisions that narrowly serve societal benefits (Costanza, 2006).

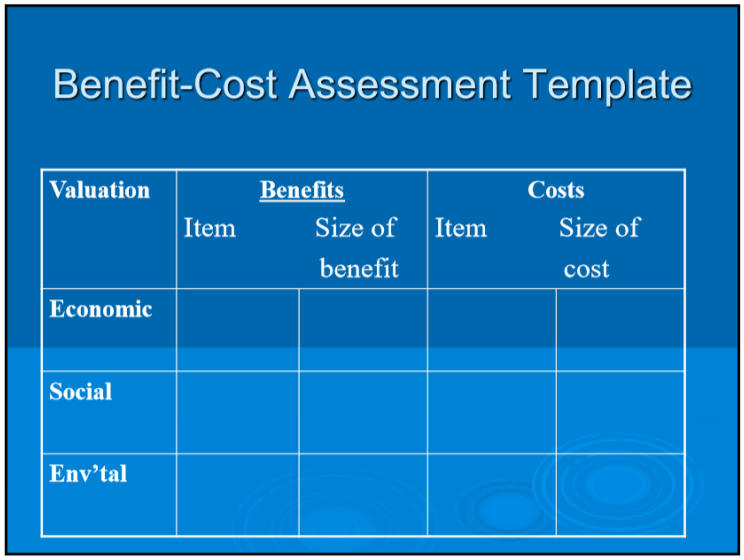

Figure 14. Social-ecological system cost-benefit analysis template (Fanning, 2018).

As outlined under the sub-classification systems, understanding sensitivity and stability of barachois ponds will also inform the eligibility of certain ponds for protection or development, by ranking ponds as; Red, highly productive, no development allowed; Yellow, moderate value, subject to mitigation or compensation, and; Green, development allowed subject only to mitigation (Figure 15) (European Communities, 2003).

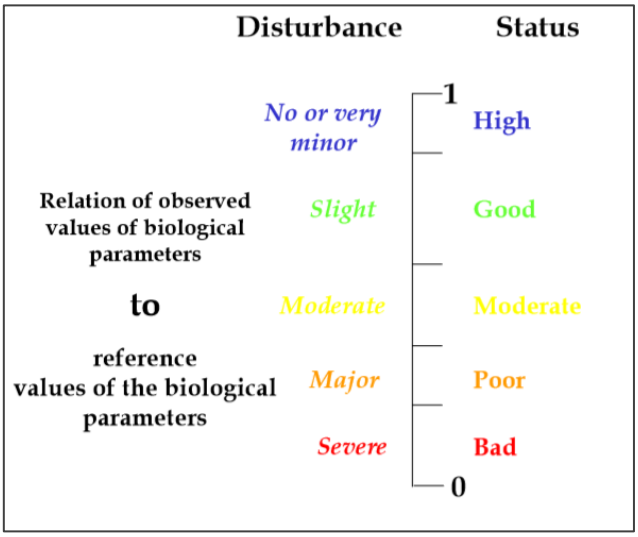

Figure 15. Qualitative values for ecological status of biological parameters (European Communities, 2003)

Ultimately, the sensitivity of coastal barriers depends on whether the barrier is currently erosional or depositional, its innate capacity to recover sediment alongshore or offshore-onshore, and whether there is space for accommodation to promote growth and establishment (Kjerfve, 1989; Shaw et al., 2006). These coastal geomorphic parameters create complex scenarios in and of themselves when justifying the protection of certain ponds, and increasingly so in the face of climate change. Yet, Statement ID # 13 demonstrates the need to consider climate change such as sea level rise, while TEK should also be used to inform climate change adaptation strategies (CEPI Steering Committee 2016). Finlayson et al. (2017) also presents six strategies for managing wetlands under climate change. These parameters should all be central to informing alteration approvals at the watershed scale in addition to size.

5.5 Coordinating integrated management

Integrated water resource management uses an ecosystem-based approach to delineate catchment or river basins as the management unit, to direct attention both up and down-stream, to monitor surface to groundwater and water quality interactions, to recognize the interconnectedness of water with other human and natural systems, and to engage stakeholders in the planning, management and implementation stages using environmental, economic and social lenses for analysis (Environment Canada, 2010; Mitchell, Priddle, Shrubsole, Veale, Walters,

Priddle, 2014). Incorporating governance and coordination mechanisms to facilitate integrated management is critical. Strong and effective leadership is required to develop and implement transparency, accountability, stakeholder involvement and knowledge transfer across jurisdictions (Environment Canada, 2010).

A lack of coordinated management and a call for more policies in place to protect barachois ponds begs the reiteration of an integrated management for barachois ponds across municipal, provincial, federal and First Nations governments (CEPI, 2006; UMA Group, 1989). Necessarily integrating the goals, objectives and tasks from each actor's plans into existing programs, structures and entities that affect lagoonal systems (Terwilliger & Wolflin, 2005). Facilitating voluntary guidelines, targeted policies, and consensus-based tools such as accords or protocols, all contribute to an integrated management toolbox (Terwilliger & Wolflin, 2005).

