

Drivers of Social Acceptability for Bivalve Aquaculture in Atlantic Canadian Communities

By

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# TABLE OF CONTENTS

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<b>LIST OF TABLES .....</b>	<b>4</b>
<b>LIST OF FIGURES .....</b>	<b>5</b>
<b>ABSTRACT.....</b>	<b>6</b>
<b>1 INTRODUCTION.....</b>	<b>7</b>
1.1 Global Perceptions of Bivalve Aquaculture.....	7
1.2 Management Problem .....	9
1.3 Research Aims and Objectives.....	9
<b>2 SOCIAL ACCEPTABILITY: BACKGROUND &amp; DEFINITIONS .....</b>	<b>10</b>
<b>3 METHODOLOGY .....</b>	<b>12</b>
3.1 Study Locations.....	12
3.2 Survey Design .....	15
3.3 Survey Distribution .....	16
3.3.1 Data Analysis.....	16
<b>4 RESULTS .....</b>	<b>17</b>
4.1 Survey Demographics .....	17
4.2 Identified Drivers .....	18
4.2.1 Environmental Drivers .....	18
4.2.2 Economic Drivers .....	20
4.2.3 Social Drivers .....	22
4.2.4 Governance Drivers .....	23
4.3 Bivalve Farming Preferences .....	24
4.4 Aquaculture Information Sources .....	26
<b>5 DISCUSSION.....</b>	<b>28</b>
5.1 Drivers of Social Acceptability .....	28

5.2 Influence of Local Settings on Social Acceptability .....	31
5.3 Impacts of Information Sources on Social Acceptability.....	32
5.4 Study Limitations .....	34
5.5 Management Recommendations .....	34
5.6 Conclusion.....	35
<b>ACKNOWLEDGMENTS .....</b>	<b>37</b>
<b>REFERENCES.....</b>	<b>38</b>
<b>APPENDICES.....</b>	<b>44</b>
Appendix A: Online Survey Questions .....	44
Appendix B: Mailing Routes.....	49
Appendix C: Statistical Tests .....	50

## LIST OF TABLES

---

**Table C1** Statistics for survey question Q9 (Figures 3, 4, & 5)..... 50

**Table C2** Statistics for survey questions Q6 (Figure 7), Q10 (Figure 8), and Q11 (Figure 9). ... 51

## LIST OF FIGURES

---

<b>Figure 1</b>	Map of local-scale study area, Antigonish Harbour, Nova Scotia .....	13
<b>Figure 2</b>	Map of local-scale study area, North Rustico Harbour, Prince Edward Island .....	14
<b>Figure 3</b>	Age and gender breakdown of study participants .....	18
<b>Figure 4</b>	Environmental themed statements ranked on a 5-point Likert-type scale.....	19
<b>Figure 5</b>	Economic themed statements ranked on a 5-point Likert-type scale .....	21
<b>Figure 6</b>	Social themed statements ranked on a 5-point Likert-type scale .....	22
<b>Figure 7</b>	Familiarity with mussel and oyster aquaculture ranked on a 4-point Likert-type scale... .....	24
<b>Figure 8</b>	Impressions of mussel and oyster aquaculture ranked on a 5-point Likert-type scale .	25
<b>Figure 9</b>	Mussel and oyster aquaculture preferences ranked on a 5-point Likert-type scale .....	26
<b>Figure 10</b>	Mussel and oyster aquaculture information sources.....	27
<b>Figure B1</b>	Mailing routes for Antigonish Harbour, NS, and North Rustico Harbour, PEI.....	49

## ABSTRACT

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Aquaculture is a growing sector in Canada; while salmon remains Canada's largest export, bivalve aquaculture production is increasing due to its perceived sustainability. Despite similar environmental effects of bivalve aquaculture on most ecosystems, the socio-economic contexts of prospective sites may differ; some ongoing and proposed bivalve farming projects are under intense public scrutiny in Atlantic Canadian communities. This research explores the environmental, social, and economic effects that inform social acceptance of bivalve aquaculture in Antigonish Harbour, NS, and North Rustico Harbour, PEI. Using a quantitative approach that examined perceptions of bivalve farming through online surveys, findings suggest that perceptions of environmental effects were mixed, social effects were negative, and economic effects were positive. Perceptions of environmental effects were similar, while economic and social effects varied between communities, suggesting that socio-economic contexts should be considered as part of prospective site evaluations. Research should be conducted at the local level to address how bivalve aquaculture may interact with communities; localized research could better identify drivers of community perception for bivalve aquaculture and potentially increase social acceptability of the industry.

*Keywords:* Bivalve farming, shellfish aquaculture, coastal communities, social acceptance, Atlantic Canada, Nova Scotia, Prince Edward Island

# 1 INTRODUCTION

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## 1.1 Global Perceptions of Bivalve Aquaculture

Seafood is becoming an increasingly important part of people's diets worldwide. In 2017, seafood accounted for 17% of the global population's animal protein consumption, and this figure continues to grow with consistent rises in total fish consumption over the last three decades (FAO, 2020). As reliance on seafood as a protein source grows, so do aquaculture production rates. Aquaculture is responsible for producing almost half of seafood protein worldwide as of 2018; this production is estimated to outpace wild capture production by more than 10% by 2030 (FAO, 2020).

Marine bivalves (including mussels, clams, oysters, scallops) are becoming an increasingly important part of the aquaculture sector and global diets overall, accounting for 89% of total bivalve production (Wijsman et al., 2019). Bivalve aquaculture is often considered a greener industry than other kinds of aquaculture, especially finfish (NRC, 2010); this perception can be attributed to a variety of factors including the lack of additive feed and antibiotics required for their production (NRC, 2010; Wijsman et al., 2019), water clarity improvements through filtration capabilities (Newell & Koch, 2004; Weitzman et al., 2019), removal of phytoplankton involved in eutrophication events (NRC, 2010; Weitzman et al., 2019), and promotion of habitat and vegetation restoration (Walker & Grant, 2009; NRC, 2010). These ecosystem services could be applied to coastal and estuarine spaces that are subject to eutrophication, erosion, and losses to submerged aquatic vegetation (NRC, 2010; van der Schatte Olivier et al., 2020).

Despite potential benefits to aquatic ecosystems, marine bivalve farming can also result in ecosystem disservices. For example, metabolic waste products can cause eutrophication in poorly flushed areas (Turner et al., 2019), and can reduce primary production through phytoplankton overgrazing when bivalves are at high stocking densities (Wijsman et al., 2019). Additionally, bivalves can alter infaunal communities at certain stocking densities (Beadman et al., 2004). Ecosystem services and disservices stemming from bivalve aquaculture are thus context dependent and must be considered for each prospective site (Newell & Koch, 2004; Turner et al., 2019). Similarly, public perceptions of ecosystem impacts stemming from bivalve aquaculture are context dependent and can be affected by a variety of interests, potentially

resulting in conflict with the aquaculture industry over the use of marine spaces (Campbell et al., 2020).

Aquaculture has been a historically controversial issue. Concerns for food safety and environmental sustainability of aquaculture are prevalent throughout North America, Europe, and Australia (Chu et al., 2010; Pigeon & Létourneau, 2014; Knapp & Rubino, 2016; Rigby et al., 2017; Flaherty et al., 2019; Ruiz-Chico et al., 2020). While bivalve aquaculture tends to generate less controversy when compared to finfish farming (NRC, 2010; Flaherty et al., 2019), perceived health risks and environmental concerns still exist for the bivalve farming industry (Garza-Gil et al., 2016; Holden et al., 2019). These perceived concerns on both a global and local scale could be part of the puzzle for determining the social acceptability of the bivalve industry at the local level.

In addition to perceived health risks and environmental concerns, perceived social and economic impacts can drive social acceptability of bivalve aquaculture (Chu et al., 2010; Flaherty et al., 2019, Mather & Fanning, 2019). Public concerns regarding social and economic impacts from bivalve farming include conflicts over marine space uses, limited or conflicting public-facing information, and aesthetic concerns (Mazur & Curtis, 2008; D'Anna & Murray, 2015; Beswick, 2019; Flaherty et al., 2019). These concerns extend to the local level, where some projects are under intense public scrutiny (Beswick, 2019; Mackenzie, 2019). Economic impacts at the local level, such as spatial conflict of existing economic and social uses with aquaculture, can influence community perceptions (Dalton et al., 2017; Holden et al., 2019).

These conflicts can be further intensified by how the community acquires information about aquaculture (Young & Matthews, 2010; Mather & Fanning, 2019). The newspaper coverage of 'marine aquaculture' is more negative in developed nations, with concerns about environmental impacts, health and food safety, and potential conflicts in ocean spaces (Froehlich et al., 2017). Other sources of information, including social media, word of mouth, and personal experiences with the industry can also play a role in determining social acceptance (Flaherty et al., 2019; Mather & Fanning, 2019). The extent that these sources of information impact perceptions can vary in differing contexts, especially on a local scale where vocal interest groups can receive significant attention within and outside of the community (Young & Matthews, 2010; Knapp & Rubino, 2016; Froelich et al., 2017; Flaherty et al., 2019; Mather & Fanning,

2019). Exploring sources of information at a local level is an important part of understanding drivers of social acceptability for bivalve aquaculture.

## **1.2 Management Problem**

Bivalve aquaculture is an industry with opportunities for sustainable growth; however, perceived environmental and health concerns, and potential conflicts between existing uses and bivalve aquaculture can lead to controversy, and ultimately, lack of social acceptance. In Atlantic Canada, the provinces of Nova Scotia (NS) and Prince Edward Island (PEI) have varying bivalve aquaculture production levels. PEI is the largest producer of oysters and mussels in Canada (DFO, 2016; DFO, 2019), and operations are expected to expand within the province (M. Ouellette, personal communication, February 14 2020). In PEI, some residents in North Rustico Harbour are concerned about the conversion of existing mussel leases to oyster farms (M. Ouellette, personal communication, February 14 2020). Bivalve aquaculture operations in NS are also expected to expand to meet existing demands (DFA, n.d. - a.; Flaherty et al., 2019). In NS, Antigonish Harbour is struggling with social acceptance for bivalve aquaculture (Beswick, 2019). As the industry evolves in these two Canadian provinces, potential conflicts over uses of the ocean spaces may also grow. Sound management practices in this industry require a clear understanding of the drivers of social acceptability for bivalve aquaculture to ensure long-term sustainability.

## **1.3 Research Aims and Objectives**

This research explores the drivers of social acceptability for bivalve aquaculture in two Atlantic Canadian communities. This research aims to determine the social acceptability of bivalve aquaculture in two communities, whether the drivers for social acceptability deviate between communities, and whether the source of bivalve aquaculture information affects perceptions of the industry. This was accomplished through surveying communities bordering Antigonish Harbour, NS, and North Rustico Harbour, PEI. Although previous studies have identified some of the environmental, economic, and social concerns that drive these perceptions throughout coastal provinces in Canada, these were focused on western Canadian perspectives or on Canadian perceptions generally (D'Anna & Murray, 2015; Flaherty et al., 2019; Holden et al., 2019). As local settings are crucial to understand public perceptions, insights resulting from

surveying Atlantic Canadian communities can assist with addressing concerns about bivalve aquaculture on a community level and may facilitate sustainable growth in this industry.

