Media Representations and Shellfish Farmer Perceptions of Ocean Acidification in the British Columbia Shellfish Aquaculture Sector

by

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ABSTRACT

MEDIA REPRESENTATIONS AND SHELLFISH FARMER PERCEPTIONS OF OCEAN ACIDIFICATION IN THE BRITISH COLUMBIA SHELLFISH AQUACULTURE SECTOR

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Shellfish aquaculture is an important cultural and economic activity in British Columbia facing threats from increased ocean acidification (OA). Media representations can influence the ways in which the public and politicians understand OA and shape the scope of adaptive policy and supports to address the issue. Conversely, shellfish farmers have first-hand knowledge and experience with ocean change and policy to address OA should reflect this. This research explores media representations and shellfish farmer perceptions of OA in the BC shellfish aquaculture sector. I conducted a thematic analysis of 29 media articles and a survey of 37 shellfish farmers. Results from the thematic analysis indicate that media representations present a narrow perspective of the issue. Results from the survey indicate that shellfish farmers do see OA as a threat, but it is one of many. Findings suggest that media representations introduced challenges and opportunities for shellfish farmers and the shellfish aquaculture industry.
DEDICATION

To my grandmothers and my mom, who opened the doors so I could walk through them.
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1 Introduction

This thesis compares and examines relationships between media representations and shellfish farmer perceptions of ocean acidification in the British Columbia shellfish aquaculture sector. The research is grounded in literature that studies the human dimensions of ocean acidification and that examines the ways that the news media discusses environmental change. The findings are timely because oceans play an important role in supporting human culture, food security and livelihood activities, because coastal ecosystems and communities are threatened by anthropogenically driven environmental change, and because potential societal responses to these challenges are communicated and potentially shaped by news media.

Since the industrial revolution, fossil fuel combustion and human land use have resulted in a near 40% increase in atmospheric $\text{CO}_2$, of which approximately one third dissolves into the ocean (Caldeira & Wickett, 2003; Doney, Fabry, Feely, & Kleypas, 2009). $\text{CO}_2$ absorption results in profound changes to the biology and chemistry of the ocean, including decreases in the pH of seawater. Referred to as Ocean Acidification (OA), decreasing pH (i.e., increasing acidity) has been shown to lead to chemically corrosive conditions for calcium forming organisms, such as shellfish, in many places (Feely et al, 2008, Caldeira & Wickett, 2003 Washington State Blue Ribbon Panel on Ocean Acidification [WSBRPOA], 2012). OA-related shellfish die-offs have already resulted in billions of dollars in financial losses and production setbacks for shellfish harvesters and farmers around the world (Narita, Rehdanz, & Tol, 2012).
In the Pacific Northwest (PNW), including British Columbia, billions of shellfish larvae have died in hatcheries over the last decade and some shellfish farmers have experienced on-farm mortality events (Barton, Hales, Waldbusser, Langdon, & Feely, 2012; WSBRPOA, 2012). Shellfish aquaculture has been referred to as a ‘canary in the coalmine’ because shellfish are vulnerable to OA, because of the close ties between shellfish health and economic livelihoods, and because shellfish farmers have frequent and first-hand experience with and observations of OA and ocean change more broadly (Mabardy et al, 2015).

As hatcheries and shellfish farms were impacted in the PNW, Canadian and coastal news media outlets picked up on some farmers’ stories of on-farm shellfish mortality and economic losses. Similar to issues related to climate change, members of the public and politicians rely on media representations of OA to help make sense of the issue (Boykoff, 2011). Unlike climate change, which has been present in the media for decades, the emergence of OA in news media reporting is relatively new. This creates an interesting opportunity to study media representations of OA and its potential implications for the BC shellfish aquaculture sector, including how shellfish farmers perceive OA and how media reporting influences (or not) preferences for adaptation.