Federal Land Managers such as those operating within First Nations Reserve lands, can likewise seek the guidance from regional Environmental Conservation Branch officers for obtaining guidelines on wetland evaluations, integrating the federal policy into decision-making mechanisms, or for deriving environmental standards (CWS, 1996). Adjacent non-federal lands that are ecologically or hydrologically linked to federal wetlands may be priority candidates for conservation partnerships of stewardship programs (CWS, 1996). In many cases too, wetland inventory and evaluation databases already exist and can be accessed publicly (CWS, 1996).

Consensus Statement ID # 4**, that barachois ponds are vital for maintaining local biodiversity, offers a starting point for consensus-building and coming together. Many jurisdictions are indirectly adjoined by SARA, the Fisheries Act, and many other federal and provincial legislation designed to protect species at risk and habitats. Further, consensus Statement ID # 27* demonstrates that all perspectives acknowledged the importance of unmanaged development as negatively impacting barachois ponds. Strong sentiments that the EIA process is not burdensome for developers in Statement ID # 35 is optimistic for moving forward on more stringent, unified development protocols. Two consensus statements signal that most barachois ponds should be classified as WSS for supporting rare species at risk e.g. migratory birds and waterfowl, and because they are vital for maintaining local biodiversity e.g. muskrat, otters, birds, loons (Statement ID # 18**; Statement ID # 4**). Participants have noted nesting and other migratory activity on and around barachois ponds from turns, herons, wading

birds, rainbow gull, black back herring, mergansers, eiders, all sandpipers, semi palmate and piping plovers, curlew, yellow legs, all shorebirds, Arctic turns, roseate turns, and red wing black bird owing to the ponds ability to support eelgrass and subsequently eel, gaspereau, alewife (personal communication, Participant E32, 1-LTBC, 4-SBC, Government, July 2018; personal communication Participant D25, 1-LTBC, 3-MR, NGO, July 2018; personal communication Participant D20, 1-LTBC, NGO, July 2018; personal communication, Participant D23, 3-MR, NGO, July 2018). Using federal policies and legislation that protect and conserve biodiversity will be key for integrating management at the watershed scale.

5.5.1 Challenges in addressing this issue

To integrate all jurisdictions and policies related to wetland conservation and management is not realistic. However, key considerations should be given to the following discrepancies as being problematic for barachois pond management. Statement ID # 37 demonstrates the challenge facing the adoption of integrated resource management policies, when these ecosystems along with their functions and benefits, are so poorly understood. Other barriers to integrated management involve capacity and resources for taking on new authority, as well as social and political relationships such as participation, educating, training, and coordinating necessary agencies and stakeholders (Cervoni, Biro & Beazley, 2008; Mitchel et al., 2014). Past initiatives by Nova Scotia for integrated management have included the 2010 Water for Life Strategy and the establishment of the NS Water Advisory Group. While this strategy initiated the creation of needed resource management strategies across NS, they were under overly-short timelines or failed to adequately address the targeted issues (Cliché & Freeman, 2017). Land use regulations are an important aspect of reaching IRM. Figure 16 shows the extent of regulated Land-Use Zones in Cape Breton. Unsurprisingly, with only a portion of the watershed experiencing regulated land-uses, the difficulty of enacting management at the watershed scale through coordinated regulations regarding land-use activities at the municipal level is difficult. Particularly for any given municipality to take the lead (personal communication, E31 Government, July 2018).

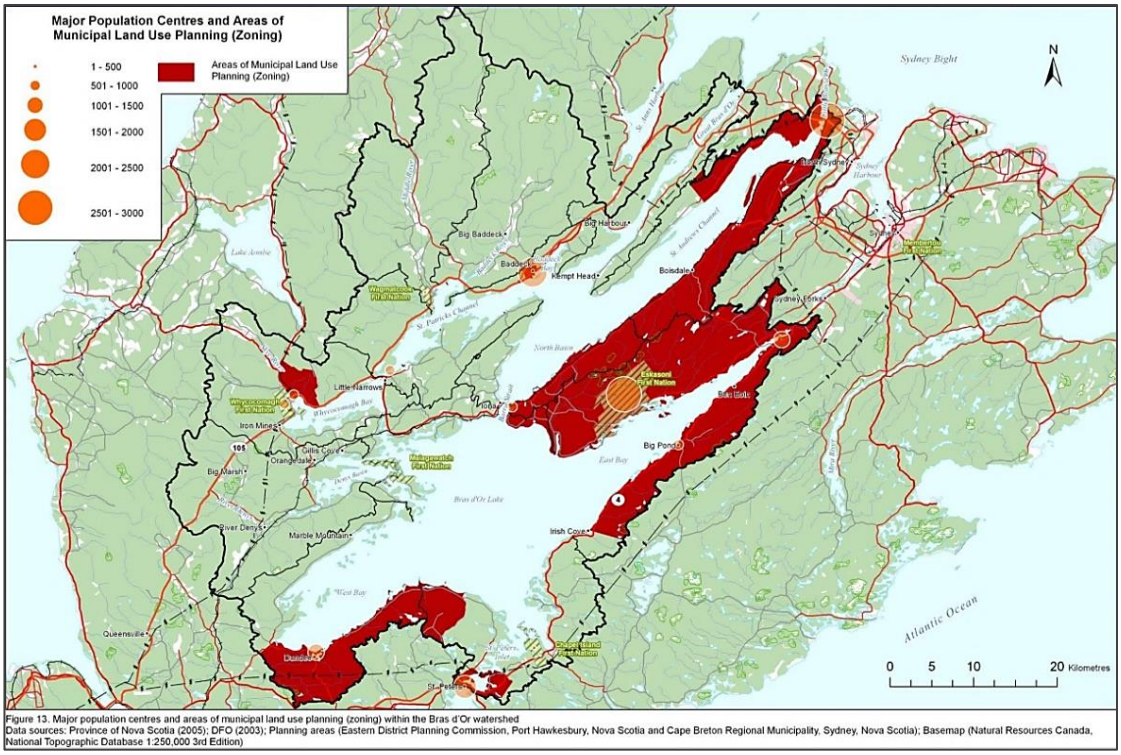

Figure 16. Major population centres and areas of Municipal Land Use Planning (Zoning), Bras d'Or Stewardship Society, n.d.