## **2 SOCIAL ACCEPTABILITY: BACKGROUND & DEFINITIONS**

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*Social acceptability* is a concept rooted in a variety of natural resource-based industries including forestry, mining, and more recently, aquaculture. The definition of social acceptability has fluctuated since its inception in the 1960s (Ford & Williams, 2016). The term made its first appearance in the public sector, where it referred to the idea that the decision-making process in natural resource management is more stable when there is broad acceptance of policy and industry practices (Ford & Williams, 2016). As the term began to evolve in the field of forestry management, Brunson (1996, p. 9) defined social acceptability as follows:

“Social acceptability in forest management results from a judgmental process by which individuals 1) compare the perceived reality with its known alternatives; and (2) decide whether the “real” condition is superior, or sufficiently similar, to the most favorable alternative condition. If the existing condition is not judged to be sufficient, the individual will initiate behavior - often, but not always, within a constituency group - that is believed likely to shift conditions toward a more favorable alternative”

This definition retains some of its original intentions, including the idea that broad acceptance of “conditions” (i.e., policy and practices) creates less resistance in the decision-making process, but also acknowledges the complexities involved in assessing what makes a practice “socially acceptable.” Members of the public judge industry practices as “acceptable” or “unacceptable,” and these judgments lead to an overall higher or lower degree of social acceptability (Brunson, 1996). This definition leads to the idea of “trade-offs” in natural resource management, where some conditions may be compromised in order to meet a desired outcome, such as environmental impacts for economic benefits (Mazur & Curtis, 2008). In other words, less desirable practices can still achieve social acceptability if the outcome is desirable to the collective community (Brunson, 1996). Krause et al. (2020) expand on this definition, where

social acceptability refers to, “a collective community-based evaluation” of actualized or perceived trade-offs (p. 2). Ultimately, social acceptability is rooted in the idea that public perceptions of industry practices and effects can vary, which in turn affects policy, natural resource-based industries, and terrestrial and coastal development.

Social acceptability is frequently discussed alongside a related concept: *social license to operate* (SLO). SLO arose in the 1990s from the mining sector and has been applied throughout natural resource management. Briefly, SLO, or a social license emerges when an industry has “the broad, ongoing approval and acceptance of society to conduct its activities” (Prno & Slocombe, 2017, p. 346). Krause et al. (2020) distinguished between the social acceptability and SLO by contrasting the broad applications of each concept. While both concepts aim to address and analyze drivers of public perceptions for specific industries, SLO is a mostly private sector approach, wherein the private sector attempts to achieve local and large-scale acceptance through a series of best practices for industry operations (Krause et al., 2020). Following this rationale, SLO can be viewed as a more tangible objective than social acceptability, where industries can obtain or achieve a social license in a community through effective communications strategies (Prno & Slocombe, 2012; Mather & Fanning, 2019; Krause et al., 2020). However, SLO may not be able to address the complexities involved in the formation of public perceptions, nor can drivers of these perceptions be easily evaluated, beyond whether a social license has been issued or withdrawn by the public (Mather & Fanning, 2019). Social acceptability is a useful concept to address the inherent complexities involved in the formation of public perceptions (Whitmarsh & Palmieri, 2009), although it too can be limited by the over-simplification of trade-offs and community-industry relationships (Ford & Williams, 2016; Campbell & Prémont, 2017; Caporale et al., 2020; Krause et al., 2020).

Modern social acceptability research has moved beyond forestry management to a variety of other resource-based sectors, including aquaculture. As previously established, aquaculture can be a contentious and controversial issue, and the social acceptability of aquaculture varies between countries and regions (Chu et al., 2010; Freeman et al., 2012; Bacher, 2015).

Accordingly, perceptions of trade-offs likely differ (Whitmarsh & Palmieri, 2009), which can impact the overall stability of industry development (Thomas et al., 2017). Developing a better understanding of what drives these perceptions can provide aquaculture regulators and industry an opportunity to develop practices addressing public concerns (Mather & Fanning, 2019).

### 3 METHODOLOGY

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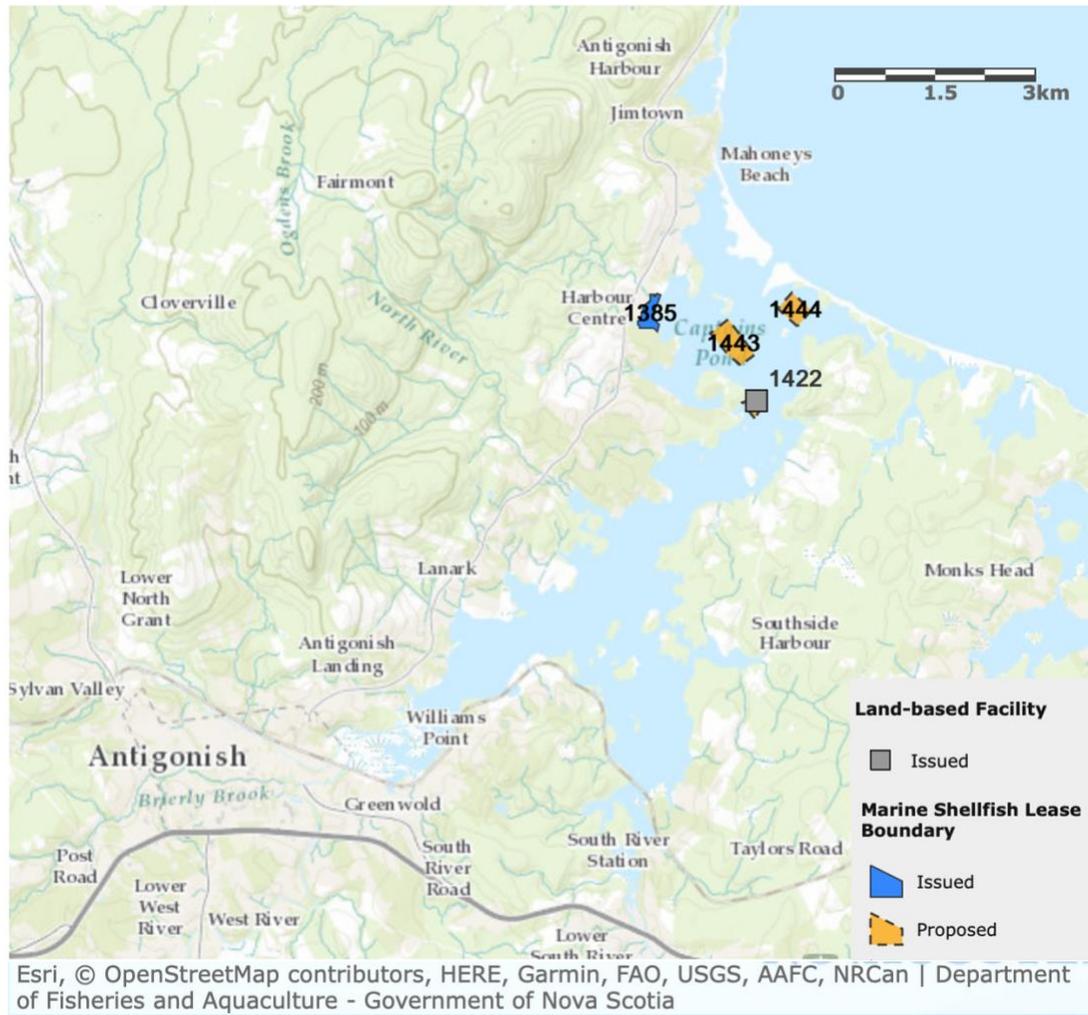
To fulfill the identified research objectives, a mixed qualitative and quantitative methods approach was used. These methods were applied to two separate sites: Antigonish Harbour, NS, and North Rustico Harbour, PEI. Online surveys in selected communities were conducted with questions guided by a review of the academic literature and grey literature, including newspaper articles and position papers, to identify potential drivers of social acceptability in bivalve aquaculture.

#### 3.1 Study Locations

The two communities surveyed in this research were identified by consulting a variety of secondary sources, including provincial media outlets and aquaculture experts.

##### *Antigonish Harbour*

Antigonish Harbour is located in the northeastern region of Nova Scotia within the county of Antigonish; Antigonish Harbour's main populace is found in the town of Antigonish, which is located to the southwest of the harbour area. The town of Antigonish is economically and culturally supported by two sectors: St Francis Xavier University and the local arts-based tourism industry (The Town of Antigonish, n.d.). The university is a major driver of activity in the region, although the summer months are largely supported by tourists and part-time residents (Destination Canada, n.d.). A proposed oyster farm, which would be one of two oyster farms in the harbour and the largest of the two (Figure 1), has generated controversy in the community (Beswick, 2019). The controversy of the proposed farm culminated in a meeting in the town of Antigonish where a variety of attendees raised concerns about impacts to the harbour ecosystem, recreational uses of the coastal space, and potential impacts to property values stemming from the implementation of a farm (Mackenzie, 2019).



**Figure 1** Map of local-scale study area, *Antigonish Harbour, Nova Scotia* including the issued and proposed aquaculture leases in the harbour. The orange pins represent the proposed oyster farm, the grey pin represents the proposed land-based oyster processing site, and the blue pin represents the pre-existing lease in the harbour (DFA, n.d. -b).

### *North Rustico Harbour*

North Rustico Harbour is found in the north-central section of Prince Edward Island within the county of Queens. The town of North Rustico is the largest residential area along the North Rustico Harbour, although much of the town is comprised of various tourist destinations. The major economic drivers in North Rustico are the tourism and fishing industries; many recreational fishing operations are present in the town and along the harbour (PEI Tourism, n.d.). The town is not far from Cavendish, which is the primary resort area on the northern shore of PEI. Similar to the town of Antigonish, many residences in North Rustico are occupied by

seasonal visitors to the area in the summer months. North Rustico Harbour is occupied by several mussel leases and oyster leases (Figure 2); however, more farmers are transitioning from mussel leases to oyster leases in the harbour. The transition has raised concerns for some residents in the North Rustico Harbour area, particularly regarding the aesthetics of the oyster cages (M. Ouellette, personal communication, February 14 2020).



**Figure 2** Map of local-scale study area, *North Rustico Harbour, Prince Edward Island*, including the issued off-bottom, bottom, and surface bivalve aquaculture leases in the harbour (Mills, 2020).

## 3.2 Survey Design

The survey was designed to target four main areas: familiarity, information sources, values, and aesthetic differences between oyster and mussel aquaculture (Appendix A). Survey questions about mussel and oyster aquaculture *familiarity* and aquaculture *information sources* were based on Flaherty et al. (2019). The Flaherty et al. study separated questions based on each type of aquaculture (e.g., finfish, bivalves, seaweed) occurring in the surveyed regions; this separation was adopted into the online survey in this study by separating mussel aquaculture and oyster aquaculture sources. *Value statements* about aquaculture perception involving a Likert-type scale were based on D'Anna & Murray (2015). D'Anna & Murray informed the content of their value statements by conducting interviews with bivalve aquaculture stakeholders in British Columbia (Canada); the value statements in D'Anna & Murray's study were based on three broad categories identified in the interviews – economy, environment, and experience. The online survey in this study utilized several of the value statements found in D'Anna & Murray's survey, positioned with different tenses based on the absence or presence of bivalve aquaculture in the Antigonish Harbour and North Rustico Harbour communities, respectively (e.g., Bivalve farms would/do). The value statements were selected based on the newspaper coverage of the controversy for the Antigonish Harbour site (Beswick, 2019; Mackenzie, 2019). The final questions in the survey used a Likert-type scale to evaluate potential *differences between mussel and oyster aquaculture perceptions*, which was based on the concerns about aesthetics raised in North Rustico Harbour about lease conversions (M. Ouellette, personal communication, February 14 2020).