As a venue where environmental issues and concerns are communicated, news media is central to connecting people’s everyday experiences with developments in environmental science and policy (Boykoff, 2011; Dryzek, 2013). Delving into how OA is discussed by news media opens up the opportunity to explore the ways that language and journalistic norms construct perspectives on shellfish farms and farmers. According to Boykoff (2009), “media representations are convergences of competing knowledges,
framing environmental issues for policy, politics, and the public, and drawing attention to how to make sense of, as well as value, the changing world" (p.434). This suggests that understanding how OA is framed by news media will constitute an important component in determining the effectiveness of OA communication, if shellfish farmers see themselves included in how OA is presented to mass audiences, and if recent policy developments reflect shellfish farmers lived realities.

1.1 Research Aim and Objectives

This research examines media representations and shellfish farmer perceptions of ocean acidification in British Columbia, Canada. Specifically, it asks: when and how has ocean acidification been presented in national and regional news media and how does this media coverage compare and/or contrast with farmer perceptions?

To address this question, three objectives will be pursued:

a) Thematic analysis of stories from regional and national news media that discuss both ocean acidification and British Columbia’s shellfish aquaculture sector;

b) Using a survey, document British Columbia shellfish farmers’ impressions of OA communication and their perceptions of its implications for the sector;

c) Compare and contrast findings from A and B and draw conclusions about how OA is situated amidst a suite of concerns that may demand shellfish sector adaptation.

To collect data, I administered a shellfish farmer survey and I conducted a systematic search of national and regional news media for stories that address OA off of British Columbia. Findings combine thematic analysis with survey results.
1.2 Outline

This thesis contains four chapters. The remainder of this chapter reviews relevant literature. It opens with a description of OA science and a current review of human dimensions of OA research. It then continues on to explore two bodies of literature: media representations of environmental issues and adaptation to environmental change. These studies contextualize this research and form the basis of the conceptual framework used in this study. Chapter 2 describes the research methods employed to address each of the above research objectives. Chapter 3 is comprised of a central manuscript based on the central findings: media representations of OA lead to challenges and opportunities for the shellfish farming industry. Chapter 4 summarizes central findings, reviews the contributions, and suggests directions for future research.

There are four key findings in this thesis. First, shellfish farmers are not feeling very well informed about OA but scientists and actors internal to the BC shellfish aquaculture industry are considered trusted sources of information and have an opportunity to be inclusive and strategic with OA related messaging. Second, national and regional media have presented a narrow view of OA, introducing potential challenges and opportunities for the BC shellfish farming industry. Third, OA is best addressed as one of many concerns for the BC shellfish aquaculture sector. Shellfish farmers tend to be concerned with other day-to-day challenges including cash flows, markets, and labour. Fourth, the social construction of vulnerability in the media may influence the level of attention paid by politicians and decision makers. This thesis contributes to a small but growing body of literature on the human dimensions of OA, to
research on media representations of environmental change, and to the scholar-practitioner community concerned with adaptation to environmental change.

1.3 Literature Review

This research draws from and contributes to three bodies of literature: human dimensions of OA; media representations of environmental issues; and, adaptation to environmental change. The opening review of OA science explains the emergence of the problem. Then, I will review the current status of human dimensions of OA research, including research gaps and opportunities. This section is followed by the second body of literature which illustrates the importance of interrogating media representations of OA. This review concludes with reviewing adaptation to environmental change. Overall, these three sections work together to provide the context necessary to position this study in the literature.