5.5.2 Opportunities for addressing this issue

Conversely, the Bras d'Or Lake watershed is an ideal candidate for combating a "one size fits all" approach, given the complexity of multi-jurisdictions working in such a relatively small area on a myriad of affairs directly and indirectly related to barachois ponds. Addressing local circumstances in integrated management is critical for identifying suitable management regimes that account for local political, social, and historical factors (Cervoni et al., 2008). Major indicators for measuring anthropogenic impacts to watersheds include road density, surface and ground water usage, length of road within 100 m of streams, stream-road crossing, road length on erodible soil, proportion of stream bound by human use, acidification index, proportion of watershed with human land-use, and proportion watershed with erodible soils (Hydrologic Systems Research Group, 2011) (Figure 17).

It is positive to note how relatively 'green' CB is, and interesting to note that it is yellow in areas with LUP.

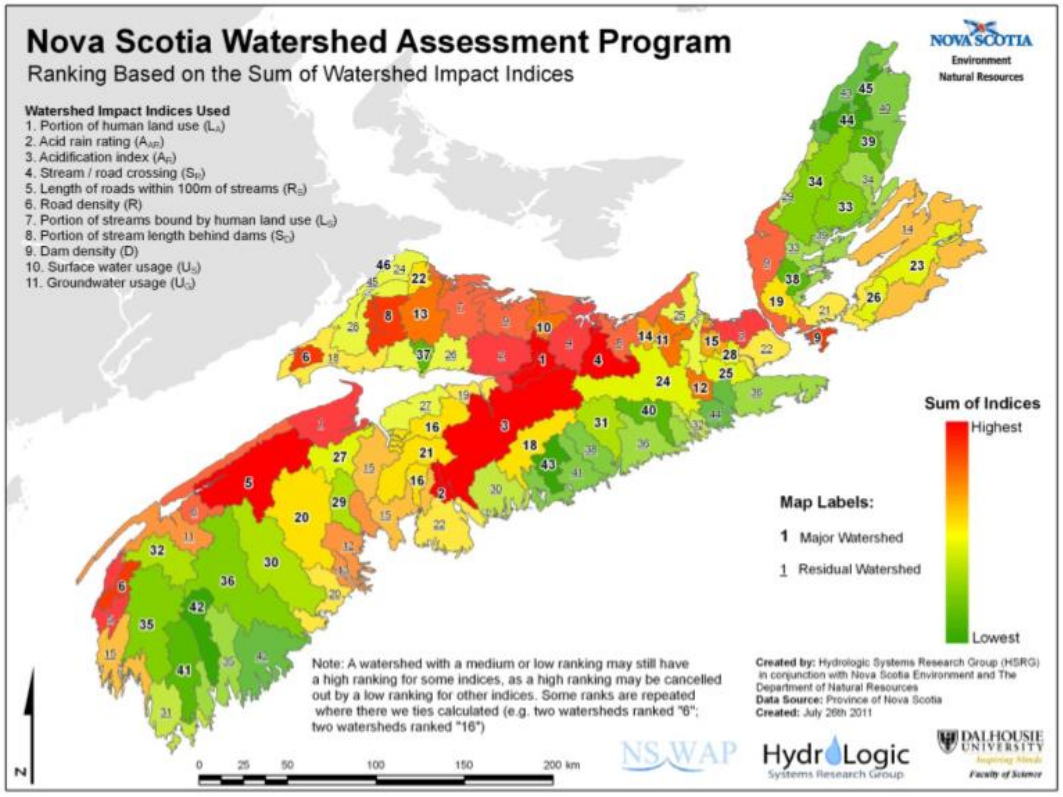

Figure 17. Major indicators for watershed health for the province of Nova Scotia (Hydrologic Systems Research Group, 2011)

The integration of water science is critical for further developing environmental policies, regulations, guidelines, instruments and tools, invigorating cross-sectoral linkages between scientists and decision-makers for barachois ponds (Environment Canada, 2010). Participants felt that Mi'kmaq Traditional Ecological Knowledge was a critical missing component from existing initiatives around barachois ponds (personal communication, Participant A8, Academia, July 2018; personal communication, Participant D20, NGO, July 2018; personal communication, Participant D22, NGO, July 2018). Therefore, it is optimistic to have CEPI, operating with such momentum, working on the implementation of an integrated management plan for the Bras d'Or Lake by mobilizing the vision of the Bras d'Or Charter into action (CEPI, 2011). As well as the Unama'ki Institute of Natural Resources (UINR), established by the Eskasoni Fish and Wildlife Commission, to represent the five First Nations communities on matters relating to the management and stewardship of resources in Unama'ki (Hatcher, 2018). The Pitu'paq

Partnership for clean water and the Bras d'Or Lake Biosphere Reserve Association for its work designating the Bras d'Or watershed as a UNESCO site (Hatcher, 2018). The Bras d'Or Preservation Nature Trust is tasked with protecting environmentally significant private lands in the BDL watershed (Hatcher, 2018). They have a further mandate to educate locals and visitors on the significance ecological and cultural heritage value of the BDL (Hatcher, 2018). And finally, the Bras d'Or Stewardship Society, promoting environmental stewardship of the Bras d'Or Lake (Hatcher, 2018). This is significant momentum already in place for management at the watershed scale!

