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Mobilizing values: using perceptions of barachois ponds in Nova Scotia to advance informed management

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Abstract

Meaningful engagement is increasingly used as a management tool for understanding the multitude of complex values and potential conflicts around marine conservation and the production of conservation strategies deemed acceptable by local communities. Barachois ponds, akin to coastal lagoons, are recognized coastal wetlands in Nova Scotia, Canada, given their distinct ecosystem services, including provisioning, regulating, and cultural services. This study examines the current discourses around the management of barachois ponds and how an increased understanding of these perceptions held by stakeholders and managers might be used to better inform integrated management of these wetland ecosystems. A mixed-methods research design using Q methodology was employed to acquire data on social perceptions surrounding the management of barachois ponds fringing the Bras d'Or Lake in Cape Breton, Nova Scotia, Canada. Four dominant perspectives were identified: the leave-them-be conservationists, the sustainable developers, the management reformists, and the science-based conservationists. Six key issue themes emerged based on an in-depth examination of these different perspectives and Q sort data. This study found that an increased awareness of the ecological, social, and cultural values attributed to barachois ponds by key stakeholders could play a critical role in better informing wetland management decision-making in Nova Scotia and elsewhere.

Key words: barachois ponds, coastal wetlands, integrated management, Q methodology, Bras d'Or Lake

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Introduction

Barachois ponds, along with tidal lagoons, are a subset of coastal saline ponds, a distinct class of wetlands in Nova Scotia (NS) listed 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).

These wetlands provide a range of invaluable provisioning, regulating, cultural, and supporting ecosystem services to humans and the natural world (Millennium Ecosystem Assessment (MA) 2005).

These include fish supply, water supply, water filtration, climate regulation, flood control, coastal protection, recreational activities, tourism, natural harbours, shoreline protection from erosion, and much more (Massachusetts Barrier Beach Task Force (MBBTF) 1994; Taylor and Shaw 2002; Finlayson et al. 2005; Shaw et al. 2006). In Cape Breton (CB), NS, Canada, where barachois ponds cover 12% of the Bras d'Or Lake (BDL) shoreline (Taylor and Shaw 2002), they also have cultural and social value for both the Indigenous Mi'kmaq people and the non-Indigenous population inhabiting the area (Denny 2013; Hatcher 2015; Giles et al. 2016; The Ontario Educational Communications Authority (TVO) 2018). Additionally, certain barachois ponds around the BDL are valued for their innate spiritual connectivity by the Mi'kmaq (Marshall et al. 2007).

Alarming decline of wetlands from development along the shores and within the watershed of the BDL, coupled with sea-level rise, is hastening the degradation of barachois ponds faster than public policy can apply corrective measures (Kennish and Paerl 2010; Chapman 2012; Collaborative Environmental Planning Initiative (CEPI) Steering Committee 2013; Bates 2017). While a considerable knowledge base has advanced understandings of barachois pond structure, function, values and threats (Rushton 1964; Strain and Yeats 2002; Taylor and Shaw 2002; Shaw et al. 2006; Parker et al. 2007; Unama'ki Institute of Natural Resources (UINR) 2007; Nixon 2013; Hatcher 2015), significant ecological and social information gaps still exist (Butler et al. 1996; Hatcher 2015). As noted by Grygoruk and Rannow (2017), while wetland policy is rightly informed by natural science, effective stakeholder involvement is also required to ensure policies have the support of those affected by them. Others have noted the importance of amassing the full range of values and benefits provided by these wetlands in any decision-making analysis related to their protection (Ruiz-Frau et al. 2011). To contribute to filling this knowledge gap, the research question for this study examines what the current discourses around the management of barachois ponds in the BDL are and how an increased understanding of these perceptions held by key stakeholders and governmental managers might be used to advance informed management of these wetland ecosystems.

Given the range of values surrounding barachois ponds and coastal lagoons—from protection to development—this paper provides context-specific social research aimed at understanding the meanings people associate with concepts related to the management and conservation of barachois ponds and marine areas in general (Hagan and Williams 2016; Sy et al. 2018). It does so by first providing a brief background of the ecological and socio-cultural values as well as threats associated with barachois ponds and the challenges currently associated with managing these ecosystems in NS. This is followed by a description of the mixed-methods design used to statistically evaluate the values and perspectives of major stakeholders around the management of barachois ponds in the BDL and the resulting key issues analysis, discussion, and conclusion.

Setting the context for barachois management in Nova Scotia

Study area

Located in CB, NS, the BDL watershed spans 3500 km^2, with six major rivers draining 42% of the watershed and covering approximately one-third of CB Island (Arseneau et al. 1977; Hipwell 2004; Hatcher 2018) (**Fig. 1**). The bays, inlets, and deep basins that characterize the BDL comprise 18% of the length of NS's shoreline, with over 400 barachois ponds fringing its shores (UINR 2007).

In 2006, some 22 000 people (not including seasonal residents) lived in the many small rural communities throughout the BDL watershed, most of which were located on the lakeshores and benefit from the ecological services provided by these ponds (Environmental Design and