1.3.1 Human dimensions of OA

1.3.1.1 OA Science

Ocean acidification is a decrease in the seawater’s pH for a prolonged period of time (Caldeira & Wickett, 2003). This change occurs due to the ocean’s absorption of approximately one third of human-generated carbon dioxide (CO₂) from the atmosphere (Caldeira & Wickett, 2003; Doney, Fabry, Feely, & Kleypas, 2009). One of the earliest documented signs of OA in scientific literature was the negative impact it has on calcium carbonate dependent organisms, such as corals and shellfish (Caldeira & Wickett, 2003; Orr et al., 2005). This change in pH results in chemically corrosive conditions for organisms that use calcium carbonite (often in the form of calcite or aragonite) to form shells, bones, or other body parts (WSBRPOA, 2012). When CO₂
concentrations in ocean water increase, the amount of carbonate ions (an important part of calcium carbonate) decreases, making it more difficult for calcifiers, such as corals and shellfish, to develop and maintain their skeletons or shells (Barton et al., 2012; Haigh, Ianson, Holt, Neate, & Edwards, 2015). For shellfish, this results in slower growth rates and higher mortality, especially in the larval and juvenile stages (WSBRPOA, 2012). Since pre-industrial times, the average ocean surface water pH has decreased by over 0.1 units, from approximately 8.21 to 8.1, and it is predicted to decrease another 0.3-0.4 units by the end of the century (Orr et al., 2005). OA’s ultimate solution requires CO₂ reduction that will take decades to accomplish (Caldeira & Wickett, 2003). Until that happens, locally feasible adaptation and mitigation strategies are needed (Ekstrom et al., 2015).

In BC’s coastal waters, localized conditions that lead to amplified OA can create OA ‘hotspots’. One of the processes that contributes to hotspots is upwelling (Ianson et al., 2016; Strong et al., 2014; Riche, Johannessen, & Macdonald, 2014). Upwelling occurs when seawater from the deep ocean is circulated onto the coastal shelf (Feely, Sabine, Hernandez-ayon, Ianson, & Hales, 2008; Hauri, Gruber, McDonnell, & Vogt, 2013; Hauri et al., 2009). Upwelled water is rich in CO₂ from decomposing organic matter, so when it is circulated from depth into coastal waters it can further decrease the pH leading to more corrosive conditions for calcifiers (Feely, Sabine, Hernandez-Ayon, Ianson, & Hales, 2008). Seasonal upwelling is a natural phenomenon that has always contributed to the rich biodiversity of the PNW, however, the timing and strength of upwelling, as well as increases in CO₂ from upwelled waters has been reportedly linked to shellfish die-offs (Barton et al., 2012; Eudeline et al., 2015; WSBRPOA, 2012). In
addition, upwelling can be amplified by heavy storms and persistent winds (Riche et al., 2014). The strength and timing of upwelling in BC and the PNW is important because the cycles and processes are ‘delicately poised’ (Riche et al., 2014). Therefore, amplified CO₂ brought by changes in wind patterns, and subsequent upwelled waters, can have serious impacts and even threaten species survival, as we have seen in reported shellfish die-offs (Barton et al., 2012). Ocean chemistry monitoring networks have identified OA amplified by coastal upwelling as responsible for the shellfish die offs (Eudeline et al., 2015; Hauri et al., 2009). However, the timing, catalysts of upwelling and OA hotspots are still unclear, as are the ways in which human communities can best respond to them.

1.3.1.2 Human dimensions of OA

Just as scientists have been working to understand how OA is impacting the marine environment, social scientists have been called to investigate and analyze the ways in which human communities are being affected. Riebesell and Gattuso (2015) have identified OA as one of the top three global ocean research priorities. In their commentary on the state of the research field, they called for more research related to the human societies affected by OA, including research that identifies “management options and policy advice” (Riebesell & Gattuso, 2015, p.14). This thesis is broadly inspired by this call, as well as the existing literature on human dimensions of OA, which will be further reviewed in this section.

Since OA has been found to impact shellfish harvests worldwide (Gazeau et al., 2013; Orr et al., 2005; Parker et al., 2013), the human communities who rely on shellfish are likewise under threat. Shellfish provide a protein rich food source to consumers
around the world (Narita et al., 2012), along with other non-market services (e.g., cultural identity, food for predators, etc.) (Cooley, Lucey, Kite-Powell, & Doney, 2012). With OA promising to continue to act as a stressor on shellfish aquaculture, job losses, revenue declines, and other indirect economic costs may occur (Cooley & Doney, 2009). For instance, the global economic costs of production loss due to OA have been estimated at over 100 billion USD by the year 2100 (Narita et al., 2012). Therefore, the threat posed by OA to global food availability, economics, and social and cultural values demonstrate the importance of human dimensions of OA research.