5.5.3 Recommendations

Embracing core principles for an ecosystem-based approach such as flexibility, adaptiveness, easily reversible, no-regret or low-regret options, consideration for cumulative impacts, engaging communities and Aboriginal peoples, shared responsibility, proactivity, and a combination of centralized and watershed-based decision-making processes, are all foundational for advancing integrated management (CCME, 2016; DFO, 2002; Finlayson et al., 2017). Other core principles include Netukulimk, a Mi'kmaq philosophy to guide respectful resource use by taking only that which is needed (McMillan & Prosper, 2016). It is also greatly important to incorporate the "Spirit of the Lake Speaks" into decision-making, as it is guided by the Mi'kmaq medicine wheel to incorporate spirit, knowledge, feelings and action, as well as two-eyed seeing to solve complex issues (CEPI, 2011). To fully reach integrated management, is important to meaningfully and respectfully include Indigenous knowledge systems (ITK) and local and traditional ecological knowledge into decision-making (McMillan & Prosper, 2016; Houde, 2007; Pyke et al., 2018). Several other factors however, must also be addressed for coordinating truly integrated management.

First, the differences in definitions of coastal saline ponds between the Nova Scotia Wetland Conservation Policy and the Canadian Wetland Classification Guide must be acknowledged to overcome any inconsistencies when referencing barachois ponds.

Second, tidal WESP-AC and non-tidal WESP-AC are insufficient on their own to adequately capture important functions and benefits of barachois ponds, particularly along the Bras d'Or Lakes where tidal range is so narrow (Petrie, 1999; Shaw et al., 2006). All wetland practitioners working with these ecosystems should ensure they are using a protocol that adequately captures the functions, benefits, and social and cultural values exhibited by each barachois pond.

Third, certain municipalities have mandates within their Municipal Planning Strategies to undertake watershed-scale management (though mostly to achieve source water protection), as well as to instill developmental buffers and setbacks for protection of aquatic resources and watercourses, while others do not. While most municipality's have prepared Integrated Community Sustainability Plans, a 7th Provincial Statement of Interest empowering autonomous action from municipalities for implementing integrated management at the watershed-scale should be created. This PSI must enable watershed scale management and multi jurisdictional partnerships for brackish water resource management. Memorandums of Understanding (MOU) between the province and the municipalities on climate change mitigation strategies as well as salt water, shorelines, or fresh water jurisdictional management issues have been used in the past for overcoming such issues (CEPI Steering Committee, 2013; Rideout, 2012; Lukens, 2000).

Fourth, the management of barachois ponds on First Nations Reserve lands is equally disjointed across each Band as it across each municipality with regards to authorizing developmental approvals and best management practices. Some Bands have best management practices, others have minimal regulations for land use activities in the watershed, others have adapted provincial building codes, while few have opted to adopt Land Codes (Hykin & Bendle, 2016; CEPI, 2011). An Indigenous wetland division or advisory committee using the Federal Policy on Wetlands Conservation Implementation Guide for Federal Land Managers and established best practices for land-use activities in collaboration with the Band Councils and AANDC, could improve coordinated management of barachois resources across First Nations lands. The Mi'kmaq Confederacy of Prince Edward Island, for instance, has an Integrated Resource Management (IRM) division tasked with offering technical advice and assistance for all facets related to resources and resource management (Mi'kmaq Confederacy of Prince Edward Island, 2018). While UINR has a wetland division, they are not frequently called upon by Band governments and developers for insights into responsible coastal development practices.

The link between one's will to develop responsibly, and those who can provide advice must be made more evident.

Fifth, the environmental triggers typically used to identify jurisdiction are not entirely sound for barachois ponds. For example, relying on environmental characteristics to trigger management is confounded by the diversity of ecotones characteristic of barachois ponds. For example, the province is triggered by freshwater and saltwater wetlands and watercourses, while the federal government is triggered by fish and fish habitat. Meanwhile barachois ponds' place in the landscape triggers management from municipalities on privately owned lands and First Nations as they occur on Reserve lands or implicate traditional lands (de Wit, 2011; Hykin & Bendle, 2016). MOU's could serve as an acknowledgement of responsibility with regards to critical, yet frequently dynamic ponds.

Sixth, while Nova Scotia Environment is the lead regulator in the province for wetland management and compliance, many participants were unsure which provincial department actually had authority over barachois ponds. This is because their jurisdictional authority is 'action' related as opposed to environmental, whereby Nova Scotia Environment exerts authority during management and enforcement related activities, while Nova Scotia Department of Lands presides over inventories and conducting studies; this relationship should be more clear to others.