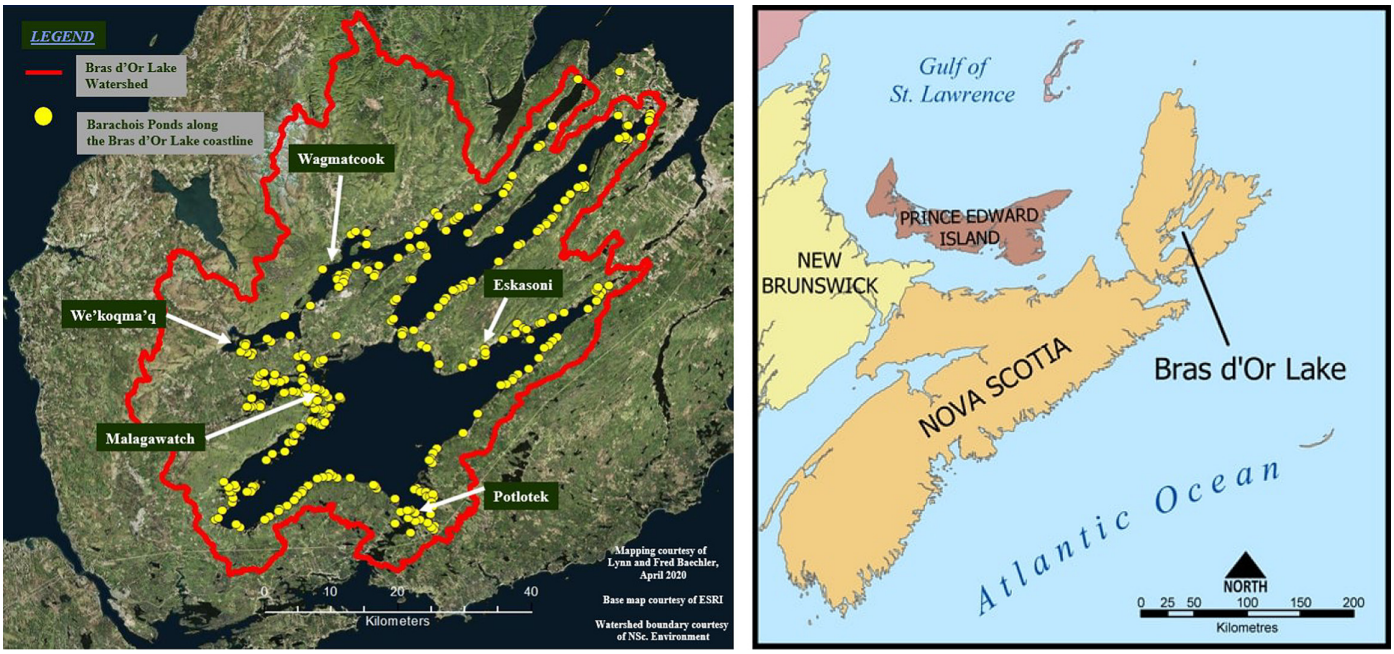

Fig. 1. The Bras d'Or Lake watershed in Cape Breton, Nova Scotia, with the 400 barachois ponds and five First Nations Communities along the shores of the BDL. Inset map showing the location of Bras d'Or Lake, Nova Scotia, Canada. Einstein, N. (May 2005). Retrieved from: en.wikipedia.org/wiki/Bras_d%27Or_Lake#/media/File:Bras_d'Or_Lake_map.png, CC BY-SA 3.0).

Management Limited (EDM) 2008). The primary resource industries occurring in the watershed include agriculture, forestry, and mining (EDM 2008).

Ecological value

Coastal lagoons are among the most productive ecosystems in the world and their role in supporting biodiversity through a range of "ecotones" (De Wit 2011, p. 32) is widely documented (Kjerfve 1994; Parker et al. 2007; Kennish and Paerl 2010; De Wit 2011; Pérez-Ruzafa and Marcos 2012; Conde et al. 2015). Known as "kidneys of the landscape", coastal lagoons, barachois ponds, and associated tidal flats act as digesters for organic material, contributing to the detritus food chain (De Wit 2011; Hatcher 2015). These ecosystems provide invaluable habitats and nurseries for important fish, invertebrates, and benthic fauna, with often-disproportionate numbers of rare or endangered species (Hanam 2000; Pérez-Ruzafa and Marcos 2012). Bald eagles frequent barachois ponds, with isolated berms providing protection from predators for migratory birds (MBBTF 1994; Hipwell 2004) (**Fig. 2**). Well-established barriers can host dune vegetation and critical coastal flora such as Swamp Milkweed (*Asclepias incarnata*) (Baechler 2014) and over time, endemic species may be produced through geographic isolation (De Wit 2011). Taken collectively, these multifaceted systems provide key ecosystem services which become tightly coupled with the values attributed to them socially and culturally.

Cultural and social values

The BDL watershed spans four municipalities and five First Nation communities and is formally recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserve, declared in 2011 (Hatcher 2018; UNESCO n.d.). The Mi'kmaq people have co-existed within Unama'ki (CB) for millennia. As discussed by Giles et al. (2016) and supported by

Fig. 2. An eagle sits atop a nesting perch overlooking MacDougall Pond in Cape Breton.

works of other scholars (Corntassel 2012; Wildcat et al. 2014), this place-based nature of Indigenous knowledge influences the "intertwining spirituality, culture, beliefs, environmental knowledge, and social code into practices in all aspects of life." (Giles et al. 2016, p. 168).

Mi'kmaq Ecological Knowledge reveals that barachois ponds (termed Pitu'we'k in the Mi'kmaq language) are valued for fisheries services and food access such as oyster cultivation and as habitat for American eel (*Anguilla rostrata*), eelgrass (*Zostera marina*), and other important marine life (Denny 2013; Hatcher 2015; Denny and Fanning 2016). With small mammals frequenting these areas, the ponds create valuable trapping grounds (E. Johnson, personal communication, 2018) as well as provide habitat for medicinal plants used by the Mi'kmaq. Additionally, these highly visible and utilized landforms also provide services that are used equally by non-Indigenous inhabitants of the area, including recreation, tourism, increased real estate values, coastal natural infrastructure, anchorage, and protection from weather (MBBTF 1994; Shaw et al. 2006; Nixon 2013). However, these critical ecosystems and their valuable services are severely threatened across CB and around the world (Hipwell 2004; Naug 2007; Chapman 2012).

Threats to barachois ponds

Globally, these important coastal wetlands have experienced significant declines from direct and indirect impacts overwhelming their biological and functional integrity, including a multiplicity of human activities and climate change (Culbert and Raleigh 2001; Kennish 2002; Kennish and Paerl 2010; Hydrologic Systems Research Group 2011; Nixon 2013) (**Figs. 3a–3c**). Locally, urbanization, agriculture, forestry, mining, nonpoint source pollution, removal of riparian vegetation, invasive species, and climate change are leading to the loss or partial destruction of barachois ponds, which has wider consequences for the BDL Biosphere Reserve (EDM 2008; Denny 2013). These include critical loss of productivity, spawning grounds, nursery areas, overwintering habitat, and fishing areas that are challenging to replace (Denny 2013). In the absence of targeted management action, the valuable ecosystem services provided by barachois ponds are increasingly threatened.

Fig. 3. (a) A former barachois pond turned marina in Cape Breton, (b) a barachois pond in Cape Breton with properties on the barrier, and (c) a paved barrier in Cape Breton, decreasing natural passage of water.

Challenges associated with current management efforts

A review of existing management efforts suggests a lack of awareness of social and cultural values associated with these ponds by managers and other decision-makers. Given the linked socio-ecological complexities associated with barachois ponds, this presents a significant information gap, highlighting the need for an integrated approach that spans multiple disciplines and sectors to effectively manage them. Additionally, incompatibilities between key policies governing barachois ponds in NS and the differing levels of governmental authority managing the ponds further reflect the lack of an integrated coastal strategy in NS and have likely stalled progress for reaching protection (National Wetlands Working Group (NWWG) 1997; NSE 2011).

At the provincial level, NS Environment (NSE) manages and enforces regulations on wetlands and watercourses, using policy mechanisms such as the NS WCP and the Tidal Wetland Ecological Services Protocol–Atlantic Canada (WESP-AC) (NSE 2011; Adamus 2018). However, beaches and barriers are managed as Crown land by NS Department of Lands and Forestry, resulting in certain parts of the same barachois pond managed separately by different provincial departments. At the federal level, mudflats, estuaries, fish habitat, and marine areas are managed by Fisheries and Oceans Canada. Wetlands and watercourses occurring on Indigenous Reserve lands are managed by federal land managers using the Canadian Wetland Classification System and the Federal Wetland Policy Implementation Guide (Government of Canada (GOC) 1991; Canadian Wildlife

Service (CWS) 1996; NWWG 1997). The separation of wetland policies across NS and Crown lands results in barachois ponds being classified as "coastal saline ponds" provincially, and "tidal lagoon marshes" federally (NWWG 1997; NSE 2011). Depth is also a factor, where ponds deeper than 2 m are considered watercourses, not wetlands, under the *Environment Act* (Province of Nova Scotia 1994–1995; Nova Scotia Environment and Labour (NSEL) 2006; NSE 2011). Further, many barachois ponds in CB are situated on municipalities with limited or nonexisting provisions under respective Municipal Planning Strategies for supporting coordinated land-use planning at the watershed scale (EDM 2008; Rideout 2012).