An important step in determining domestic policy to address OA is establishing vulnerability. In order to assist US policy and decision makers to organize and prioritize societal responses to OA, Ekstrom and colleagues (2015) conducted an interdisciplinary vulnerability assessment for the entire US shellfishery. The researchers assumed that by addressing existing vulnerability, future vulnerability can be reduced. Their analysis explored the three key dimensions of vulnerability: exposure, sensitivity, and adaptive capacity. Based on assessments from all three dimensions, researchers were then able to over-lap each dimension and identify overall vulnerability. Their analysis identified why and where vulnerability from OA varies among the many coastal regions in the USA, and thus, revealed opportunities to explore adaptive strategies. Their study highlighted gaps in knowledge related to OA exposure, sensitivity, and adaptive capacity, including how to benchmark successful adaptation, how anthropogenic carbon interacts with local drivers of OA, and the importance of shellfish to community well-being. Each of these gaps presents opportunities for further research and engagement.
Since shellfish farmers live and work within the BC shellfish aquaculture sector and are experts in observing ocean change, understanding their perceptions of OA is an important component in developing effective policy for adaptation (Byron, Bengtson, Costa-Pierce, & Calanni, 2011). A US based national representative study on the public's perceptions of OA exists (Leiserowitz, Smith, & Marlon, 2010), however, the shellfish-farming population of focus in my study is a specific group with direct experience with coastal environmental changes and specialized local knowledge. Indeed, people who have daily interactions with an environment and whose livelihoods are threatened by changing climatic conditions tend to have a better understanding of environmental risks (Nakashima, Galloway McLean, Thulstrup, Ramos Castillo, & Rubis, 2012). Additionally, research on commercial stakeholders found that financial dependence and first-hand experience leads to a greater awareness of climatic change and motivation for conservation behavior (Sakurai et al., 2011). Therefore, I find it helpful to turn to the few pieces of literature on stakeholder perceptions of OA. To begin, Frisch, Mathis, Kettle and Trainor (2015) surveyed fishery-dependent Alaskan residents on their level of understanding regarding OA. This region is particularly vulnerable to OA due to the ocean circulation pattern and a strong reliance on subsistence and commercial fisheries. Researchers found that many respondents had heard of OA and could identify its dominant drivers, but there was a low level of confidence regarding OA science and fisheries-related risks. Frisch and colleagues (2015) also acknowledge the role of the media in communicating OA risks to Alaskans, but they do not undertake a critical analysis in this area.
Similarly, in their study on the US West Coast shellfish industry, Mabardy and colleagues (2015) found that 94% of respondents had heard of OA and approximately half of respondents had personally experienced negative impacts from OA. In general, their sample had a fairly advanced understanding of OA, were concerned about the problem, and were cautiously optimistic about adaptation (Mabardy et al., 2015). Die-off events in the BC shellfish aquaculture sector can be seen and felt by shellfish farmers; many have personally witnessed rapid on-farm die-offs and OA is often discussed as a catalyst for specific events and to increased vulnerability more broadly (Barton et al., 2012; WSBRPOA, 2012).

1.3.2 Media representations of environmental issues

In an era frequently referred to as the Anthropocene, questions about how humans interact with the environment are prominent. This includes questions about how the environment is understood by the public and policy makers. Indeed, while scientists have been working to understand the biophysical processes associated with global environmental change, social scientists have become increasingly interested in the ways in which environmental issues are communicated (Comfort & Park, 2018). Thus, the field of environmental communication emerged in order to explore the complex flows of information between scientists and audiences, with mass media as the conduit between them (Logan, 2001). Literature that examines the role of media in communicating messages about the environment is particularly important to my work.