The survey (Appendix A) began with a series of demographic questions, including age, gender, harbour located close to, and personal or family/friend involvement in the aquaculture industry. Next, participants were asked to rate their familiarity with mussel and oyster aquaculture separately on a 5-point scale where 1 = very unfamiliar, 2 = somewhat unfamiliar, 3 = somewhat familiar, 4 = very familiar, 5 = prefer not to answer. The survey continued with the participants being asked to identify sources of information for mussel and oyster aquaculture separately; participants selected as many sources that they determined necessary. A series of value statements related to bivalve aquaculture generally were provided, followed by value statements about the differences between mussel and oyster aquaculture generally. The value

statements were rated on a 6-point Likert-type scale where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree, and 6 = I don't know. The final question in the survey provided an option for respondents to leave comments if desired.

### **3.3 Survey Distribution**

The online survey was conducted from mid-June to early September in 2020 under Dalhousie University Marine Affairs Program Ethics Review Standing Committee (MAPERSC) file # 2020-05. The survey was administered online through Opinio, a survey tool hosted on Dalhousie servers. Respondents were required to be 18 years of age or older and a resident near either Antigonish Harbour or North Rustico Harbour.

The online survey was distributed using postcards with a link to the Opinio survey website. The postcards were distributed to residential addresses using a Canadian mailing service, The Printing House<sup>1</sup>. The residential addresses that received postcards were determined by the Smartmail Marketing™ routes available through Canada Post (Figure B1). 3229 postcards were mailed to Antigonish Harbour and 822 postcards were mailed to North Rustico Harbour. For a 95% confidence interval with a 5% margin of error, sample sizes of 344 and 263 were required for Antigonish Harbour and North Rustico Harbour, respectively. The first postcards were mailed to Antigonish Harbour and North Rustico Harbour during the week of June 15, 2020; a second round of postcards were mailed to North Rustico Harbour in late August 2020.

#### **3.3.1 Data Analysis**

Of the 3229 postcards mailed to Antigonish Harbour and the 822 postcards mailed to North Rustico Harbour, 75 and 43 surveys were completed for each community, respectively. These samples represented a 95% confidence interval and a margin of error of 11% for Antigonish Harbour, and a 95% confidence interval and a margin of error of 15% for North Rustico Harbour. To analyze the data, a Mann-Whitney U test was conducted to determine significant differences between responses from Antigonish Harbour and North Rustico Harbour in Likert-type statements (Appendix B).

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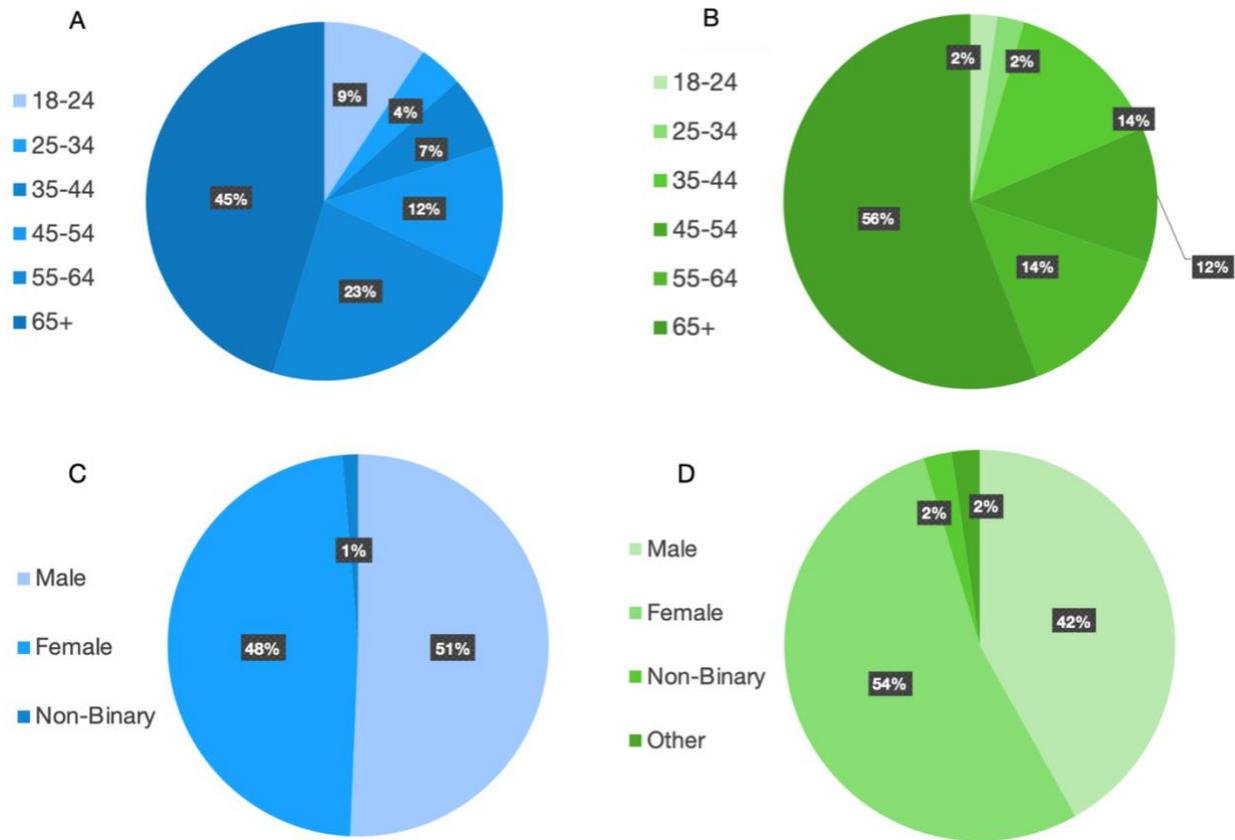
<sup>1</sup> The Printing House (Halifax office): <https://www.tph.ca>

## 4 RESULTS

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### 4.1 Survey Demographics

The survey had a total of 118 respondents with 75 respondents from the Antigonish Harbour area (AH) and 43 from North Rustico Harbour area (NRH). Senior participants, whom are 65 years or older, accounted for 45% of AH respondents and 56% of NRH respondents (Figure 3A, 3B). Younger adults (18-34) accounted for 13% and 4% of respondents in AH and NRH, respectively (Figure 3A, 3B). More female identifying participants (54%) responded in NRH than male participants (42%, Figure 3D), whereas the gender of respondents was more evenly distributed in AH (Figure 3C). Regarding family/friend and personal involvement in the aquaculture industry, 18% of AH respondents indicated they knew family or friends involved in the industry, contrasted with 33% of respondents in NRH. Personal involvement in the aquaculture industry accounted for 3% of AH survey respondents and 5% of NRH survey respondents.



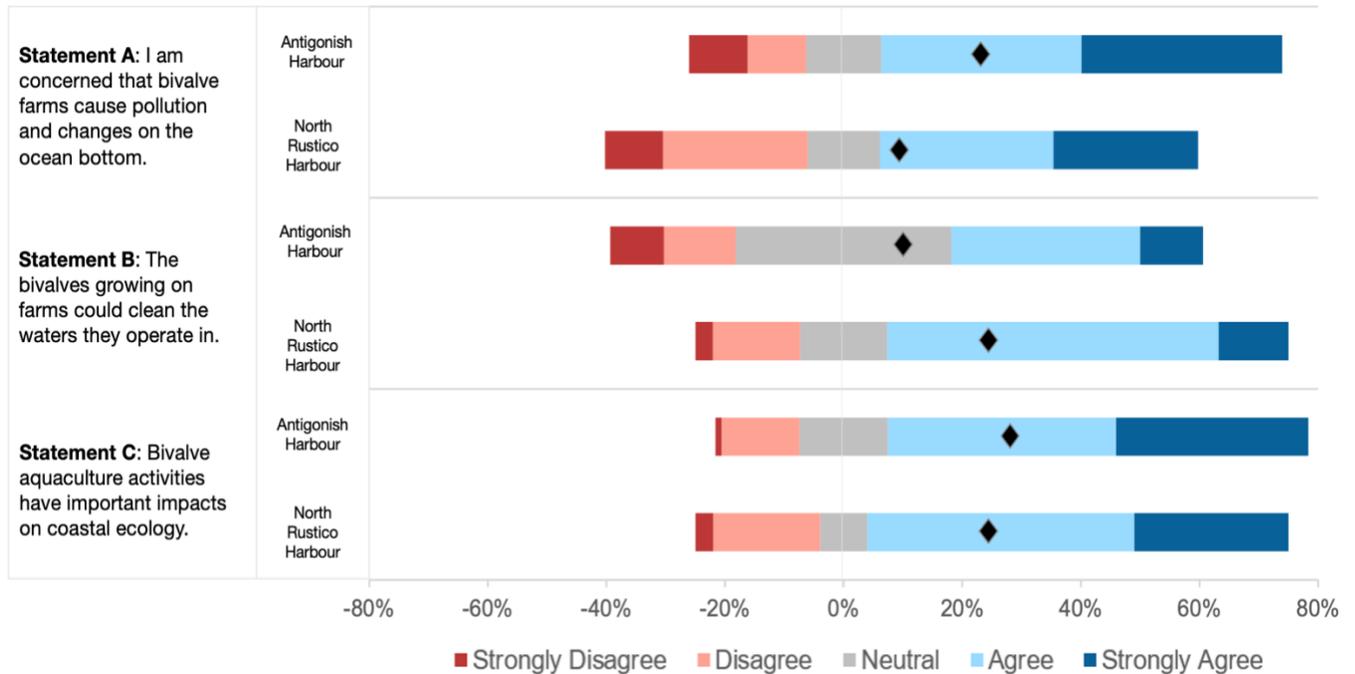
**Figure 3** Age (A & B) and gender (C & B) breakdown of study participants in Antigonish Harbour n= 75 (blue) and North Rustico Harbour n = 43 (green).

## 4.2 Identified Drivers

### 4.2.1 Environmental Drivers

The environmental drivers of social acceptability encompass Likert-type statements A, B, and C (Figure 4). AH and NRH respondents both agreed that pollution and alterations to the ocean floor can stem from bivalve farming (median = agree). NRH respondents generally agreed that farmed bivalves could clean water the farms operate in (median = agree) while AH respondents felt neutral about this statement (median = neutral); however, the community responses regarding this statement were statistically similar ( $p = 0.076$ ; Table C1). Both communities thought that bivalve aquaculture can have important impacts on coastal ecology (median = agree), although it is important to note that no differentiation was made between

positive or negative impacts in the phrasing of this statement (Figure 3). Accordingly, both communities shared the same perception of all environmental drivers.



**Figure 4** Environmental themed statements ranked on a 5-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response. Accordingly, negative and positive percentages indicate overall disagreement or agreement with the statement, respectively. The diamond indicates the median response; there are no statistically significant differences between communities.