Given these challenges, and to continue to benefit from the services provided by these ponds, examining the approval process across these multiple jurisdictional levels to prevent damage before it occurs is important. Additionally, information prioritizing corrective management actions that also try to minimize unintended consequences and have the support of key stakeholder groups is critically needed (Scherer et al. 2014; Adamus 2018). Such information should include both biogeophysical studies based on desired characteristics of a well-functioning pond as well as an understanding of the benefits derived from these ecosystem services that stakeholders value (Granek et al. 2009).

Methods

Data for this study to address the research questions were generated using Q methodology and semi-structured interviews. The research protocol was developed based on guidance on how to rigorously conduct Q methodology (Brown 1980) and on the qualitative use of semi-structured interview data to provide additional insight on the choices made by respondents during the Q sorting process (Hagan and Williams 2016). The study protocol received approval from the Research Ethics Board at Dalhousie University. Thirty-three participants with some knowledge of barachois ponds were selected from five key stakeholder groups, including academia (A), business (B), government (G) (federal, provincial, municipal), nongovernmental organizations (NGO), and locals (L) (defined as anyone living in the BDL watershed full-time or seasonally). For the government stakeholder group, respondents were identified based on their involvement in the management of barachois ponds or in decision-making that affected barachois ponds, whereas academic respondents had demonstrated expertise in wetlands research. Nongovernmental respondents included those involved in wetlands conservations. Locals as well as industry respondents were identified based on their prior interest in the use of these areas. All data collected from each respondent was done individually, with interviews conducted immediately following the Q sorting exercise. The total time for the Q sort and interview with each respondent was approximately 90 min.

Q method

Q method operationalizes both qualitative data (interviews, inductive logic) and quantitative data (numbered statements, factor analysis) to systematically study human subjectivity around values and beliefs by generating patterns of perspectives revealed through factor analysis, transforming subjective perspectives into quantifiable data (Stephenson 1965; Webler et al. 2009). Given that qualitative outputs correlate with statistical confidence, the use of Q methodology can lead to more informed decision-making and policy implementation. It is increasingly employed in conservation management, where the requirement to draw upon evidence-based conservation meets the need to include public perception research, such as local and Indigenous knowledge (Barry and Proops 1999; Adams and Sandbrook 2013; Bennett 2015; Jefferson et al. 2015).

The following five steps are required for executing a Q methodology study: (*i*) selecting statements; (*ii*) selecting participants; (*iii*) sorting; (*iv*) statistical analysis; and (*v*) interpretation (Brown 1993;

Van Exel and de Graaf 2005; Hagan and Williams 2016; Loring and Hinzman 2018; Weitzman and Bailey 2018).

Selecting statements: building the concourse and the Q set

A review of published and grey literature on barachois ponds and similar marine environments (e.g., coastal lagoons, tidal lagoons, saline ponds, salt ponds, and the various spellings of "barachois pond", etc.) was conducted to develop a suite of 104 statements or the "concourse" from 22 articles that were relevant to the management of barachois ponds (Brown 1993; Butler et al. 1996; Weitzman and Bailey 2018). The statements were then inductively grouped into five overarching categories and screened for duplication and ambiguous statements (Brown 1980; Webler et al. 2009). This resulted in 52 final statements covering widely different aspects surrounding the topic of barachois ponds that were deemed broadly representative of the management (29%), benefits (23%), threats (17%), development (17%), and general (14%) statement categories. The final statements were written in positive, negative, or neutral orientations to support the quasi normal distribution in the Q sort exercise (**Table 1**) (Webler et al. 2009). The Q set was pretested by a wetland practitioner employed by NSE for clarity, balance, and comprehensiveness, with statements adapted based on the feedback received.

Table 1. Q set Statements ($N = 52$).

	Statement and ID number	Category
1	Barachois ponds are important year-round fishing grounds for trout, eels, gaspereau.	Benefits
2	Dredging artificial openings in barachois ponds to purify water conditions in ponds that support oyster leases is a valid reason for their alteration.	Management
3	Barrier beaches that define barachois ponds are important ecosystems in their own right.	Benefits
4	Barachois ponds are vital for maintaining local biodiversity e.g., muskrat, otters, birds, loons.	Benefits
5	Barachois ponds are very threatened by pollutants such as pesticides, herbicides, fertilizers.	Threats
6	Barachois ponds are very threatened by oil and other chemicals enter the ponds by surface run-off from roads.	Threats
7	Building or maintaining artificial openings in barachois ponds is an important method for managing water levels to avoid flooding.	Management
8	Dredging artificial openings in barachois for recreational purposes is not a valid reason to alter barachois ponds.	Management
9	Building or maintaining artificial openings in barachois ponds is necessary for managing algal blooms or reducing nutrient levels in Barachois.	Management
10	In general, the construction and maintenance of infrastructure (roads, wharves) does not greatly impact barachois ponds.	Development
11	Industrialization, e.g., fish plants, energy projects, negatively impact barachois health.	Development
12	Residential or recreational coastal development within 100–200 m negatively impacts barachois health.	Development
13	Climate change e.g., sea-level rise, storm intensity, ocean acidification, invasive species, are not imminent threats to barachois ecosystems.	Threats

(*continued*)

Table 1. (*continued*)

	Statement and ID number	Category
14	Barachois ponds promote salt marsh wetlands by facilitating hydrophytic vegetation, e.g., plants that are adapted for life in saturated soils such saltwater cordgrass, sedges and rushes.	Benefits
15	Barachois ponds do not demonstrate fluctuating hydrology from year to year, e.g., water depth, flow patterns, duration and frequency of flooding.	General
16	Upland owners should be consulted when the development of barachois ponds is being considered.	Management
17	Barachois ponds including barriers, do not protect against flooding.	General
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.	Benefits
19	Barachois should be classified as wetlands of special significance for having high social/cultural importance.	Benefits
20	Barachois ponds are significant features that add value to the landscape (aesthetic/economic).	Benefits
21	Barachois ponds detract from the landscape. They are a nuisance.	General
22	Infrastructure around barachois ponds detract from the "naturality" of the landscape, lessening its overall worth.	Development
23	Barachois are mainstays for recreational activities, e.g., boating, ice-hockey, bird watching, walking, swimming, kayaking.	Benefits
24	Fishing is only valuable in barachois ponds whose channels are wide enough to allow sea water to enter.	Management
25	An inventory of the diverse barachois pond habitats and their associated species composition is lacking.	Management
26	The management of barachois ponds is uncoordinated.	Management
27	Unmanaged growth is an important driver of negative environmental impacts on barachois ponds.	Threats
28	Barachois ponds are an important part of my cultural and or personal identity.	Benefits
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.	Benefits
30	There is adequate policy and (or) legislation protecting barachois ecosystems.	Management
31	The size of a barachois pond is an important determinant in its value and worth.	General
32	The water in barachois ponds is stagnant and (or) full of undesirable marine plants/algae.	General
33	Protecting naturally occurring barachois ponds is not critical as they can be artificially constructed, even matching ecosystem function.	Management
34	In general, the majority of barachois ponds change form notably from year to year from wind storms and storm surges.	General
35	The requirement to conduct Environmental Impact Assessments (EIA) prior to dredging barachois channels creates unnecessary setbacks for development.	Management
36	Small barachois ponds (<100 m^2) ought not to be protected as they are not as ecologically valuable are larger ones.	Management