5.6 Educating Stakeholders

Given that barachois ponds are perceived as significant features that add value to the landscape, but that their ecological and regulatory complexity are not well-understood, it is unsurprising that many perspectives strongly agreed that there ought to be more educational initiatives promoting barachois ponds (Statement ID #s 20, 37, 51, 3, 29). The fact that Statement ID # 37 confirms most people do not know what barachois ponds are, both supports and challenges the enactment of an education initiative around barachois.

5.6.1 Challenges for addressing this issue

While certain barachois ponds have been assessed, the difficulty is sustaining ongoing monitoring after the fact. Community-based monitoring programs are one option for overcoming

this issue (personal communication, Participant B10, 3-MR, Industry, July 2018). However, to be successful, they require robustness and standardization of the inventorying procedures, a level of interest from politicians and decision-makers on the outcomes of the program, willing participants from school boards, students or locals, non-governmental organizations and the province, consistent funding sources, the continuation of programming, a strong communications coordinator to disseminate results back to decision-makers, and specific and culturally responsive evaluation techniques for each program objective (Sharpe & Conrad, 2006). While this is much to overcome for populating a barachois pond inventory, it is achievable.

5.6.2 Opportunities for addressing the issue

Barachois ponds are ideal candidates for integrating cultural knowledge and scientific inquiry, including medicinal and edible plants, weather, seasons, animal behavior and habitat, tides, erosion and relocation, snow and ice (Stephens, 2003). Yet participants felt that Mi'kmaq Traditional Ecological Knowledge (TEK) was a critical missing component from existing initiatives around barachois ponds (personal communication, Participant A8, Academia, July 2018; personal communication, Participant D20, NGO; personal communication, Participant D22, NGO). Barachois ponds and their unique components are predisposed for learning (Stephens, 2003). As such, the ponds have been highlighted in Bras d'Or Watch, a citizen science initiative created by the Bras d'Or Lake Biosphere Reserve Association (Atlantic Coastal Action Program (ACAP), 2018). Other initiatives include a trail system project planned along the Bras d'Or Lake guided by Msit No'kmaq (we are all related) and the Bras d'Or Lake Biosphere Reserve (BLBR) for ensuring all is connected (Hatcher, 2018). Focusing on barachois ponds for learning offers opportunities to record empirical observations and data in nature, recognize patterns between sites and across years, verification through repetition, infer and predict changes, learn about plant and animal behavior, life cycles, and habitat needs and the interdependencies between them (Stephens, 2003).

Meanwhile, under the provincial wetlands program, a project proponent who alters or destroys wetlands must generally restore a minimum of 2:1 wetland function (NSE, 2011). However, this is not always possible given the limited viable land available for such exchanges. To address this, NSE has established alternative means to meet the requirements for the 2:1 wetland compensation program, by permitting certain projects that "develop public education

materials" and "conduct or support wetland research", to count as valid wetland compensation projects (NSE, 2017).

The Department of Natural Resources led the 2013-14 barachois pond inventory, where high-school students were data collectors during a rapid assessment of 150 of the 400 ponds, refining their skills as scientific field technicians, while helping to populate the provincial inventory. While much can be learned from that initiative, it is positive to note that this has already been approved as a valid approach for data collection for populating the provincial inventory (CEPI Steering Committee, 2014). For all reasons combined, barachois ponds are the perfect subject matter for a proposed, two-eyed seeing, integrative science wetland inventory program.

5.6.3 Recommendations

The creation of an integrative science Toqwa'tu'kl Kjijitaqnn / two-eyed seeing Etuaptmumk wetland inventory program for high school students, could help meet four critical needs: greater educational initiatives around barachois ponds that account TEK; the need to include barachois ponds in the provincial wetland inventory; a lack of guidance for shaping culturally appropriate criteria for social and cultural importance; and Nova Scotia Department of Environment's need for alternative wetland compensation projects. The proposed summer-program would span two years, nominating grade 10 students who would complete the program in their 11^{th} year. This time-span is necessary to address issues and concerns in data verification processes across years, ensuring an element of consistency in data sampling and recording procedures, while providing opportunities for peer leadership and mentorship.

Barachois ponds are ideal candidates for teaching culturally responsive science curriculum outcomes (Stephens, 2003). Exploring barachois ponds through dual knowledge systems; the Indigenous and the Western knowledge systems, for populating provincial wetland inventory of barachois ponds effectively merges respect, relationships, reverence, reciprocity, repetition and responsibility with hypothesis testing, data collection, data analysis, and model and theory building (Bartlett, Marshall, Marshall & Iwama, 2015; Institute for Integrative Science & Health, 2007). The two-eyed seeing approach holds potential to expose youth to embracing moral rights regarding animals, habitats, and nature more broadly, while providing meaningful social and cultural as well as immersive experiences with nature, all factors known to

deeply affect human capacity to form relationships with the natural world (Chawla, 2009). These formative experiences can work to break down the separation between self and nature, while promoting shared perspectives and compassion for different cultures, genders, race, species and even habitats (Chawla, 2009; Fawcett, 2002). Further, this program could promote a sense of efficacy or the confidence that one can solve the problems they face and improve their lives through by unifying efforts, mastering new experiences, and succeeding vicariously through peers during peer leadership (Chawla, 2009). To comply as a wetland compensation program, the program must develop specific, measurable, attainable, relevant, time-bound (SMART) objectives for measuring the numerous program outcomes (personal communication, J. Higgins, September 2018; NAAEE, 2009). Table 10 provides various action words useable for attaining unique learning outcomes.