Environmental issues were addressed in several comments left by respondents from both communities the end of the survey. Some respondents had concerns about water quality, negative impacts to marine mammals and shorebirds, eelgrass, and overall health of the harbours. This respondent from NRH indicated mixed feeling about environmental impacts and summarizes most negative impacts commentators raised,

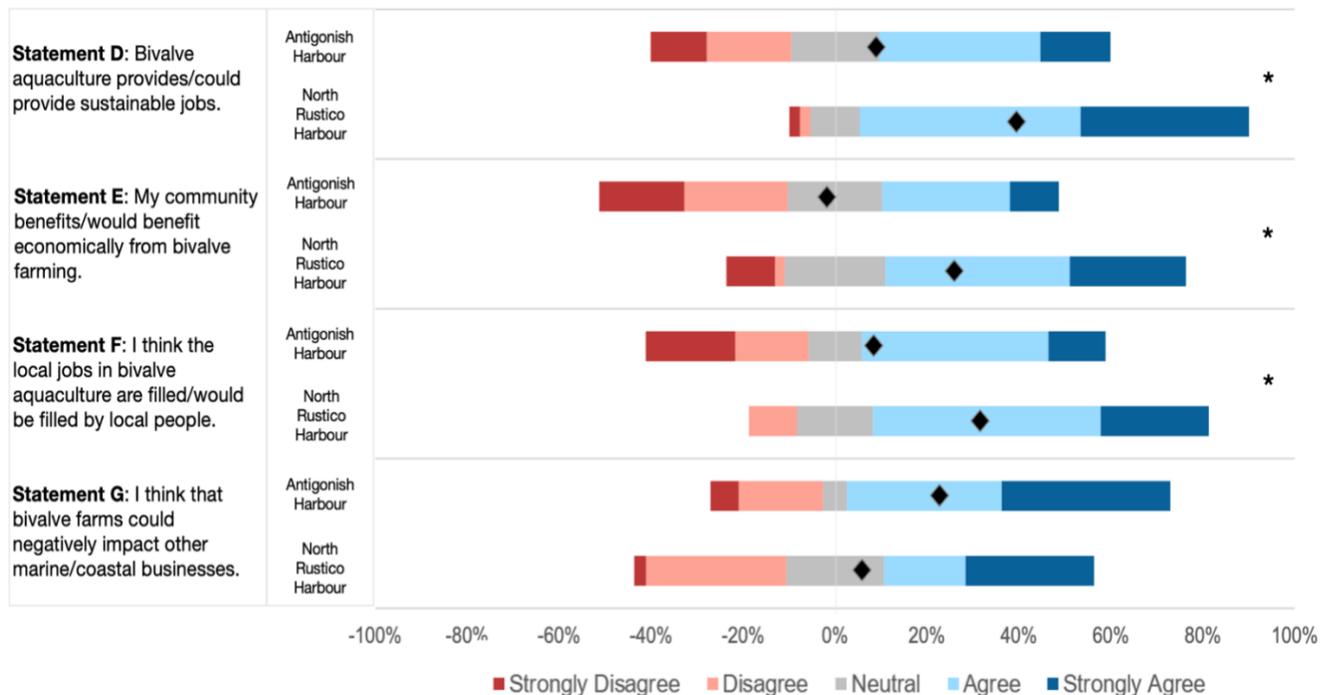
“Since our arrival on the Island 30+ years ago, my wife and I have seen more and more of these two industries (first mussel, now oyster) covering estuaries throughout the north shore of the province. Knowing the critical role of estuaries as nurseries of the marine ecosystem, we are deeply worried that these industries have been gradually choking the

life our of this ecosystem in waters in and around the Island... Having dove once under a mussel bed in one of our estuaries, I was astounded by the thick layer of suspended waste underneath it. However, I was also impressed by the amount of life, including starfish, clinging to the mussel socks.”

Some respondents in both communities indicated that the harbours were well suited to aquaculture, although most respondents who commented had more negative perceptions of environmental impacts from bivalve farming practices.

#### **4.2.2 Economic Drivers**

The economic drivers of social acceptability encompass Likert-type statements D, E, F, and G (Figure 5). Respondents from NRH generally felt that bivalve aquaculture provides or could provide sustainable jobs with a benefit to their economy (median = agree), whereas AH respondents felt more neutrally about these possibilities (median = neutral); the variation in these responses were statistically significant ( $p < 0.05$ ; Table C1). Regarding the potential for filling jobs in bivalve farming with local people, both communities reported the same median response (median = agree), but they were statistically different ( $p < 0.05$ ; Table C1), with AH respondents leaning towards a more neutral response. AH respondents generally believed that bivalve farms could negatively impact marine or coastal businesses (median = agree), while NRH respondents felt neutral about this statement (median = neutral); however, the community perceptions for this statement were not statistically significant ( $p = 0.218$ ; Table C1). The perceptions of economic drivers were the most variable between communities.



**Figure 5** Economic themed statements ranked on a 5-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response. Accordingly, negative and positive percentages indicate overall disagreement or agreement with the statement, respectively. The diamond indicates the median response, and the asterisk indicates statistically significant differences between communities.

AH respondents who commented on economic issues had mixed opinions about how the presence of bivalve aquaculture could impact the economy of their community:

“Loss of tourist industry jobs would outweigh any gain in aquaculture jobs.”

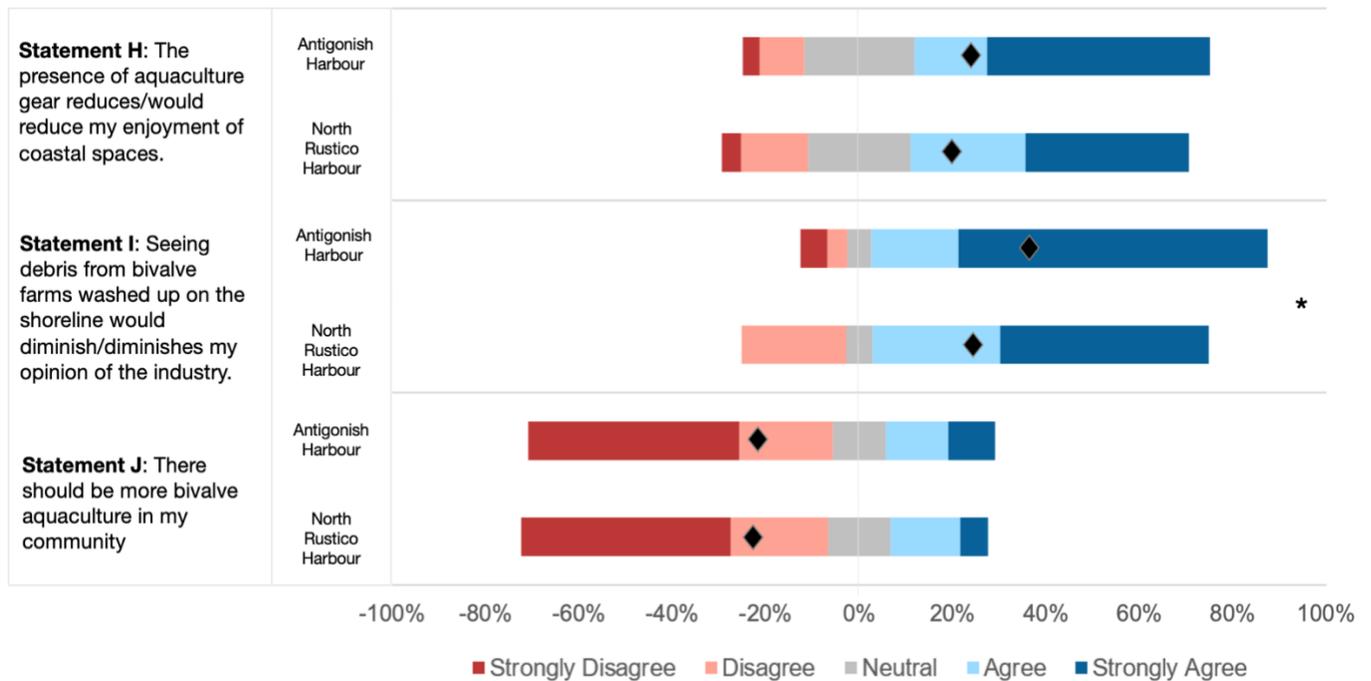
“Both mussel and oyster aquaculture provide direct and indirect employment benefits.”

“Aquaculture only supports minimal seasonal work for few people...”

Several comments discussed potential negative impacts to property values as a result of bivalve aquaculture. Respondents felt that “aquaculture would... have a significant negative impact on the value of [their] properties” and “...how [bivalve aquaculture] affects beauty of the area [and] other [people’s] property values... is important to consider”. Impacts to property values was a recurrent theme for respondents in both communities.

### 4.2.3 Social Drivers

The social drivers of social acceptability encompass Likert-type statements H, I, and J (Figure 6). AH and NRH respondents both felt that bivalve aquaculture gear would impact their enjoyment of harbour spaces (median = agree). AH and NRH respondents both felt that the presence of debris would diminish their enjoyment of the harbour (median = strongly agree), while NRH respondents did not believe as strongly (median = agree); these community variations were statistically different ( $p < 0.05$ , Table C1). AH and NRH respondents felt that there should not be more bivalve aquaculture in their communities (median = disagree), although it is important to note that the wording of this statement did not address whether respondents were satisfied with the current level of bivalve aquaculture in their communities. Overall, both communities had similar perceptions of social drivers with some variation about the presence of aquaculture debris.



**Figure 6** Social themed statements ranked on a 5-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response. Accordingly, negative and positive percentages indicate overall disagreement or agreement with the statement, respectively. The diamond indicates the median response, and the asterisk indicates statistically significant differences between communities.

Respondents in both communities reported additional impacts to social uses of the harbour, including recreational activities and aesthetics uses. The following respondent from NRH identified potential positive benefits from oyster farming, such as cleaner waters, and proceeded to address the following social impacts that were frequently discussed in the comments,

“Where I live we would... lose the recreational benefits and intangible benefits such as the beautiful view of the water in Rustico Bay. This is very important to tourism as well. People come to PEI to enjoy swimming, kayaking, gorgeous views and ugly black oyster cages would be a detriment to all of these. There are many areas more appropriate where [recreational] use isn't as important... there are kids playing and swimming in the water almost every day.”

Respondents in both communities indicated concerns about other social uses of the harbour becoming compromised. These concerns often stemmed from the physical attributes of the harbour; several respondents indicated that they believed the harbour was too “shallow” and “narrow” for bivalve aquaculture activities to occur without compromising current uses of the harbour.