(*continued*)

Table 1. (*concluded*)

	Statement and ID number	Category
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).	Threats
38	Barachois ponds do not hold as much value if they have been altered by a single storm event.	General
39	Barachois ponds are not ideal environments for aquaculture development.	Development
40	Barachois ponds have been negatively affected by lowered investments in wastewater treatment facilities.	Threats
41	Lack of regulated tourism poses negative consequences related to illegal fishing activities in the barachois ponds.	Management
42	Incompatibilities between professional and recreational fishing are negatively affecting fish, shellfish, and bait resources.	Threats
43	Fishing in barachois ponds has local economic and social importance and is even perceived as additional income for some families.	Benefits
44	Many barachois ponds should be filled in and developed to support a variety of regional economic developments.	Development
45	Barachois ponds have immense scientific value for they are essentially a mesocosm for the greater ocean.	Benefits
46	Conservation and protection efforts impede development efforts around barachois ponds.	Development
47	Barachois ponds hold untapped potential for economic development.	Development
48	We do not know enough about the barachois ecosystems to effectively manage them.	Threats
49	Barachois ponds are commonly used for illegal dumping of garbage.	Threats
50	It is important that all barachois ponds are valued equally, as each offer something different and unique worth protecting.	Management
51	More stakeholders ought to recognize the value of barachois ponds through outreach initiatives (e.g., environmental education programs, development of infrastructure).	Management
52	Certain barachois ponds in Cape Breton hold potential for tidal lagoon power generation.	Development

Selecting participants

A strength of Q methodology lies in its relatively low number of participants required to generate statistically meaningful results (Brown 1980; Barry and Proops 1999). Given the focus of our study on understanding stakeholder values to inform the management of barachois ponds, it was important to solicit points of views from those affected by and affecting management decision-making. These included respondents from academia who study these ecosystems; businesses who can generate economic activity from the use of the ponds; government bureaucrats who manage the ponds; locals who may derive social, economic, and aesthetic or cultural value; and NGOs who advocate for their protection. As specified in Q methodology, respondents were not randomly selected and were identified based on their theoretical relevance or informed opinions regarding the problem being studied (Webler et al. 2009; Hagan and Williams 2016). For our study, five to eight informed individuals per stakeholder group were selected based on their relevance and knowledge of the topic of barachois

ponds in CB or NS more generally. In addition to the research team identifying potential participants based on these two criteria, participants were provided with the opportunity to share their prior knowledge of barachois ponds ahead of scheduling their Q sort exercise.

Sorting exercise

The Q sorts were administered individually in person over a three-month period between June and August 2018. The 52 numbered statements were shuffled and handed to participants to reflect on whether they agreed, disagreed, or felt neutral or undecided, placing each statement into one of three respective piles until all statements were sorted (Watts and Stenner 2012; Hagan and Williams 2016; Weitzman and Bailey 2018). The participant then sorted the statements within the "agree" pile, beginning with the two statements that they felt "very strongly" (+5) toward, and three they felt "strongly" (+4) toward. All remaining statements in the agree pile were sorted according to their level of decreasing agreement relative to very strongly agree (McKeown and Thomas 2013; Hagan and Williams 2016). This step was repeated for the "disagree" pile. Participants were provided with qualifying descriptors of very strongly (±5), strongly (±4), moderately (±3), weakly (±2), very weakly (±1), and neutrality/no opinion (0) when asked. The sorting exercise resulted in a quasi-normal distribution (**Fig. 4**). No significance was given to vertical distribution.

The Q sort was followed by a semi-structured interview to gain additional insight on participants' justification for "very strong and strongly" statements (±5, ±4) only (Hagan and Williams 2016; Weitzman and Bailey 2018) (**Supplementary Material 1**). Participants began the exercise by signing a consent form. Interviews were recorded and transcribed for accurate interpretation.

Statistical analysis

Data were analyzed using free online software, PQMethod 2.11. This included the generation of a correlation matrix, factor analysis, study variance, and factor loading scores (Watts and Stenner 2012). A correlation matrix showed degrees of (dis)similarities among participants' Q sorts (Curry et al. 2013). Factor analysis was performed on the correlation matrix using principal component analysis (PCA) and varimax factor rotation (Curry et al. 2013). Varimax rotation creates a factor solution by maximizing the degree of explained variance on as few factors as possible (Webler et al. 2009), whereas the PCA method produces a solution that maximizes the variance of each factor (Brown 1980). Dominant factors emerged through analysis of the factor solutions

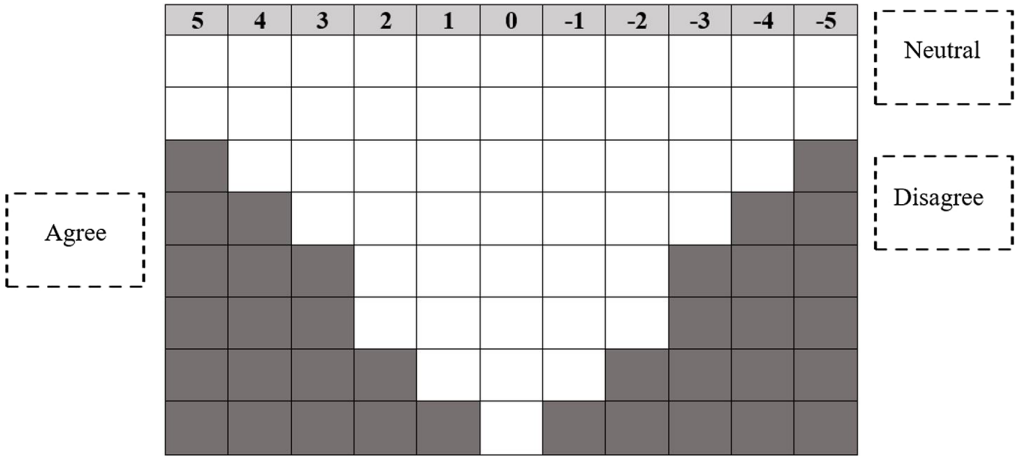

Fig. 4. Quasi-normal distribution sorting board. One white square for each statement. Participants pre-sorted each statement, placed into either agree, disagree, or neutral piles before sorting each pile onto the board.