Examples of Action Words Used to Help Set Objectives for Different Levels of Learning					
KNOWLEDGE	COMPREHEND	APPLY	ANALYZE	SYNTHESIZE	EVALUATE
define	discuss	demonstrate	distinguish	design	appraise
record	explain	employ	debate	construct	assess
list	differentiate	illustrate	calculate	create	judge
name	identify	translate	diagram	propose	predict

Table 10. Action words for creating different learning outcomes (NAAEE, 2009).

First, the program will require an evaluation that demonstrates the project is effectively meeting the requirements of the wetland compensation program. Second, the data and metadata must be verified and quality-checked for use in the provincial wetland inventory (Ballard, Dixon, & Harris, 2016; Sharpe & Conrad, 2006). Third, an evaluation is required for demonstrating the retention and value of two-eyed seeing and integrative science concepts for youth. Fourth, the program itself as using a youth-focused integrative citizen-science approach to inventorying wetlands must be evaluated. This overall program evaluation must come from both the facilitators as well as the students, to necessarily begin crafting a rubric for how students assess environmental activities and programs (Chawla, 2009). It is further critical to devise evaluations that reflect the unique contextual socio and political factors within which the summer camp operates (Carleton-Hug & Hug, 2010). However, it is critical when working with culturally

diverse groups, that evaluation methods should be culturally responsive and diversified (Stephens, 2003). Methods for evaluating such programs are shown in Table 11.

Table 11. Environmental Education Evaluation Methods.

Evaluation methods (*= culturally responsive)	Reference
Observed behaviour of students whenever possible	(Chawla, 2009)
Checklists	(Hug & Hug, 2010)
Evaluation frameworks such as MEERA (My Environmental Education Evaluation Resource)	(Hug & Hug, 2010)
Indicators	(CCL, 2010; Hug & Hug, 2010)
Performance tasks	(Stephens, 2003)
Informal interviews*	(Hug & Hug, 2010; Stephens, 2013)
Informal discussions*	(Stephens, 2003)
Concept mapping*	(Stephens, 2003)
Self evaluations*	(Stephens, 2003)
Journal and learning logs*	(Stephens, 2003)

Barachois ponds could be further highlighted, invoking public interest, in the Treasured Wetlands of Nova Scotia program with Ducks Unlimited and the Nova Scotia Department of Lands and Forestry (personal communication, Participant D25, 1-LTBC, 3-MR, NGO, July 2018). Barachois ponds could be characterized as an extension of the children's book, The Oyster Garden, Kiju' Tells Her Story (UINR, 2016). They could also be included as interpretative signs in conjunction with Mi'kmaq youth and Elders, or in education resources on the Bras d'Or Biosphere that had been planned in schools, or included in stories and legend creating (CEPI, 2015). Along with a UNESCO portal for ocean literacy and a new national coalition for marine education, there are numerous avenues to pursue for creating an education initiative around barachois ponds (Canada Ocean Literacy Coalition, 2018; UNESCO, 2017). The final question within the semi-structured interview following the Q-sort exercise asked, "How would you like to see this information used?" Numerous participants expressed their desire for greater public education and outreach initiatives. For the full list, refer to Appendix 4.

CHAPTER 6. CONCLUSION

This research provides a rigorous account of the individual perceptions and dominant perspectives around the management of barachois ponds in Cape Breton from five stakeholder groups. The multitude of perspectives and values, uncovered as Q-sort data, are mobilized into the construction of six key issues that hinder effective management of barachois ponds in Nova Scotia. To recap, the six issues include: 1) the need for an adaptation of Wetland Ecological Services Protocol for Atlantic Canada (WESP-AC) specifically designed for functional assessments of barachois ponds in Cape Breton; 2) the need to include barachois ponds within the provincial wetland inventory using a more comprehensive sub-classification; 3) the need for more robust social and cultural importance criteria for designating Wetlands of Special Significance, and greater opportunities for public input; 4) the need to instill greater rigor into the permitting and approval processes for barachois pond alterations; 5) the need to coordinate integrated management at the watershed scale, collaborating land-use activities across all relevant jurisdictions; and 6) the need to educate stakeholders on the value of barachois ponds through innovative outreach initiatives. Yet, given limited resources and narrow mandates for addressing all issues, simply understanding the key issues may not be relevant… and therefore, requires further distillation. Consequently, to refine management priorities, five statements that recurred during the formation of the six key issues are put forward as critical starting points for all future management strategies.