#### **4.2.4 Governance Drivers**

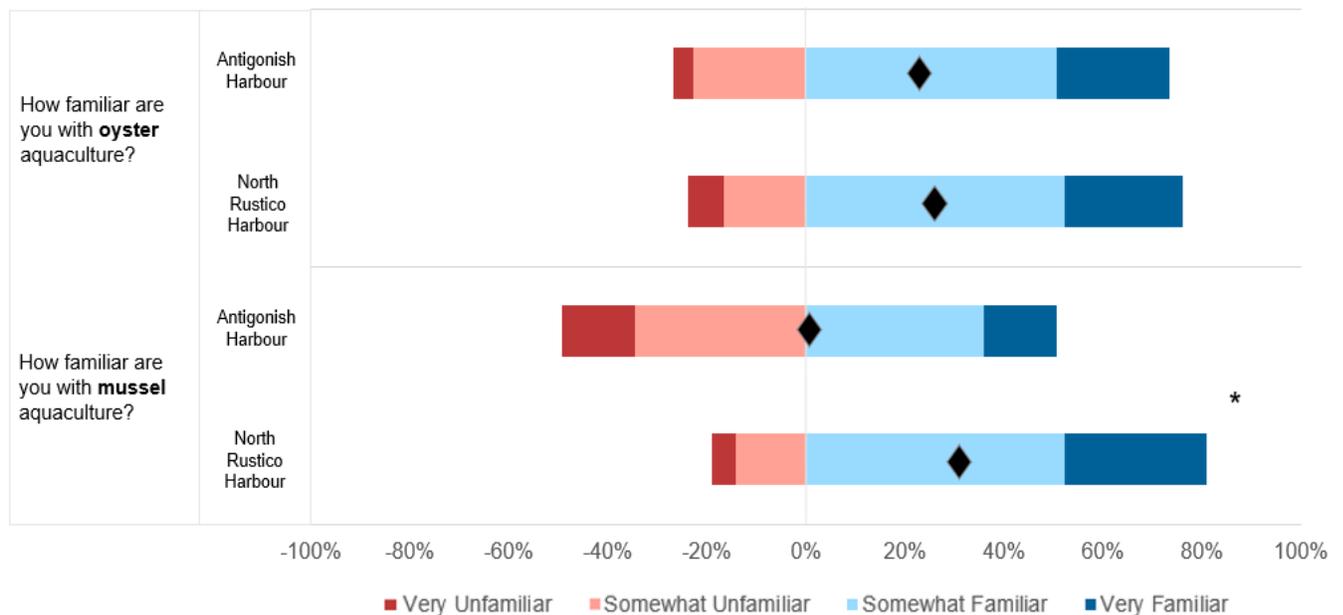
Although none of the value statements about bivalve aquaculture discussed relevance of the roles of government or aquaculture managers specifically, several commenters mentioned that both of these stakeholders impact their perception of the bivalve aquaculture industry. The following NRH respondent indicated that their perceptions of bivalve aquaculture have changed over time, which addressed most of the negative responses left by other commenters,

“I used to feel that it was a moral responsibility to share [the harbour] with the Aquaculture companies, but there is no 'sharing' on their side. They seem to have very little concern or consideration for us as they grow their leases and add more and more gear. We are not consulted in any way. We are told that the water quality is improving, but I no longer trust either the government or the businessmen.”

Other respondents indicated that they would be more supportive of bivalve aquaculture on a smaller scale and if it were “owned by the local population”. Only a couple of respondents contradicted these mostly negative perceptions of government and industry, saying that “the public should have nothing to do with [rules and regulations for the bivalve aquaculture industry]... I hate not in my backyard type politics”. Respondents in both communities addressed the governance drivers in the comments section of the survey.

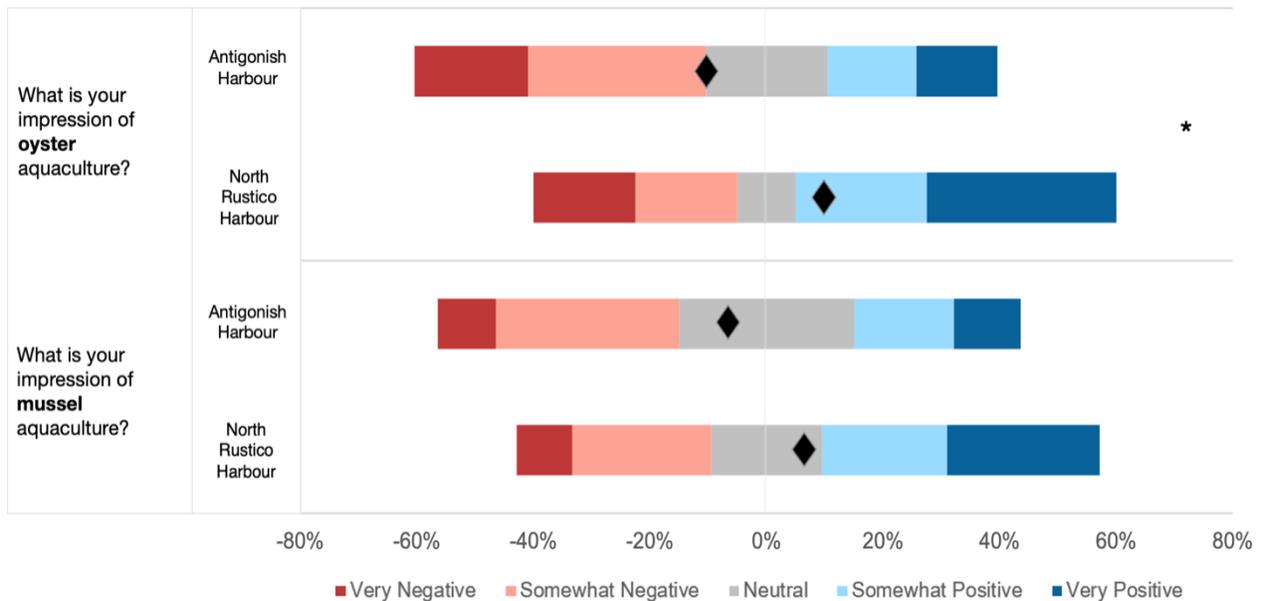
### 4.3 Bivalve Farming Preferences

AH and NRH respondents both had some familiarity with oyster and mussel aquaculture (median = somewhat familiar). There were no differences between the level of oyster familiarity in both communities (Figure 7). While the median responses for mussel farming familiarity were the same, the variation in responses between communities was statistically different, with AH respondents leaning towards a more neutral response ( $p < 0.05$ , Table C2).



**Figure 7** Familiarity with mussel and oyster aquaculture ranked on a 4-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response (i.e., the intersection of somewhat unfamiliar and somewhat familiar). Accordingly, negative and positive percentages indicate overall unfamiliarity or familiarity with the statement, respectively. The diamond indicates the median response, and the asterisk indicates statistically significant differences between communities.

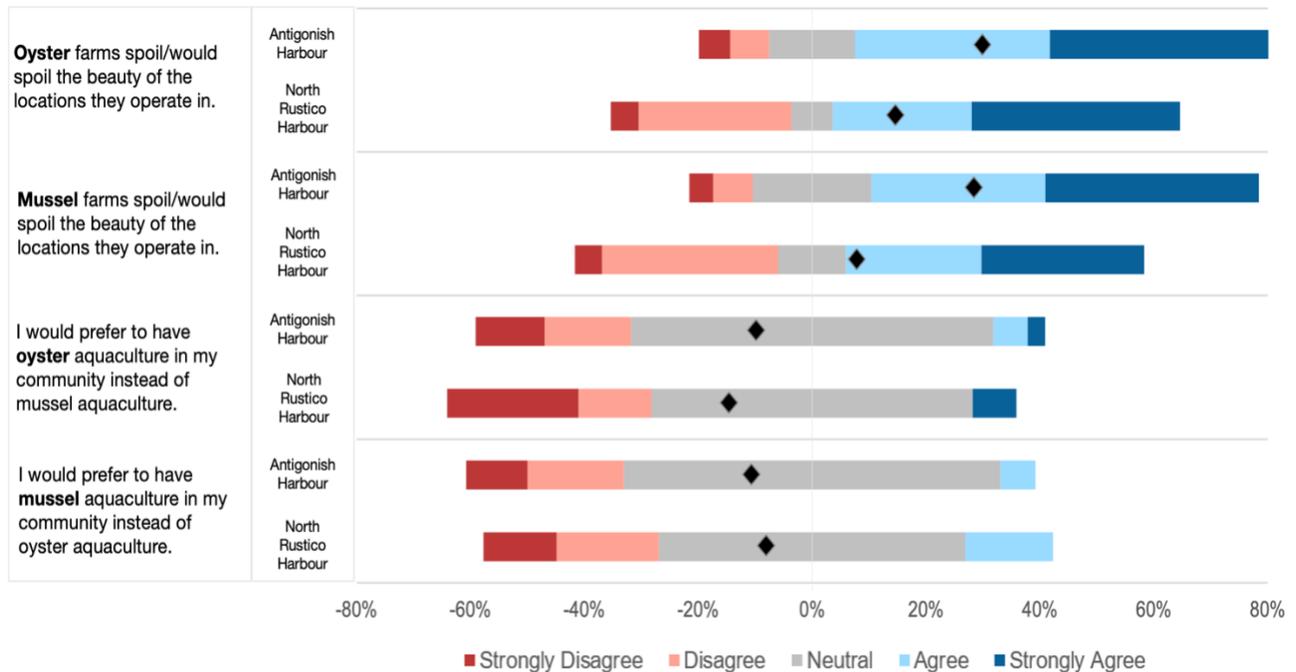
Despite equal familiarity with oyster aquaculture, respondents from NRH had a more favourable impression of this farming activity (median = somewhat positive) when compared to AH (median = neutral). These variations in responses were statistically significant ( $p < 0.05$ ; Table C2). In contrast, AH and NRH respondents had a similar and more neutral impression of mussel aquaculture (median = neutral). In general, there was some variation between the communities about their impressions of aquaculture (Figure 8).



**Figure 8** Impressions of mussel and oyster aquaculture ranked on a 5-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response. Accordingly, negative and positive percentages indicate negative or positive impression of bivalve aquaculture, respectively. The diamond indicates the median response, and the asterisk indicates statistically significant differences between communities.

In terms of aesthetic preferences, both AH and NRH respondents felt that the presence of mussel and oyster aquaculture would spoil the beauty of the harbours (median = agree). The communities did not have a strong positive or negative preference for either oyster or mussel aquaculture in their respective harbours (median = neutral). The mussel-oyster farming preference statements have the largest number of neutral responses for both communities when compared to any of the statements throughout the survey (Figure 9). Accordingly, there are no

differences between the communities about the aesthetics preferences for mussel and oyster aquaculture.