(Stephenson 1965; Webler et al. 2009). The extent to which individual Q sorts typify a given factor is known as factor loading (Watts and Stenner 2012). Participants with similar perceptions will load significantly under the same factor or perspective (Stephenson 1965). A Q sort is considered significant at the 0.1 level of significance for a given factor if the participant's factor loading exceeds ±0.36, or $2.58 \times (1/\sqrt{N})$, where N equals the number of statements sorted (Brown 1980; McKeown and Thomas 2013). Raising the significance level to 0.5 permitted the use of more stringent criterion to reduce the number of confounded sorts, or participants who load significantly into more than one factor, maximizing the heterogeneity of perspectives (Watts and Stenner 2005; Tiernon et al. 2017; Weitzman and Bailey 2018). The Q sort data for this study are available on Open Science Framework (osf.io/5w9th/?view_only=5af502686fd54612b6c0eb3af683c3dc).

Interpretation

Methods for interpreting the Q sort data into dominant perspectives are described below. Interpretation of key issue themes, however, emerged as an independent pursuit to more aptly address "how" an increased understanding of dominant perspectives could better inform integrated management of these coastal wetland ecosystems.

The perspectives

The final factor rotation solution was chosen when it comprised three to four factors. At least five participants defined each factor producing a factor reliability score of 95%, it contained the fewest confounded sorts possible, and it had an explained variance of 10% or greater for each factor (Brown 1980; McKeown and Thomas 1988; du Plessis 2005; Webler et al. 2009; Watts and Stenner 2012; Hagan and Williams 2016). Interpretation of dominant perspectives arising through the factor solution were identified from the Q sort data using only extreme statements (±5, ±4) and distinguishing statements (*), defined as statements ranked statistically different from other factors ($p < 0.05$) (Brown 1980). Statements that were both distinguishing and extreme were firstly considered (±5*, ±4*) for interpretation, followed by distinguishing statements of any rank (McKeown and Thomas 2013). Each perspective is a summary of the values and views captured in the semi-structured interviews of only those participants who loaded significantly under that factor (excluding confounded sorts) (Watts and Stenner 2012).

The key issue themes

While some perspectives were more commonly held than others, not all participants loaded wholly into a single perspective. Perceptions from those with composite viewpoints or sentiments from unanimously agreed upon statements were instrumental in crafting the key issues for management. The following steps were taken to identify and frame the six emergent key issue themes.

1. Scan factor array scores for all moderate, strong, very strong, and distinguishing values (**Supplementary Material 2**).

2. For each statement with such values, interviews were scanned for excerpts that spoke to that statement.

3. Once identified, only interview data from individuals who loaded significantly under a given perspective were used to explain that perspective in greater detail. For example, both Perspectives 2 (from sustainable developers) and 3 (from management reformists) reacted to Statement #31 (the size of a barachois pond is an important determinant in its value and worth). In their semi-structured interview, Participant A8, Perpective 3 managment reformist and Perspective 4 science-based conservationist shared a sentiment that advanced a more complete understanding of the issue of "size". While their perspective was confounding, it nonetheless aligned with Persptective 3 management reformist; therefore, their words were permitted for use in the identification and framing of that key issue theme.

Results

Current discourses around barachois ponds in the Bras d'Or Lake

Based on the analysis, four factors or "dominant perspectives" (P) were identified that accounted for 72% of the study variance. Presented in the order appearing in the factor solution, they are the leave-them-be conservationists (P1 LTBC; 22%), the sustainable developers (P2 SD; 12%), the management reformists (P3 MR; 20%), and the science-based conservationists (P4 SBC; 18%). Table 2 shows the factor loading scores of each participant across the four perspectives. A total of seven participants

Table 2. Factor loadings for each participant across the four perspectives (P).

Participant ID and stakeholder affiliation	P1, let-them-be conservationists	P2, sustainable developers	P3, management reformists	P4, science-based conservationists
Perspective 1—let-them-be conservationists				
Academic A3	**0.6247**	0.2178	0.1973	0.4942
Academic A6	**0.5242**	0.2077	0.3561	0.4085
Business B14	**0.6368**	0.4232	0.2571	0.4353
Local L17	**0.7340**	0.0967	0.1305	0.1347
Nongovermental organization NGO20	**0.5893**	0.2896	0.3826	0.3030
Nongovermental organization NGO22	**0.7494**	−0.0631	0.2684	0.2634
Nongovermental organization NGO27	**0.6096**	0.4355	0.3388	0.2499
Perspective 2—sustainable developers				
Academic A1	−0.0412	**0.7458**	0.2624	0.2196
Business B9	0.2710	**0.5079**	0.3332	0.2733
Local L15	0.3151	**0.5673**	0.3677	0.4647
Local L16	0.1398	**0.7647**	0.1231	−0.0033
Perspective 3—management reformists				
Academic A5	0.4884	0.2676	**0.5440**	0.2968
Academic A7	0.4902	−0.1560	**0.5735**	0.3544
Business B10	0.0385	0.2400	**0.7767**	0.2830
Nongovermental organization NGO23	0.4127	0.2858	**0.6868**	0.1392
Nongovermental organization NGO24	0.4501	0.1718	**0.5224**	0.4662
Government G30	0.4031	0.3116	**0.6184**	0.3841
Government G31	0.1020	0.2674	**0.7655**	0.3195
Government G33	0.3880	0.3588	**0.5976**	0.1128
Perspective 4—science-based conservationists				
Academic A4	0.3642	0.4784	0.0541	**0.6210**
Business B11	0.4718	0.0350	0.2822	**0.5800**
Business B12	0.0940	0.3758	0.2561	**0.7022**
Local L18	0.2920	0.0571	0.3758	**0.7055**

(*continued*)

Table 2. (*concluded*)

Participant ID and stakeholder affiliation	P1, let-them-be conservationists	P2, sustainable developers	P3, management reformists	P4, science-based conservationists
Local L19	0.3755	0.4333	0.3564	**0.5438**
Nongovermental organization NGO26	0.4868	0.1100	0.2295	**0.6297**
Confounding sorts				
Academic A2	**0.6867**	0.2421	0.1512	**0.5073**
Business B13	**0.5547**	0.2107	**0.6542**	0.2427
NGO N25	**0.5901**	0.2574	**0.5553**	0.2897
Government G28	**0.5391**	0.2458	**0.5897**	0.1416
Government G29	**0.4951**	0.2313	0.3724	**0.5163**
Government G32	**0.5413**	0.2677	0.2360	**0.6233**
Academic A8	0.2134	0.0545	**0.5443**	**0.6485**
No significant perspective				
Nongovermental organization NGO21	0.3666	0.4332	0.4895	0.4027
% Explained variance	22	12	20	18
Total defining Q sorts	7	4	8	6
Total sorts	13	4	12	10

Note: Participants who scored significantly for a given perspective (factor loadings ≥0.5), are marked in bold.