The first was already noted, that barachois ponds are strongly and very strongly regarded as significant features that add value to the landscape (Statement ID # 20). These are worthy elements on the landscape and warrant additional protection. Second, perspectives felt strongly and very strongly that climate change poses imminent threats to barachois ponds in Nova Scotia (Statement ID # 13). Heeding all Municipal Climate Change Action Plans and the Bras d'Or Lakes Development Standards is a minimum, while continual revision and adaptation of plans in the face of new knowledge is ideal. Third, two perspectives strongly and very strongly disagreed that there is adequate policy and legislation for protecting barachois ecosystems (Statement ID # 30). Integrated resource management at the watershed scale is an essential management priority for achieving sustainable development of important transboundary resources. Memoranda of Understanding should be enacted across municipal and provincial, provincial and First Nations regarding formal jurisdiction over certain brackish water systems. Further, given that barachois

ponds demonstrate significant social and cultural values, more robust criteria for WSS designation and greater opportunities for public input should be enacted, integrating environmental citizenry with conservation policies. Fourth, size is strongly and very strongly perceived as inadequate as an indicator for measuring the value or worth of barachois ponds and coastal lagoons (Statement ID # 31). This is exacerbated when the functional assessment protocols for ensuring all benefits and functions of aptly sized wetlands are captured, are not adequately capturing the barachois pond's most protected ecotone; the salt marsh. As an alternative to size as a measure of value and worth, implementing a comprehensive sub-classification system that recognizes the relationships between key characteristics and functions and benefits is strongly advised. And, fifth, it is critical to protect naturally occurring barachois ponds as they are not readily 'tradable' within the No Net Loss policy (Statement ID # 33). Despite this, it is acknowledged that pursing an education initiative under the guise of NNL would serve as an effective means to build and expand a provincial barachois pond inventory.

The subsequent loss and devastation of barachois ponds that will occur in time if watershed-scale management is not implemented, poses consequences for the entire Bras d'Or Lake Biosphere Reserve. Designation as a BLBR serves to commemorate the values and significant efforts upheld by the Bras d'Or Lake Biosphere Reserve Association (BLBRA) and CEPI, who are working tirelessly at implementing sustainable management practices and principles for balancing wellbeing of people with environment, and educating and informing future actions. Yet, despite significant advancements in coordinating integrated management at the watershed scale, these efforts and corresponding funding mechanisms must not only persist but must expand to include barachois pond ecosystems. Becoming enlightened to the perspectives of the individuals residing amongst and using barachois ponds is invaluable for generating political buy-in and securing long-term financing mechanisms for groups and departments working towards their protection.

It is important that regulators and politicians take note that clean, healthy barachois ponds ecosystems are highly valued by all perspectives. It is not enough to understand a perspective, however. Perspectives must be mobilized into action through all appropriate channels. Interestingly, given the uncertainties surrounding the precise ecological values of barachois pond ecosystems, their social-ecological values are known, and ready to become mobilized into action.

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APPENDICES

Appendix 1 Closing interview script

Thank you for completing the Q sort. I appreciate all the time and focus you deliberately used to sort each statement, well done!

We will conclude the exercise with a brief interview of 4 questions to help me gain a sense of your thoughts and motivations behind your sort. We will only discuss the Q statements you placed in the -5 and +5 and the -4 and +4 columns. The interview is recorded and will last upwards of 10 minutes.

Question 1- What were the deciding factors that helped you determined these statements as being the most agreeable?

Question 2- What lead you to sort these statements as being the least agreeable?

Question 3- Were there any statements or perspectives that you felt were missing or not well represented within the Q sample?

Question 4- How would you like to see this information used?

Thank you so much for all your time. I will send you a summary of the results once they are available.

Take care.

Appendix 2. Significant loadings of all participants under their corresponding perspectives.

Participants who loaded significantly on any given factor are marked by an 'X' and bolded. Participant IDs that appear in bold signifies a confounding sort, or that the individual loaded significantly into more than one perspective. A factor score of 0.5< was considered significant.

Participant ID and Stakeholder Affiliation	**1) Let-them-be Conservationists**	**2) Sustainable Developers**	**3) Management Reformists**	**4) Science-based Conservationists**
1. A1; *Academia*	-0.0412	**0.7458X**	0.2624	0.2196
2. A2	**0.6867X**	0.2421	0.1512	**0.5073X**
3. A3	**0.6247X**	0.2178	0.1973	0.4942
4. A4	0.3642	0.4784	0.0541	**0.6210X**
5. A5	0.4884	0.2676	**0.5440X**	0.2968
6. A6	**0.5242X**	0.2077	0.3561	0.4085
7. A7	0.4902	-0.1560	**0.5735X**	0.3544
8. A8	0.2134	0.0545	**0.5443X**	**0.6485X**
9. B9; *Industry*	0.2710	**0.5079X**	0.3332	0.2733
10. B10	0.0385	0.2400	**0.7767X**	0.2830
11. B11	0.4718	0.0350	0.2822	**0.5800X**
12. B12	0.0940	0.3758	0.2561	**0.7022X**
13. B13	**0.5547X**	0.2107	**0.6542X**	0.2427
14. B14	**0.6368X**	0.4232	0.2571	0.4353
15. C15; *Local*	0.3151	**0.5673X**	0.3677	0.4647
16. C16	0.1398	**0.7647X**	0.1231	-0.0033
17. C17	**0.7340X**	0.0967	0.1305	0.1347
18. C18	0.2920	0.0571	0.3758	**0.7055X**
19. C19	0.3755	0.4333	0.3564	**0.5438X**
20. D20; *NGO*	**0.5893X**	0.2896	0.3826	0.3030
21. D21	0.3666	0.4332	0.4895	0.4027
22. D22	**0.7494X**	-0.0631	0.2684	0.2634
23. D23	0.4127	0.2858	**0.6868X**	0.1392
24. D24	0.4501	0.1718	**0.5224X**	0.4662
25. D25	**0.5901X**	0.2574	**0.5553X**	0.2897
26. D26	0.4868	0.1100	0.2295	**0.6297X**
27. D27	**0.6096X**	0.4355	0.3388	0.2499
28. E28; *Government*	**0.5391X**	0.2458	**0.5897X**	0.1416
29. E29	0.4951	0.2313	0.3724	**0.5163X**
30. E30	0.4031	0.3116	**0.6184X**	0.3841
31. E31	0.1020	0.2674	**0.7655X**	0.3195
32. E32	**0.5413X**	0.2677	0.2360	**0.6233X**
33. E33	0.3880	0.3588	**0.5976X**	0.1128
% Explained Variance	**22**	**12**	**20**	**18**

Appendix 3. Consensus statements.