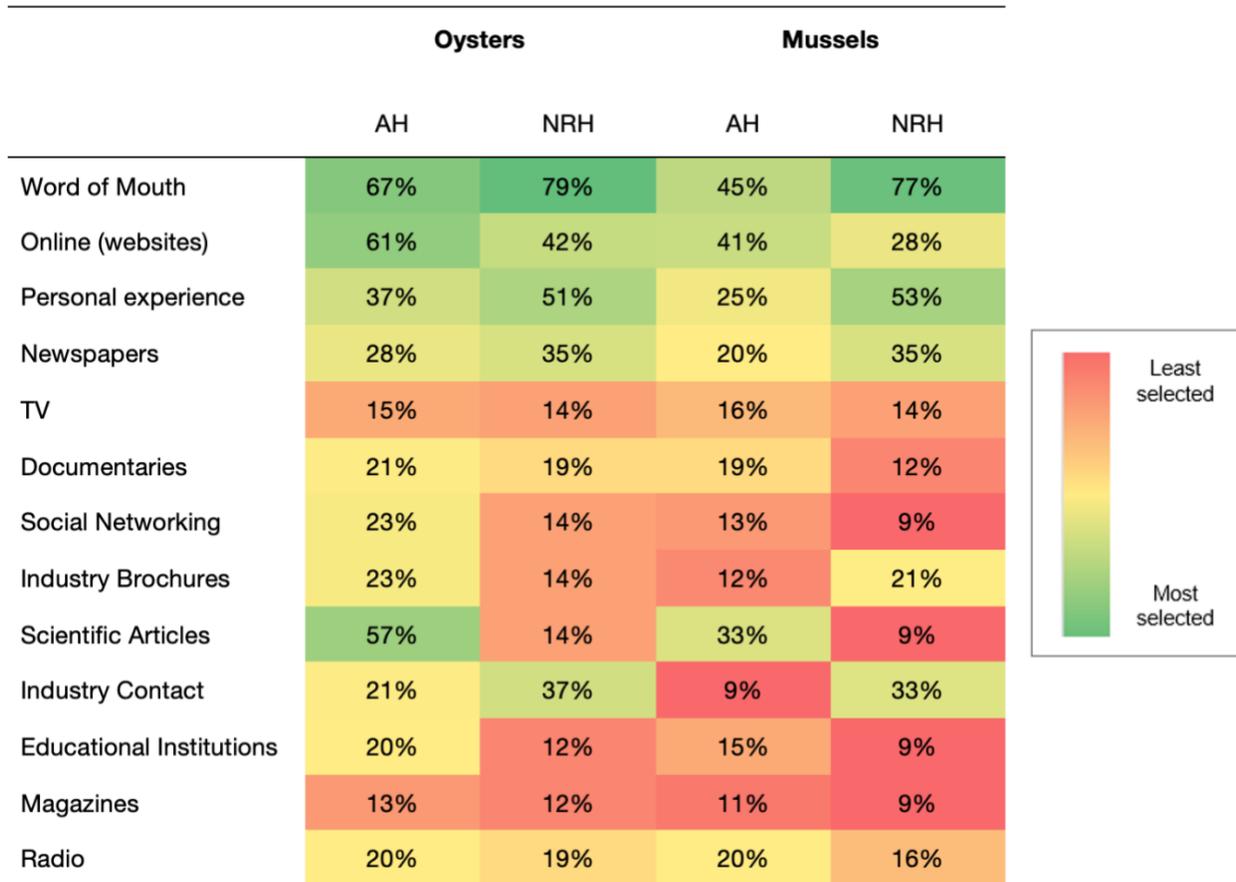


**Figure 9** Mussel and oyster aquaculture preferences ranked on a 5-point Likert-type scale by respondents from Antigonish Harbour and North Rustico Harbour. The percentage of responses is plotted for each Likert category, with the bar centered at the neutral response. Accordingly, negative and positive percentages indicate overall disagreement or agreement with the statement, respectively. The diamond indicates the median response; there are no statistically significant differences between communities.

#### 4.4 Aquaculture Information Sources

In general, AH respondents selected more information sources for oyster aquaculture when compared to mussel aquaculture, and NRH respondents had a similar number of sources for both aquaculture types (Figure 10). Word of mouth was the most frequently selected oyster and mussel aquaculture information source for both AH and NRH respondents. AH respondents selected word of mouth more frequently for oyster aquaculture when compared to mussel aquaculture; a similar percentage of respondents from NRH selected word of mouth as an information source for both aquaculture types. Other sources of information that both AH and NRH respondents frequently selected were online websites and personal experiences. AH

respondents selected online websites more frequently than NRH respondents for both types of bivalve aquaculture. NRH respondents selected personal experiences more frequently than AH respondents for both types of aquaculture as well.



**Figure 10** Oyster and mussel aquaculture information sources selected by respondents from Antigonish Harbour (n = 311, n = 218) and North Rustico Harbour (n = 164, n = 147). Respondents could select more than one response.

The percentage of AH respondents that selected scientific articles as a source of oyster aquaculture information was more than four times the percentage of NRH respondents; similarly, AH respondents selected scientific articles as a source for mussel aquaculture three times more than NRH respondents (Figure 10). Newspapers and industry contacts were also relevant sources, particularly in the NRH community.

## 5 DISCUSSION

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Understanding social acceptability is crucial for the sustainability of the aquaculture industry. The drivers of acceptability were determined through analyzing value statements associated with environmental, social, and economic effects of bivalve farming in two communities from Atlantic Canada; survey participants perceived social impacts the most negatively. Perceptions of the social and economic effects varied between the two communities, whereas perceptions of environmental effects did not. Furthermore, given the role that knowledge has in the formation of perceptions, the sources of aquaculture information were also determined; word of mouth was the most relevant information source of bivalve aquaculture.

### 5.1 Drivers of Social Acceptability

Community perceptions of environmental effects of bivalve aquaculture were mixed, as some effects were viewed more positively and others negatively. Contrarily, perceptions of social and economic effects were mostly negative and positive, respectively. Additionally, the emergence of governance drivers during the survey demonstrated that community perceptions of how aquaculture is regulated and managed can also impact social acceptability of the industry.

Regarding *environmental drivers*, participants were concerned about negative impacts such as pollution, impacts to aquatic vegetation and coastal and marine wildlife; however, some participants identified potential positive impacts, including water cleanliness and artificial habitats that aquaculture gear can create. The mixed negative and positive perceptions regarding environmental effects of bivalve aquaculture were supported by the literature (D'Anna & Murray, 2015; Thomas et al., 2017). The mixed perceptions have been related to uncertainties about bivalve aquaculture interactions with coastal ecosystems (Mazur & Curtis, 2008; D'Anna & Murray, 2015; Flaherty et al., 2019). Given that aquaculture environment interactions are site specific and also depend on the farmed biomass (Filgueira et al. 2016; Turner et al., 2019), there are cases in which aquaculture has exceeded the carrying capacity of the system leading to ecosystem impacts (Raillard & Ménesguen, 1994; Smaal et al., 2001), but in other cases, bivalve aquaculture has minimized potential eutrophication (Guyondet et al., 2015; Lavaud et al., 2020). Accordingly, the local context and documented positive and negative impacts in the scientific literature could explain the mixed public perceptions about potential environmental effects.

Generally, community members are more likely to be supportive of aquaculture when they believe that the activities do not degrade local ecosystems, and this perception can be improved when communities are provided information about environmental impacts (Katranidis et al., 2003; Flaherty et al., 2019). Therefore, localized studies about environmental effects of bivalve aquaculture could reduce mixed opinions about the potential impacts (Mazur & Curtis, 2008), and are crucial for aquaculture sustainability.

Survey participants had the most negative perceptions of *social drivers* related to the enjoyment of coastal spaces. The main social drivers included debris and aquaculture gear washing onto coastal spaces, impacts to recreational activities due to the conflict for space, and aesthetic concerns, which echo social drivers found in the literature (D'Anna & Murray, 2015; Knapp & Rubino, 2016). While also generally negative, the perception of social drivers was slightly more variable on the Pacific coast of Canada and it was highly dependent on the involvement of participants in the industry (D'Anna & Murray, 2015). Those involved in the industry focused on economic and environmental benefits from bivalve farming rather than on negative social impacts (D'Anna & Murray, 2015). The low involvement of participants in this study in the aquaculture industry could explain the stronger focus on social and environmental effects rather than economic benefits. Negative social impacts are often viewed as a trade-off for local economic benefits (Katranidis et al., 2003; Mazur & Curtis, 2008; D'Anna & Murray, 2015; Knapp & Rubino, 2016); therefore, economic benefits can play a role in mitigating the negative perceptions of the social drivers, further emphasizing the importance of localized studies that consider the social dimension of bivalve aquaculture (Whitmarsh & Palmieri, 2009; Holden et al., 2019).

Community perceptions of *economic drivers* tended to be more positive than the environmental or social drivers. The positive economic drivers included the creation of local jobs in a perceived sustainable field; however, potential impact to property values was a frequent concern. As stated previously, social impacts are often viewed as a trade-off for economic benefits; however, these trade-offs are not straightforward (Katranidis et al., 2003; Mazur & Curtis, 2008; D'Anna & Murray, 2015; Knapp & Rubino, 2016). For example, current research about the impacts of aquaculture on property values suggests a wide range of impacts depending on the coastal context (Evans et al., 2017). These impacts could be minimized with coastal planning that focuses on integrating industrial aquaculture structures with the coastal seascape

(Evans et al., 2017). Accordingly, similar to environmental and social drivers, the assessment of the effects of aquaculture on economic drivers is highly dependent on coastal settings.

The survey did not include questions designed to address *governance drivers*; however, participants addressed governance themes frequently in the comments. There is a desire for better transparency and accountability from regulators and aquaculture managers in how bivalve aquaculture sites are selected and regulated, particularly in the comments from AH, which emphasized distrust between community members and governance institutions. Trust is a key component of social acceptability for aquaculture operations (Barrington et al., 2010; Schlag & Ystgaard, & 2013; Holden et al., 2019), so existing controversy involving bivalve farming may stem from a lack of trust in government and industry, as well as limited transparency about project logistics and potential impacts to coastal spaces (Mazur & Curtis, 2008; D'Anna & Murray, 2015). Furthermore, since aquaculture developments depend on shared uses of coastal spaces between public and private interests, potential conflict may arise between social uses of the coastal space with aquaculture infrastructure (Knapp & Rubino, 2016; Holden et al., 2019). These concerns are echoed by community members on the Pacific coast of Canada, some of whom describe a theme of alienation stemming from restricted views, noises, and debris as a result of aquaculture developments (D'Anna & Murray, 2015). Given the role that coastal spaces and their cultural uses have in the well-being of communities (Outeiro & Villasante, 2013), the allocation of public space to a private entity must be a transparent process. Similar to the aesthetic concerns and impacts to property values, the feeling of alienation from public and private coastal space division can be an important determinant of social acceptability for bivalve aquaculture.

In general, Canadians have a favourable perception of the industry's potential for economic growth and perceived sustainability (Flaherty et al., 2019), which is echoed in international research (Mazur & Curtis, 2008; Chu et al., 2010; Bacher, 2015; Ruiz-Chico et al., 2020). This view is generally supported by the results of this study, where the surveyed communities felt that the industry has some environmental and economic benefits, yet concerns about environmental and social effects of bivalve aquaculture were strong. According to D'Anna & Murray (2015), attitudes towards bivalve farming could be shifted through better integration with existing community industries and activities, which is echoed in the comments of some survey respondents. Therefore, coastal zone planning that considers a variety of current

economic and social uses, such as tourism, may address some of the concerns about impacts to property values, conflict for space, and reduce the overall aesthetic impact from bivalve farms (D'Anna & Murray, 2015; Evans et al., 2017; Holden et al., 2019). In general, improved transparency in the industry when dividing public and private spaces can address feelings of distrust and alienation (Mazur & Curtis, 2008; D'Anna & Murray, 2015). Finally, since environmental, social, and economic effects of bivalve aquaculture are context-dependent, studies assessing social acceptability of the industry should be performed at a local scale (Mather & Fanning, 2019; Krause et al., 2020).