(two academics (A2, A8), one from business (B13), one from a NGO (NGO25), and three from government (G28, G29, G32)) loaded significantly across two of the four perspectives, denoting confounding sorts. One NGO participant (NGO21) did not load significantly into any of the resulting perspectives.

A brief description of the four perspectives and areas of consensus among them are provided below based on the factor arrays for each of the Q sort statements for each perspective (**Supplementary Material 2**), followed by a review of the affiliation of stakeholders holding each of the perspectives.

Perspective 1—the leave-them-be conservationists

This first perspective focused primarily on protecting barachois ponds as Wetlands of Special Significance (WSS) owing to their high social and cultural importance, particularly among the Mi'kmaq people. While the ponds are perceived to contribute to the landscape, their value was not necessarily seen as economic. As such, dredging inlets for aquaculture or recreational purposes were not viewed as valid reasons for altering barachois ponds. Consistent with an overall view of the need to protect these landforms, this perspective did not believe that environmental impact assessments created unnecessary setbacks for development.

Perspective 2—the sustainable developers

The discourse among the sustainable developers focused on issues surrounding the lack of awareness and outreach around the benefits provided by barachois ponds among landowners, as well as the inadequacy of current policies and legislation protecting the ponds. Despite this, the sustainable developer was the only perspective that felt enough is currently known about barachois ponds to effectively manage them. Also significant among this perspective, in contrast to the leave-them-be conservationists,

was a recognition that not all barachois ponds should be valued equally, with size as an important criterion for determining protection levels.

Perspective 3—the management reformists

In contrast to the sustainable developers discourse, perspectives shared by the management reformists focused on the insufficiency of knowledge available to effectively manage barachois ponds in Nova Scotia. Although this was the only perspective to feel neutral that all barachois ponds should be valued equally, size was not recognized as an important criterion for valuation. This perspective further identified that an inventory of current ponds and associated species composition is lacking. Overall, the management of barachois ponds was viewed as uncoordinated and there was a strong sense of the need to reform policy and legislation that specifically protected barachois pond ecosystems.

Perspective 4—the science-based conservationists

Not surprising, scientific value of barachois ponds was a key component of the discourse of the science-based conservationists. Although this perspective shared similar views as the leave-them-be conservationists, notably that barachois ponds are significant features that should be classified as WSS, the discourse around the need for protection was much more inclined toward the outcomes of scientific experimentation and case-by-case assessments. This is the only perspective to maintain neutrality toward all reasons to artificially dredge barachois ponds, including for managing algal blooms, recreational purposes, and supporting oyster lease ponds. This perspective recognized the immanency of threats from climate change and an understanding of the ponds' fluctuating hydrology as critical considerations for reaching effective management. In line with the sustainable developers, this perspective was the strongest supporter of outreach initiatives that address the gap between the true value of barachois ponds and their perceived value.

Consensus statements

Consensus statements are those ranked similarly across all four perspectives ($p < 0.05$) and are therefore not supportive in the creation of individual perspectives. However, consensus statements are instrumental points for identifying key areas of commonality across all perspectives and hence help with identifying management actions that can leverage the agreement of a diversity of key stakeholders (Hermelingmeier and Nicholas 2017). Of the 52 statements sorted by respondents, 15 were found to be significantly correlated across all perspectives (**Supplementary Material 2**). Focusing on those for which there was strong to very strong positive agreement, all perspectives ranked barachois ponds as vital for maintaining local biodiversity and their barrier beaches as important ecosystems. On the disagreement scale, all perspectives strongly disagreed that artificially constructing barachois ponds could provide the equivalent ecosystem function of naturally occurring ponds, or that various regional economic developments were a valid reason for infilling barachois ponds. Consensus statements that perspectives moderately supported were the importance of barachois ponds for supporting rare and at-risk species such as migratory birds, and their role in promoting salt marshes by facilitating hydrophytic vegetation. These findings indicate support for the use of conservation as a basis for protection, and suggest that none of the perspectives would support granting approval to destroy barachois ponds, even with a "no net loss" policy that provided for the construction of artificial ones to replace the loss of naturally occurring ponds.

Stakeholder affiliation and the four perspectives

An assessment by affiliation of each of the participants was undertaken by analyzing the data in **Table 2** and is presented in **Table 3**. Although confounding sorts were not used in the creation of any perspective, for the purpose of this table, participants with confounding sorts were counted under

Table 3. Stakeholder affiliation within the four perspectives (P).

Affiliation and participant ID #	P1, leave-them-be conservationists	P2, sustainable developers	P3, management reformists	P4, science-based conservationists	Confounded sorts
Academia (A)	3	1	3	3	2
Business (B)	2	1	2	2	1
Local (L)	1	2	0	2	0
Nongovermental organization (NGO)	4	0	3	1	1
Government (G)	3	0	3	3	2
Total (including confounding sorts)	39%	12%	33%	33%	+10%

both of their perspectives, given that the individual factor matrix scores were significant for either perspective.

The results show that for the leave-them-be conservationists and science-based conservationists, affiliation had little influence on the held perspective given that all five stakeholder groups comprised both perspectives. For the management reformists, only the local stakeholder groups were absent from this perspective, while NGO and government participants were both missing from the sustainable developers perspective. These findings could be initially interpreted to mean that affiliation appeared to have little influence on the perspective that any individual stakeholder might have with respect to barachois ponds. However, it would be appropriate to conduct a follow-up study with a larger number of stakeholder categories before affirming this conclusion.

How perceptions inform the management of barachois ponds

One unique feature of Q methodology is its ability to provide a means for mobilizing the views of largely siloed stakeholders into a single critical dialogue. Understanding "how" the identified perspectives could advance informed management led to further analysis of the factor array data (**Supplementary Material 2**), information gleaned from the semi-structured interviews on why statements were viewed as "strongly" and "very strongly", perceptions from confounded sorts and consensus statements, in addition to the dominant perspectives. The six key issue themes highlight a range of concerns surrounding the management of barachois ponds in CB, exposing the depth of shared concerns, the granularity of conflicting points of view, along with solutions for informed management.

Alteration permitting process

A leading thematic area of concern among the respondents was the permitting process that allowed for alteration of barachois ponds. As exemplified by the following quote, the issue of size as a criterion was cautioned as well as the need to recognize connectivity within and across ecosystems

> Bigger isn't necessarily better. One may have a larger economic, productivity, or recreational value, but each one has its own place in the system (Participant A8, P3 MR, P4 SBC) (Statement #31).
>
> These are unique ecosystems: plants, animals, bugs—everything is interconnected within that small ecosystem. One alteration can affect and disrupt the whole chain (Participant NGO26, P4 SBC) (#10).