---

1 Mass media is defined as traditional media formats with broad consumer bases, including television, web, film, advertisements, books, and radio (Comfort & Park, 2018). News media refers to Newspapers and their respective websites (Comfort & Park, 2018). Media is the collective means of mass communication (Comfort & Park, 2018).
Media representations connect people’s lived realities and experiences with understandings of science and policy (Boykoff, 2011; Liu, Vedlitz, & Alston, 2008; Mayeda, Boyd, Paveglio, & Flint, 2018; Schäfer & Schlichting, 2014). In fact, media representations have been analyzed and applied as proxy for public opinion (ie, Schlag, 2011). Likewise, policy and decision makers often rely on media messages to help make sense of complexities related to science and governance (Boykoff, 2011). According to Boykoff (2008), “media messages are critical inputs to what becomes public discourse on today’s climate challenges” (p.2). Therefore, analyzing media representations of OA may shed light on how the public and policy makers understand and interpret OA related science and the way OA is interacting with the BC shellfish farming community.

Mass media is a key political player throughout the policy making process (Soroka et al., 2012). Politicians are affected by the media just like everyone else (Dearing & Rogers, 1996; Soroka et al., 2012). They look to the media for cues on which issues to prioritize and to gain a sense of public opinion (Walgrave & Van Aelst, 2006). As such, when an environmental issue receives more attention by the media, political attention may follow (Downs, 1972). Indeed, mass media are uniquely positioned to regularly impact the policy process, often without being recognized in their role (Soroka et al., 2012). Through agenda-setting and issue framing, media may influence which issues or aspects of issues warrant public and political attention (Cohen, 1963; McComb & Shaw, 1972; Scheufele & Tewksbury, 2007).

While climate change and other environmental issues have been analyzed by media studies, a gap remains in the literature on how media represents OA. Similar to
issues around climate change, OA communication presents challenges involving uncertainty, complex science, invisibility (i.e. OA is unable to be seen by the naked eye), and politicization. With this in mind, I now turn to the literature on media representations of climate change. In 2014, a meta-analysis of the research field revealed 133 articles on media representations of climate change (Schäfer & Schlichting, 2014). This substantial body of work examines representations of climate change through all types of media in many diverse geographical areas. In addition, climate reporting is location, time, and context specific and is influenced by many complex factors such as dominant worldviews, history and journalistic norms (Boykoff, 2011; Schäfer & Schlichting, 2014). In Who Speaks for the Climate?, Max Boykoff (2011) argues that media representations of climate issues, including prognosis and diagnosis, are highly publicized and politicized issues influenced by a dynamic mix of factors. Mass media has helped elevate climate change to the most commonly known environmental issue of our time, and it has also contributed to it being one of the most contentious issues, plagued by polarized political and individual perspectives (Boykoff, 2011).

Studies of other climate-related environmental issues also show that media plays a powerful role in influencing public and political spheres. In their study on media representations of water issues as health risks in the US, Mayeda, Boyd, Paveglio, & Flint (2018) argued that despite numerous water-related issues (decreasing water quality and increasing contamination), health-associated risks were seldom mentioned, and those that were mentioned had direct and immediate impacts. Mayeda and colleagues (2018) found that newspaper reporting did not correlate with the nature of
water-related health risks, which were often long term. This study, and others, suggest that media representations of environmental issues are framed by media actors in certain ways, and are ruled by journalistic norms – both topics will be discussed more in Chapter 3.