## **5.2 Influence of Local Settings on Social Acceptability**

Although both Antigonish Harbour (AH) and North Rustico Harbour (NRH) communities shared the same perception regarding the environmental implications of bivalve aquaculture, differences emerged mostly in economic effects and to a certain degree in social drivers. Particularly, AH respondents were less certain of the ability of the industry to create sustainable, local jobs that would contribute to the local economy, whereas NRH were more certain of these economic benefits. The uncertainty about the potential economic benefits seen in the AH respondents suggests that the community does not believe the industry will provide enough benefits to be worth the social and environmental trade-offs involved in its operation, following the rationale by Outeiro & Villasante (2013). In regard to social drivers, AH respondents perceived aquaculture debris more negatively than NRH. The variations in economic and social drivers between both communities can reflect how the same drivers may be perceived differently based on community context, with AH respondents perceiving bivalve aquaculture more negatively. Accordingly, AH respondents generally oppose the implementation of bivalve aquaculture in their community, as suggested by the more negative responses about potential aquaculture expansion in their community. Similar to environmental effects, differences in socio-economic contexts can emphasise particular drivers over others depending on community priorities (Mazur & Curtis, 2008; Ford & Williams, 2016). For example, locals who value recreational uses as a crucial part of the coastal space are more likely to perceive changes to that space negatively (Shafer et al., 2010); similarly, homeowners with waterfront views may be more likely to perceive visual impacts from shellfish aquaculture on the surrounding landscape

negatively (Dalton et al., 2017). Therefore, the differing perceptions in both communities could be related to specific socio-economic settings.

Similar to other communities throughout PEI, NRH has been a site for bivalve aquaculture developments for several decades (PEI tourism, n.d.; Mills, 2020); contrarily, AH had only been recently considered as a prospective site at the time of this study (Beswick, 2019). Shifts in community opinion can occur with exposure to specific industries; a community that initially disapproves of changes in land use for the proposed industry may begin to perceive the industry more positively if the community observes economic benefits (Ford & Williams, 2016). According to Katranidis et al. (2003), long-term exposure to the aquaculture industry can reveal economic benefits influencing social acceptability, which may relate to the experiences of both communities in this study. Overall awareness of the aquaculture industry also seems to have a role in aquaculture perception, as those with higher awareness and exposure to the industry tend to be more supportive of aquaculture development (Freeman et al., 2012; Thomas et al., 2017). However, it would be incorrect to assume that exposure to the industry is the only requirement to achieve social acceptance, as the interactions between aquaculture, coastal spaces, and communities are dynamic (Dalton et al., 2017; Thomas et al., 2017). Identifying and addressing the drivers of social acceptance for bivalve aquaculture requires contextualized consideration of environmental, economic, and social dimensions.

### **5.3 Impacts of Information Sources on Social Acceptability**

Most survey participants received their information about bivalve aquaculture as word of mouth along with personal experiences. The frequency of these sources, along with the selection of industry contacts by NRH, is supported by the existing literature, where word of mouth, personal experiences, and industry contacts are most frequently cited information sources for bivalve aquaculture by Atlantic Canadians (Flaherty et al., 2019). Similarly, it has been suggested personal experiences can play a large role in public perceptions of aquaculture, especially in regions less knowledgeable about the industry (Young & Matthews, 2010; Bacher, 2015). As previously established, perceptions are context-specific, and the knowledge that informs perceptions may also vary with context (Brunson & Shindler, 2004). The prevalence of word of mouth, personal experience, and industry contacts suggest that the local communication network has a role in the flow of information, which can influence social acceptability (Maxwell

& Filgueira, 2020). For example, having industry involved in the local communication network may improve acceptability (Brunson & Shindler, 2004; Mazur & Curtis, 2008; D'Anna & Murray, 2015). Accordingly, the different exposure to aquaculture in both communities can shape the communication network, level of knowledge, and consequently perception of the industry.

More than half of AH respondents indicated they get some of their information about oyster aquaculture from scientific articles, whereas NRH respondents indicated they do not commonly use scientific articles as an information source. The contrasting interest in scientific articles for the communities could be explained by differing exposure to the industry. Since the prospective oyster farm in AH is a recent development and under public scrutiny (Beswick, 2019; Beswick, 2020), this could explain a higher interest in scientific publications for AH respondents as their community engages with the new development. Additionally, news articles were also commonly selected sources in both AH and NRH, echoing the results for Atlantic Canadians in Flaherty et al. (2019). News articles in Canada feature more negative coverage of marine aquaculture relative to other developed countries (Froehlich et al., 2017), and media interest in aquaculture tends to increase when controversy occurs (Young & Matthews, 2010; Rickard et al., 2018). Given that the portrayal of aquaculture in the media has a role in aquaculture perception (Feucht & Zander, 2017), and the media is viewed somewhat reliably in Atlantic Canada (Flaherty et al., 2019), the negative media portrayal of the industry may impact overall perceptions.

Despite the fact that participants selected seven sources of information on average, some of the comments from participants suggest that there is a need for increased or improved sources of aquaculture information; for example, the following respondent from AH stated that "... more information needs to be presented to the public". As previously established, effects and perceptions of bivalve aquaculture are context dependent (Mathers & Fanning, 2019; Krause et al., 2020), which can result in the prioritization of certain effects depending on the community (Mazur & Curtis, 2008; Ford & Williams, 2016). Therefore, information needs in communities can differ as well (Mazur & Curtis, 2008), as exemplified by the different use of scientific articles in this study. However, it is important to note that increasing information and knowledge does not necessarily improve public perceptions of bivalve aquaculture (Brunson & Shindler, 2004; Ford & Williams, 2016). In fact, increasing aquaculture knowledge can increase

conflicting claims, resulting in more uncertainty (Young & Matthews, 2010). Future research should explore how information sources and level of knowledge about the industry interact with the formation of public perceptions.

#### **5.4 Study Limitations**

Recruitment was the primary limitation for this study. Recruitment by mail targets households rather than individuals; while the postcards with the survey link may have reached desired households, there was no control over who answered the survey within that household. Our demographic information indicates most respondents in both communities were seniors (45% AH, 56% NRH), which does not accurately reflect the demographics of the community, where seniors in the major residential centres only represent 30% of the AH and 23% of the NRH populations (Statistics Canada, 2017a; Statistics Canada, 2017b). Therefore, our study covers the responses of community members, but it is not representative of the community itself. Furthermore, we intended the survey to be mailed to households in close proximity to the waterfronts of both AH and NRH; however, the targeted mailing routes used to distribute the survey postcards to households encompassed a larger area than intended, especially in the NRH area. Additionally, we could not guarantee that households collected the postcard. Lastly, the survey took place in the wake of ongoing controversy about a proposed oyster farm in the Antigonish Harbour, which may have caused bias in the survey results. For example, the Friends of Antigonish Harbour, a local environmental interest group that possesses an anti-aquaculture position (Friends of Antigonish Harbour, 2019), posted the link to the online survey on Facebook on July 3, 2020. Therefore, it is important to restate that the perceptions in this study represent individual voices, but not the community as a whole.

#### **5.5 Management Recommendations**

Social acceptability of bivalve aquaculture is affected by community perceptions, and these perceptions can vary at the local level. Therefore, increasing the number of studies assessing perceptions of bivalve farming at the local level are key to understanding drivers of social acceptability. There are uncertainties about the environmental, social, and economic effects of bivalve aquaculture and mistrust of aquaculture regulators in both surveyed communities. Therefore, aquaculture regulators must be transparent and communicate effectively

about industry practices to reduce uncertainty and establish trust. Additionally, since industry involvement in communities improves perception (Brunson & Shindler, 2004; Mazur & Curtis, 2008; D'Anna & Murray, 2015), regulators could improve social acceptability by involving locals through employment and as part of the decision-making process through meaningful engagement (Chu et al, 2010; Knapp & Rubino, 2016; Campbell et al., 2020). Given the role of local sources of information in aquaculture knowledge and perceptions, an unbiased knowledge broker acting as a mediator between stakeholders could mitigate conflict. Lastly, prospective aquaculture sites should be considered on a case-by-case basis for more than environmental feasibility, as the consideration of the socio-economic context of the area improves the integration of bivalve farming with the existing coastal space, ensuring long-term sustainability of the site and industry (Whitmarsh & Palmieri, 2009; Thomas et al., 2017; Calporale et al., 2020).

## **5.6 Conclusion**

Aquaculture production is expected to increase worldwide as demands for seafood protein increases. Consequentially, aquaculture regulators must expand operations in order to meet consumer demands. The bivalve farming industry is an important part of the solution; however, conflicts between the industry and coastal communities could impede further development. This research explored environmental, social, and economic drivers of social acceptability in two Atlantic Canadian communities and found that the drivers are similar to those in existing literature. While the perception of environmental drivers was similar in both communities, there was variation in perceived economic drivers of social acceptability, which suggests that acceptability of the industry should be considered on a community basis. Measuring impressions of aquaculture could operate as a stand-in for social acceptability, and the difference in drivers may have led to the differences found in community impressions. Communities have different needs and priorities for coastal spaces, and conflicts between economic and social uses of coastal spaces will occur more frequently as bivalve aquaculture continues to grow. Aquaculture regulators should consider community priorities for coastal spaces when evaluating prospective sites, and improve communication and transparency regarding industry practices. A local focus in bivalve aquaculture research, and the integration of socio-economic context, can address the complexity involved in assessing and achieving social

acceptability. A better understanding of social acceptability drivers and improved community integration with the decision-making process can provide a stronger foundation for aquaculture regulators and communities to meet desired outcomes.

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# APPENDICES

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## Appendix A: Online Survey Questions

### Drivers of Social Acceptability for Shellfish Aquaculture in Atlantic Canada

This research project is led by Shannon Wood, a Master of Marine Management student at Dalhousie University and is funded through the laboratory of Dr. Ramón Filgueira. Your participation is voluntary and you may withdraw from the survey at any time prior to completion. **No personally identifying information will be collected, and all responses will be anonymous.**

This online survey should take about 5 to 10 minutes to complete.

The survey will ask you questions about your perceptions of shellfish aquaculture operations in Atlantic Canada. You will also be asked to provide demographic information about your age, gender, and involvement of yourself, family, and/or friends in the aquaculture industry. If at any time you feel you cannot answer a question, or if a question makes you uncomfortable, you can select prefer not to answer or exit the survey entirely by closing your internet browser. Incomplete surveys will not be included in the analyses. If you do complete the survey and you change your mind later, the information you provided cannot be removed as your response is anonymous.

For any questions, concerns, or more information about the study, please contact Shannon Wood (shannon.e.wood@dal.ca, (647)520-7045). You can also contact the project's supervisor, Dr. Ramón Filgueira, at ramon.filgueira@dal.ca. The results of this study will be used for **academic purposes only**, and used only for peer-reviewed publication and part of a graduate project for the Master of Marine Management program. This research has been reviewed according to the Marine Affairs Program Ethics Review Standing Committee. If you have any ethical questions, you can contact them by email at marine.affairs@dal.ca (and reference MAPERSC file # 2020-05).

### **Before you begin, please click the following buttons, agreeing that:**

- I have read the above information explaining the study. I understand that participating is my choice, and that I may leave the survey any time before completion.
- I am at least 18 years of age.
- I am currently a resident near Antigonish Harbour, NS, or North Rustico Harbour, PEI.
- This is the first time I have completed this survey.