Concern was also raised by respondents regarding the rationale for alteration (e.g., dredging to support water conditions in oyster lease ponds), the lack of current understanding of the functional

role of ponds sufficient to justify alteration, and the limited time invested in project design and assessments phases in advance of the alteration permitting process. More specifically, as illustrated by the following quote, the sense conveyed by some respondents was that it may be more a lack of economic investment rather than a thorough review process that is limiting the current amount of barachois pond alteration. This strongly suggested the lack of legitimacy afforded to the governmental process by many of the stakeholders, regardless of their perspective.

> In the case of a proposed RV park on a barachois pond in CB, nothing seemed to be stopping developers except for their own investors falling through (Participant NGO27, P1 LTBC) (#44).

> Adequate policy and legislation protection for barachois ponds needs to allow some mechanism for considering case-by-case assessments beyond [generic] marine wetland [designation] (Participant A1, P2 SD) (#30, #50).

Inventory and sub-classification

Participants from across all five stakeholder groups and all four perspectives commented extensively on the importance of barachois ponds to provide a suite of localized ecosystem services and the need for a better understanding of the different wetland habitat types across the BDL watershed. To address these gaps in knowledge, the need for a comprehensive classification system that allowed barachois ponds to be inventoried and assigned appropriate protection measures according to key characteristics was recommended. Suggestions for subclassification included turnover time, water source, inlet, barrier and pond characteristics, salinity, biology, sediment chemistry, historical and existing use, and significance to the Mi'kmaq people, indicating that governmental managers need to be more nuanced when categorizing these wetlands. The following quotes from respondents illustrate the concern voiced around this thematic area.

> There needs a better understanding of each coastal wetland habitat type, form, and function, and how they interact with one another (Participant B13, P1 LTBC, P3 MR) (#25).

> Broader importance indicators must be considered beyond size… is it a nursery? a sediment basin? a bioreactor? a coastal wetland? shoreline protection? (Participant B10, P3 MR) (#31).

> There are significant knowledge gaps around barachois ponds, such as species composition, form and function, role in ecosystem, and differences between barachois in BDL vs. Bay of Fundy vs. Atlantic (Participant B13, P1 LTBC, P3 MR) (#48).

> This is hindering the effective management and protection of barachois ponds (Participant B10, P3 MR) (#48).

> Developing a classification system would allow stakeholders to construct buildings, structures and houses with minimal impacts (Participant N20, P1 LTBC) (#50).

Educating stakeholders and the public

Yet another important theme that emerged from the qualitative analysis of the data was the need for education and awareness to serve the general public and managers geared toward increasing collective understanding of the role barachois ponds play in the overall ecosystem. This theme resonated across all perspectives and among all stakeholder categories. This finding strongly suggested the potential for educational opportunities to be seized at multiple levels; for example, these shore-based subaquatic ecosystems serve as a living laboratory for schools and camps by demonstrating how the physical and biological world interact, are dependent, and are related. For this reason, barachois ponds can enhance opportunities for shared knowledge and understanding through the two-eyed seeing approach among Indigenous and non-Indigenous users of the BDL ecosystem.

> People will change by learning more about the contributions barachois ponds make to the environment and how valuable they are (Participant L19, P4 SBC) (#51).
> When people's eyes open to their ecological value, you see their mind switch, valuing it more as a habitat (Participant L15, P2-SD) (#29).

Coordinating integrated management

The growing recognition of the lack of integration among decision-makers was a repeated theme among participants interviewed for the study. Participants particularly aligning with the management reformists perspective noted the need for integration at the municipal level as well as a nested provincial approach to decision-making if the services provided by these wetlands are to be maintained.

> A collective agreement between all municipalities on how best to manage barachois ponds is needed; it is difficult for any one municipality to take the lead when subsequent municipalities are not following suit (Participant G31, P3 MR) (#26).

Although the focus of the responses was specific to barachois ponds, this lack of an integrated approach to management was viewed as systemic within the province, as there is currently no provincial strategy, legislation or Statement of Provincial Interest calling for a holistic approach to managing NS's coastal issues.

> Nova Scotia lacks planning around coastal development and coastal growth (Participant NGO21, no perspective) (#27).
>
> Everyone is operating in silos; no one is talking (Participant B10, P3 MR) (#26).
>
> A lack of regulatory frameworks is preventing all regulatory entities from operating under a similar perspective, with everyone looking at development in these areas similarly (Participant G31, P3 MR) (#26).

Social and cultural importance criteria

Another key thematic area that emerged from the qualitative content analysis was the lack of recognition of the role of barachois ponds beyond their ecological value, and the need for culturally sensitive criteria for designating barachois ponds as WSS for having high social and cultural importance. Given the strong Indigenous presence around the BDL, the importance of managers understanding the social, medicinal, and spiritual value placed upon these ponds can significantly affect how they are managed.

> When Elders or knowledge keepers are approached about these place names, we'll see the significance of why it's called this. When we have that understanding, we have an appreciation for what's there, and for how to use them (Participant NGO22, P1 LTBC) (#19).
>
> Medicines in barachois ponds that play a significant role in Mi'kmaw history have likely been lost (Participant NGO26, P1 LTBC) (#19).

Functional assessment protocol

Despite the province having a "no-net-loss" Wetland Conservation Policy and use of provincial or federal wetland classification guides (NWWG 1997; NSE 2011), respondents in this study identified deficiencies associated with these tools pertaining to barachois ponds (inconsistently defined across guides), as well as within the functional assessment tools currently being used such as the Tidal WESP-AC (Adamus 2018). For instance, conditions and indicators were largely calibrated from areas with pronounced tidal zonation (Adamus 2018), meanwhile the narrow tidal gradient of the BDL (Taylor and Shaw 2002) has created instances for wetland practitioners whereby salt marshes in the BDL do not reach optimal scores. Evidence of the importance to improve these natural and socio-

cultural criteria, specifically as they apply to the BDL, was noted particularly among the participants who associated with the management reformists and the sustainable developers perspectives.

> A holistic approach for determining their value and worth, one that considers all interacting aspects of the environment is ideal when making decisions on their significance and value. Current policy and legislation do not allow for this … (Participant A1, P2 SD) (#30).
>
> Tidal WESP-AC relies on tides to provide presence of high and low marsh for scoring. The BDL has narrow tides, so you don't really get those two zones, or if you do, it's very small. (Participant N24, P3 MR) (#14).

These findings suggested wetland practitioners need to examine the deficiencies in the current functional assessment protocols to ensure they are capturing the diversity of functions and benefits provided by these systems along the BDL.

This cross-examination of the perspectives and identification of overlapping concerns that emerged from the analysis highlight how such knowledge might be used to inform more effective management of barachois ponds. It provides supporting evidence to managers and other key stakeholders of the emergence of the overall value of barachois ponds and broader legislative considerations affecting their management in the BDL and more widely, across Nova Scotia. It also provides managers with initial guidance on what key stakeholders consider priority areas to be addressed and as such, lays the foundation for a deeper exploration of the importance of the six key issues.