The challenges associated with communicating environmental issues in the media are many. Despite an overwhelming consensus in the scientific community that anthropogenic climate change is a serious problem that needs to be addressed urgently, journalistic norms like non-biased reporting lead to climate change deniers being given equal attention in US media as climate scientists (Boykoff & Boykoff, 2007). In addition, media reporting tends to be event driven: “events with immediate impacts are both easier and more attractive to cover than continuous monitoring of a known issue” (Soroka et al., 2012, p. 8). As such, the long-term nature of climate change and other environmental issues does not match well with media preferences for events that are sensational and immediate (Boykoff & Boykoff, 2007). Even the language of scientific findings, which are generally discussed in a professional language that employs a vocabulary of caution and probability does not usually cross over smoothly to the clear-cut style of language valued in journalism (Weingart, Engels, & Pansegrau, 2000). Media can also facilitate discrediting an issue, effectively steering the public’s attention away from the environmental issue and towards personal scandals or conflicts. For example, in 2008, following their most recent report, some IPCC scientists were criticized for mistakes and leaked email correspondence, leading to questions about the integrity of their scientific work (Gupta, 2010).
Along with challenges associated with communicating environmental issues in the media, there are also benefits and opportunities. The prominence of media in people’s lives creates a unique opportunity for scientists and political leaders to strategically utilize messaging to obtain a positive outcome (Frisch et al., 2015; Kelly, Cooley, & Klinger, 2014; Nisbet, 2009; Romsdahl, Kirilenko, Wood, & Hultquist, 2017). For example, local governments in the UK have used media and other communication methods to reframe climate change in order to address adaptation (Romsdahl et al., 2017). In addition, after OA wiped out juvenile shellfish stocks in Washington and monitoring stations established that OA was the cause, Kelly Cooley and Klinger (2008) found that individual stories of economic loss and hardship in the media were integral to attracting political attention to the issue. These case studies suggest that media can be a powerful medium for communicating climate-related messages, and decision makers and politicians can use media to steer political initiatives. As such, effective climate change communication must accurately represent science, while also tailoring each message to relate to the existing values, perceptions, and attitudes of the audience (Nisbet, 2009). Thus, a complex climate policy debate can be made relevant, understandable, and personally important (Soroka et al., 2012). This approach to communication, however, requires a clear understanding of a population’s views on an issue as well as an examination on the messages that have traditionally informed public perceptions.

1.3.3 Adaptation to Environmental Change

OA researchers have identified the need to move from acclimation to adaptation within aspects related to management alternatives and policy recommendations
In this context, adaptation can be defined as “actions taken to reduce or moderate or adjust to the expected or actual negative effects of climate change and take advantage of new opportunities” (Ford et al., 2010, p.375). In other words, adaptation can reduce a system’s sensitivity to a problem and increase its capacity to cope (Wilbanks & Kates, 2010). Adaptive strategies may involve various stakeholders, including government, scientists, and policy makers (Ford et al., 2010). Furthermore, adaptive strategies generally fall within economic resources, human and social capital, and technological opportunities (Martens, McEvoy, & Chang, 2009; Smit & Wandel, 2006). Regardless of the context, adaptive planning needs to involve the people who are most at risk – in this case, shellfish farmers. For these reasons, it is essential that initiatives to support shellfish farmers in their efforts towards OA adaptation integrate their perceptions of OA science and their preferences for adaptation.

This thesis research was conducted on the BC shellfish aquaculture sector, which has been identified as vulnerable to OA (Ekstrom et al., 2015). The vulnerability of any system is related to the exposure and sensitivity of the system to risk and the capacity or resilience of the system to adapt (Berkes, 2007; Folke, Hahn, Olsson, & Norberg, 2005; Smit & Wandel, 2006; Young et al., 2009). This idea suggests that by examining perceptions on adaptations, I am also exploring perceptions of vulnerabilities. A common purpose of vulnerability analysis is to assess the degree to which negative impacts from climate change could be offset by adaptation. As seen in Figure 1, \( V_{ist} = \) Vulnerability of a system \( (I) \) to a climatic stimulus \( (s) \) in time \( (t) \) is a function of \( ES_{ist} = \) Exposure-Sensitivity of a \( (i) \) to \( (s) \) in \( (t) \), and \( AC_{ist} = \) Adaptive Capacity of \( (i) \) to deal with
In other words, the vulnerability of any system (at any scale) is influenced by the systems exposure and sensitivity, and adaptive capacity. This formula indicates that vulnerability is a property of a system, and provides the basis for justifying an empirical approach to vulnerability assessments (Young et al., 2009).