Consensus Statements p<0.01**		**1**	**2**	**3**	**4**
4	Barachois ponds are vital for maintaining local biodiversity e.g. muskrat, otters, birds, loons.	4	5	4	5
12	Residential or recreational coastal development within 100 – 200 meters negatively impacts Barachois health.	1	1	1	2
16	Upland owners should be consulted when the development of Barachois ponds is being considered.	0	1	2	0
18	Most Barachois should be classified as wetlands of special significance for they support rare species at risk e.g. migratory birds and waterfowl.	4	3	2	3
32	The water in Barachois ponds is stagnant and/ or full of undesirable marine plants / algae.	-2	-4	-3	-4
33	Protecting naturally occurring Barachois ponds is not critical as they can be artificially constructed, even matching ecosystem function.	-4	-5	-4	-3

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Consensus Statements p<0.05*		**1**	**2**	**3**	**4**
3	Barrier beaches that define Barachois ponds are important ecosystems in their own right.	4	3	4	4
14	Barachois promote salt marsh wetlands by facilitating hydrophytic vegetation, e.g. plants that are adapted for life in saturated soils such salt water cordgrass, sedges and rushes.	2	3	3	2
27	Unmanaged growth is an important driver of negative environmental impacts on Barachois ponds.	2	3	2	2
34	In general, the majority of Barachois change form notably from year to year from wind storms and storm surges.	0	0	2	1
38	Barachois ponds do not hold as much value if they have been altered by a single storm event.	-2	-3	-3	-2
40	Barachois have been negatively affected by lowered investments in wastewater treatment facilities.	0	1	0	-1
42	Incompatibilities between professional and recreational fishing are negatively affecting fish, shellfish, and bait resources.	-1	-1	0	0
43	Fishing in Barachois ponds has local economic and social importance and is even perceived as additional income for some families.	0	1	1	2
44	Many Barachois ponds should be filled in and developed to support a variety of regional economic developments.	-5	-5	-5	-4

Appendix 4. Education strategies extracted from participant's answers to, "how would you like to see this information used?", following completion of their Q-sort exercise.

Target audience	Education piece	Participant ID
School children	Science programs, science camps, Guardian programs.	Participant C15, 2-SD, Local
Kids	Books.	Participant E28, 1-LTBC, 3-MR, Government
5-15 years old	Field trips. The natural world is more appealing to younger folks.	Participant E29, 1-LTBC, 4-SBC, Government
Kids, tourists	Apps, pamphlets.	Participant A8, 3-MR, 4-SBC, Academia
Elementary school children	Elementary school chapter on barachois ponds, general knowledge and best practices.	Participant A5, 3-MR, Academia
Municipal staff, Councillors and Elected officials	Provide a summary report.	Participant E32, 1-LTBC, 4-SBC, Government
Municipal Councillors	Inform on the value of protection and ecologically sensitive areas using dollars and cents lens.	Participant E31, 3-MR, Government
Municipal Councillors, Planning departments	Made aware of the importance of barachois ponds.	Participant D20, 1-LTBC, NGO
Provincial regulators	Inform government policy.	Participant D23, 3-MR, NGO
Regulatory folk	Published technical report or executive summary report.	Participant B13, 1-LTBC, 3-MR, Industry
Policy makers, politicians, cottage & home owners	Published in a peer-reviewed journal, white paper translation.	Participant D21, No Perspective, NGO
Developers and homeowners	Coastal development guidelines that cover the dynamics of shorelines.	Participant C16, 2-SD, Local
Industry members	Promote the scientific/ cultural/ economic uses of barachois ponds.	Participant B9, 2-SD, Industry
Managers	Develop policies relating to the ecological, social, and cultural values.	Participant D24, 3-MR, NGO
Bras d'Or Lake Biosphere Reserve Association	Make barachois ponds a larger part of the Biosphere Reserve's story.	Participant B11, 4-SBC, Industry
First Nations, general	Reflect the two-eyed seeing approach.	Participant D22, 1-LTBC, NGO

General	A story, song or dance that doesn't promote myths and legends, that doesn't pretend we know everything, but that doesn't get bogged down in the qualifiers, all while making bold statements.	Participant D20, 1-LTBC, NGO
General	Make this an issue people actually think about.	Participant D27, 1-LTBC, NGO
General	A video or other multimedia showcasing major take-away messages.	Participant D26, 4-SBC, NGO
General	Communicate simply without using technical jargon on the importance and benefits that can come from an undisturbed ecosystem.	Participant A7, 3-MR, Academia
General	Get the knowledge out there, target a lack of understanding.	Participant A3, 1-LTBC, Academia
General	Information on the policies, and why they are protecting valuable barachois ponds.	Participant C18, 4-SBC, Local