Discussion

Understanding the complexity of values and worldviews embedded in stakeholder perspectives is essential for advancing informed dialogue by mobilizing consensus areas into convergence points for addressing areas of conflict (Harrison and Loring 2014; Bennet 2015; Jefferson et al. 2015). However, as shown by Sy et al. (2018) and supported by Loring and Hinzman (2018), identifying consensus areas among key stakeholder groups in marine conservation is not always clear, and innovative ways must be found to garner stakeholder perceptions and concerns in a controlled, pragmatic, and cost-effective way. As illustrated in this study, Q methodology provided a forum for critical discourse by adjoining once siloed perspectives into a vibrant and rigorous discourse focused around benefits, threats, and pathways for action. It facilitated a detailed discussion among 33 participants from five stakeholder groups around key issues hampering the management of barachois ponds in CB/Unama'ki.

Of the four statistically identified perspectives (leave-them-be conservationists, sustainable developers, management reformists, and science-based conservationists), it is important to recognize that no single perspective held any more validity than the other, and to cater to any single perspective could be misleading, considering that several participants held more than one perspective. However, the identification of these four statistically significant perspectives provides insight into the nuances between them that is informative to managers and decision-makers. First, the different perspectives clearly show that stakeholders do not simply fall into the expected two dichotomous camps of conservationist versus developers. Rather, they highlight the key priorities that distinguish each perspective, providing opportunities for understanding subtle value differences that could undermine management efforts that do not reflect these values. For example, the leave-them-be conservationists differed significantly from the other three perspectives by giving priority to protecting barachois ponds over any other potential use, including recreational use. Based on the discourse supported by this perspective, management of barachois ponds can be simplified by declaring them all to be of Wetlands of Special Significance. In contrast, the science-based conservationists had no position on the use of modifying barachois ponds for recreational activity and instead gave priority to the need for

science-based knowledge to informing management. Contrary to this position, the sustainable developers did not see the need for more knowledge to manage the ponds and more than other perspectives, and they strongly agreed on using the ponds as unique learning opportunities, including implementation of protection levels based on the characteristics of individual ponds and a willingness to protect them based on informed scientific assessment of each pond. Regarding the management reformists, the distinguishing feature of this perspective centered around very strong beliefs that management was uncoordinated, that there is inadequate policy protecting barachois ponds, and that the knowledge needed to effectively manage the ponds was lacking, suggesting considerable room for improvement by government managers and decision-makers. These insights into the perceptions and values between the four perspectives suggest that wetland managers and more broadly, natural resources managers and decision-makers, need to be cognizant of the complexity, context, and values underpinning stakeholders' support or lack thereof surrounding conservation policies (Ruiz-Frau et al. 2011; Grygoruk and Rannow 2017). A related second insight gained from the research on the role of values and priorities as distinguishing features among the different perspectives is the immediate need for managers, researchers, and other stakeholders to be aware of the dynamism associated with both the biogeophysical nature of barachois ponds and the changing socio-political context surrounding the management of these wetlands (Shaw et al. 2006; Nixon 2013; Hatcher 2015). As observed by Loring and Hinzman (2018) in their work on using Q methodology to identify how people prioritize values for the marine environment, "researchers and managers ought not to expect any set of research methods to provide durable representations of what people value." (p. 376).

As a method gaining increasing use in natural resources public perception research (Barry and Proops 1999; Jefferson et al. 2015; Weitzman and Bailey 2018), in addition to identifying different discourses among stakeholders, Q methodology has the advantage of also identifying areas of consensus among the diversity of perspectives. In our study, given that the strongest consensus statements were that barachois ponds are vital for maintaining biodiversity, and that the ponds are not readily restorable if lost, managers could reasonably assume that any actions that have the potential to irreversibly threaten ecological and (or) cultural values associated with the ponds should be forestalled unless proven harmless. Additionally, it is critical that these areas of agreement among the different perspectives be used as a platform for bringing together multiple users and perspectives for continued dialogue around strategies aimed at addressing barachois pond management. With NS in the midst of introducing a Biodiversity Act (Bill No. 116. *An Act to Provide for the Conservation and Sustainable Use of Biodiversity in Nova Scotia*. Available at nslegislature.ca/legc/bills/63rd_2nd/1st_read/b116.htm) in addition to a Coastal Protection Act (Bill No. 106. *Coastal Protection Act*. Available at nslegislature.ca/legc/bills/63rd_2nd/1st_read/b106.htm) these consensus points provide opportunities that may help in advancing the formation of suitable policies under these legislations by highlighting a unified appeal amongst disparate perspectives.

Lastly, another insight of value to wetland managers and decision-makers obtained from our study is that stakeholder affiliation may not be a major factor in addressing issues regarding the management of barachois ponds, given the multiplicity of backgrounds held by many participants. This is consistent with the findings from previous research (Weitzman and Bailey 2018) and suggests that consideration should be directed more towards addressing the identified key issues, as these are instrumental in focusing the viewpoints and concerns from all perspectives and stakeholder groups into cohesive arguments for change. These collectively identified issues serve to address the threats to barachois ponds through an alternative approval process, supported by a classification and inventory system for barachois ponds based on scientific knowledge and the use of protocols that are guided by the functioning of these ecosystems (Kennish and Paerl 2010; Conde et al. 2015). Additionally, they also focus on addressing educational and socio-cultural concerns (Hipwell 2004; Denny 2013; Giles et al. 2016) as well as the need for a more coordinated and integrated approach to managing barachois ponds, as has been called for in previous work (Naug 2007; Rideout 2012).

Conclusion

Using Q methodology, this study contributes timely insights regarding the effective management of barachois ponds as wetlands of special significance in Cape Breton, Nova Scotia. Four distinct perspectives emerged through statistical analysis of social narratives, each with its set of unique priorities reflecting underlying core values of multiple stakeholders who are relevant to barachois ponds. The study contributes to improving environmental management by also identifying common ground on which consensual decision-making for action can build. Specifically, this research provides effective insights that will contribute positively to finding management solutions that meet multiple needs. These include the importance of barachois ponds as significant features that add value to the landscape and agreement that they should not be filled in to support regional economic development without further information supporting this rationalization.

The greatest point of contention was whether enough is or is not known to effectively manage the ponds, which can also be addressed through continued strategic discussions. Overall, this research contributes to advancing informed management by mobilizing perceptions and values into key issues and consensus statements useable as a starting point for managers and decision-makers in Nova Scotia working with barachois ponds. Additionally, we suggest that the findings from this study could also be instrumental in providing valuable lessons to conservation managers more broadly on a range of perspectives with the potential to affect management outcomes.

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Author contributions

LR and LF conceived and designed the study. LR performed the experiments/collected the data. LR and LF analyzed and interpreted the data. LR and LF contributed resources. LR and LF drafted or revised the manuscript.

Competing interests

The authors have declared that no competing interests exist.

Data availability statement

All relevant data are within the paper and in the Supplementary Material.

Supplementary materials

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2020-0060.

Supplementary Material 1

Supplementary Material 2

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