If you have accepted all the items above, please click the "Start" button below to begin the survey. If you wish to leave the survey at any time, simply close the browser. Your responses will only be saved once you click the "Submit finished survey" button at the end of the survey.

### **General Information**

1. What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

2. What gender do you identify as?

- Male
- Female
- Non-binary
- Other \_\_\_\_\_

3. Which harbour is your home located close to?

- Antigonish Harbour, NS
- North Rustico Harbour, PEI

4. Are you involved in the aquaculture industry?

- Yes
- No
- Prefer not to say

5. Do you have friends or family involved in the aquaculture industry?

- Yes
- No
- Prefer not to say

6. How familiar are you with the following types of shellfish aquaculture?

	Very unfamiliar	Somewhat unfamiliar	Somewhat familiar	Very familiar	Prefer not to answer
Oysters	<input type="radio"/>				
Mussels	<input type="radio"/>				

7. Where do you get your information about oyster aquaculture? (Please check all that apply).

- Word of mouth (friends, family, work colleagues)
- Online – websites
- Personal experience
- Newspapers
- TV
- Documentaries
- Social networking (Twitter, Facebook)
- Industry brochures
- Scientific articles
- Industry contact
- Education institutions
- Magazines
- Radio
- Other \_\_\_\_\_

8. Where do you get your information about mussel aquaculture? (Please check all that apply).

- Word of mouth (friends, family, work colleagues)
- Online – websites
- Personal experience
- Newspapers
- TV
- Documentaries
- Social networking (Twitter, Facebook)
- Industry brochures
- Scientific articles

- Industry contact
- Education institutions
- Magazines
- Radio
- Other \_\_\_\_\_

9. I would like to know your views about current/possible shellfish aquaculture operations in your community. A list of statements has been compiled from various sources about this topic. These statements assume that both mussel and oyster aquaculture have similar ecosystem roles and economic implications. Please indicate your level of agreement with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
I am concerned that shellfish farms cause pollution and changes on the ocean bottom.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The shellfish growing on farms could clean the waters they operate in.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shellfish aquaculture activities do not have important impacts on coastal ecology.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shellfish aquaculture provides/could provide sustainable jobs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My community benefits/would benefit economically from shellfish farming.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the local jobs in shellfish aquaculture are filled/would be filled by local people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that shellfish farms could negatively impact other marine/coastal businesses.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The presence of aquaculture gear reduces/would reduce my enjoyment of coastal spaces.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seeing debris from shellfish farms washed up on the shoreline would diminish/diminishes my opinion of the industry.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There should be more shellfish aquaculture in my community.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. What is your impression of the following types of shellfish farming?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	I don't know
Oysters	<input type="radio"/>					
Mussels	<input type="radio"/>					

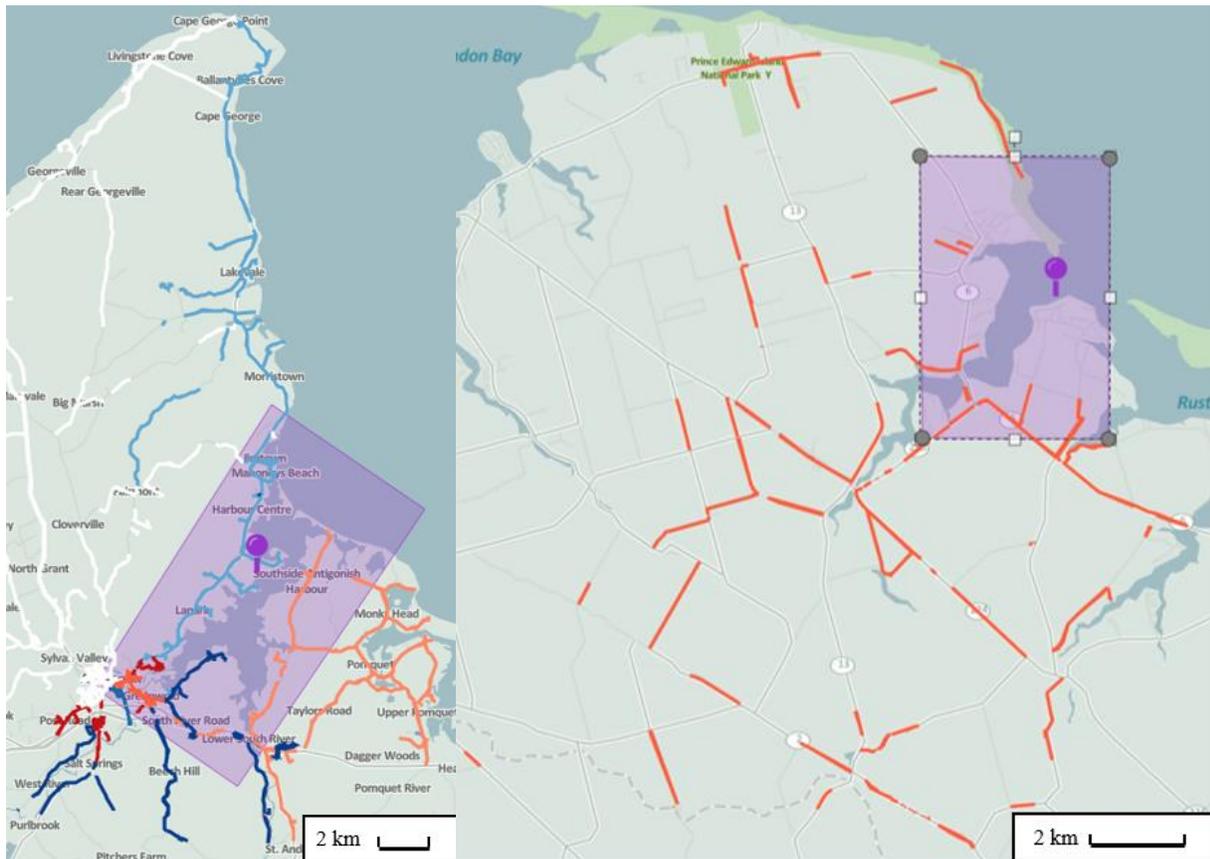
11. What are your views on mussel and oyster farms? Please indicate your level of agreement with the following statements:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
Oyster farms spoil/would spoil the beauty of the locations they operate in.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mussel farms spoil/would spoil the beauty of the locations they operate in.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would prefer to have oyster aquaculture in my community instead of mussel aquaculture.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would prefer to have mussel aquaculture in my community instead of oyster aquaculture.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. If you wish to include any comments about the topic that were not captured in this survey, please write your comments below.

Thank you for participating in this survey.

## Appendix B: Mailing Routes



**Figure 11** Mailing routes for Antigonish Harbour, NS (left), and North Rustico Harbour, PEI (right). The coloured lines indicate the different mailing routes that include the residential addresses for the desired study area (one colour = one mailing route). Postcards were mailed to residential addresses along the coloured lines. The purple boxes indicate the desired study areas for household surveying.

## Appendix C: Statistical Tests

**Table C1** Statistics for survey question Q9 (Figures 3, 4, & 5). Medians were ranked using a 5-point Likert-type scale, where 1, 2 indicated disagreement, 3 indicated neutrality, and 4, 5 indicated agreement. The term shellfish was replaced with bivalve for the purposes of Figures 3, 4, 5.

Statement	Location	n	Median	Mean	Std. Deviation	Mann-Whitney U	P-value
<b>Statement A:</b> I am concerned that shellfish farms cause pollution and changes on the ocean bottom.	AH	71	4	3.72	1.300	1221.5	0.143
	NRH	41	4	3.34	1.353		
<b>Statement B:</b> The shellfish growing on farms could clean the waters they operate in.	AH	66	3	3.23	1.093	889.5	0.076
	NRH	34	4	3.59	0.988		
<b>Statement C:</b> Shellfish aquaculture activities do not have important impacts on coastal ecology.*	AH	68	2	2.13	1.064	1215.0	0.593
	NRH	38	2	2.26	1.131		
<b>Statement D:</b> Shellfish aquaculture provides/could provide sustainable jobs.	AH	68	3	3.22	1.244	730.5	p<0.001
	NRH	41	4	4.22	0.852		
<b>Statement E:</b> My community benefits/would benefit economically from shellfish farming.	AH	71	3	2.89	1.337	906.0	p<0.001
	NRH	41	4	3.78	1.255		
<b>Statement F:</b> I think the local jobs in shellfish aquaculture are filled/would be filled by local people.	AH	67	3	3.09	1.252	935.5	p<0.01
	NRH	41	4	3.80	0.901		
<b>Statement G:</b> I think that shellfish farms could negatively impact other marine/coastal businesses.	AH	70	4	3.71	1.264	1145.0	0.218
	NRH	38	3	3.39	1.285		
<b>Statement H:</b> The presence of aquaculture gear reduces/would reduce my enjoyment of coastal spaces.	AH	72	5	4.10	1.224	1302.0	0.184
	NRH	42	4	3.83	1.267		
<b>Statement I:</b> Seeing debris from shellfish farms washed up on the shoreline would diminish/diminishes my opinion of the industry.	AH	70	5	4.34	1.141	1106.0	p<0.05
	NRH	40	4	3.95	1.197		
<b>Statement J:</b> There should be more shellfish aquaculture in my community.	AH	71	2	2.35	1.321	1402.5	0.911
	NRH	40	2	2.30	1.244		

\*Statement C was reworded in Figure 3 in the affirmative (i.e., bivalve aquaculture activities *have* important impacts) for clarity.

**Table C2** Statistics for survey questions Q6 (Figure 7), Q10 (Figure 8), and Q11 (Figure 9). Medians for Q6 were ranked on a 4-point Likert-type scale, where 1, 2 indicated unfamiliarity and 3, 4 indicated familiarity. Medians for Q10 and Q11 were ranked on a 5-point Likert-type scale, where 1, 2 indicated unfamiliarity or disagreement, 3 indicated neutrality, and 4, 5 indicated familiarity or agreement.

Question/Statement	Location	n	Median	Mean	Std. Deviation	Mann-Whitney U	P-value
How familiar are you with oyster aquaculture?	AH	75	3	2.92	0.784	1542.0	0.838
	NRH	42	3	2.93	0.838		
How familiar are you with mussel aquaculture?	AH	75	3	2.51	0.921	1050.0	p<0.01
	NRH	42	3	3.05	0.795		
What is your impression of oyster farming?	AH	72	3	2.74	1.321	1102.5	p<0.05
	NRH	40	4	3.35	1.528		
What is your impression of mussel farming?	AH	70	3	2.89	1.161	1200.0	0.095
	NRH	42	3	3.31	1.352		
Oyster farms spoil/would spoil the beauty of the locations they operate in.	AH	73	4	3.93	1.147	1329.0	0.301
	NRH	41	4	3.61	1.358		
Mussel farms spoil/would spoil the beauty of the locations they operate in.	AH	72	4	3.90	1.115	1194.0	0.053
	NRH	42	4	3.40	1.326		
I would prefer to have oyster aquaculture in my community instead of mussel aquaculture.	AH	66	3	2.73	0.869	1154.0	0.314
	NRH	39	3	2.56	1.095		
I would prefer to have mussel aquaculture in my community instead of oyster aquaculture.	AH	65	3	2.68	0.752	1222.5	0.729
	NRH	39	3	2.72	0.887		