\[ V_{ist} = f (E S_{ist}, A C_{ist}) \]

Figure 1: Vulnerability equation. Young et al., 2009

An important distinction in vulnerability research is how the research is approached: top-down or bottom-up. Some scientists and experts who use a top-down approach tend to assume their perceptions are “naturally the way the world is” (Wynne, 1991: 112, emphasis in original). However, this is often not the case. The imposition of climate knowledge from scientists and experts down to the public has proven to be problematic. This is often due to experts dismissing lay knowledge and perceptions through top-down projections of vulnerability and adaptation assessments (Buys, Aird, van Megen, Miller, & Sommerfeld, 2014). Top-down analysis, including adaptive policy developed in a top-down style, tends to overlook local contexts, where many of the most effective adaptations take place (Smit & Wandel, 2006).

As an alternative and/or supplement to top-down approaches, researchers developed bottom-up assessments that aim to identify the conditions to which a community is sensitive from the perspective of the community (Schroter et al., 2005; Smit & Wandel, 2006). This approach has a direct and practical focus on adaptation in that it explores the types of adaptive management that are realistic in a community. Moreover, for adaptation measures to be relevant at the community level, the
community needs to be involved in identifying existing vulnerabilities and capacities. These participatory assessments allow for the identification of stimuli outside of climate change, including cultural, political, institutional, economic, and technological forces (Smit & Wandel, 2006; Young et al., 2009). This is important because communities often have their own concerns and priorities that have little to do with climate change (Young et al., 2009).

Understanding a community’s perceptions in relation to climatic stimuli can still reveal interconnections and opportunities, even between seemingly unrelated variables (Liechenko & O’Brien, 2008). For example, in the dryland community of the Elqui Valley in Chile climate scientists found that although the community is severely threatened by climate change, local residents were “more concerned with meeting the needs of daily life rather than what could happen in the future” (Young et al., 2009, p. 271). However, researchers found links between climatic stresses and lessening kinship and a lack of technological, financial and human resources, which all contributed to increased vulnerability (Young et al., 2009). This suggests that local people may have different priorities, and understanding their perceptions is critical for scientists and policy makers. Therefore, even though oceans in the PNW have been identified as vulnerable to OA, understanding shellfish farmers’ perceptions of the issues surrounding OA is equally as important as understanding OA science for developing adaptive strategies.

The previous literature in this section on adaptation provided me with context for developing the survey and for exploring the material constructions of and links between vulnerability and adaptation for the BC shellfish aquaculture sector. However, due to the nature of vulnerability and its tendency to sit at the intersection of nature and culture
(Oliver-Smith, 2004), I am also interested in social constructions of vulnerability and associated impacts. Specifically, this research acknowledges that the way vulnerability and adaptation are represented in the news media could influence its standing as an environmental concern. As Paschen and Ison (2014) argue, “how we ‘story’ the environment determines how we understand and practice adaptation, how risks are defined, who is authorized as actors in the change debate, and the range of policy options considered” (Paschen & Ison, 2014, p.1083).
2 Methodology

This chapter will describe this study’s regional context and methodology, including descriptions and justifications of methods and procedures, sampling strategies, and an explanation of my analysis. To begin, section 2.1 will describe the regional context of the British Columbia shellfish aquaculture sector as a prime location for exploring the relationships between media, shellfish farmers, and OA. Then, as this study utilized a mixed-methods approach, sections 2.2 to 2.4 will describe the collection and analysis of data based on this study’s objectives as seen in Table 1 on page 33.

2.1 Regional Context

This research took place in the British Columbia shellfish aquaculture sector, as seen in Figure 2 on page 44. Shellfish aquaculture in BC is Canada’s top producer of cultivated oysters, clams, and scallops (Fisheries and Oceans Canada, 2016). In 2016, BC’s farmed shellfish sector harvested 9,300 tonnes of product worth approximately $53.3 million in wholesale value (BC Ministry of Agriculture, 2016). The Strait of Georgia (SoG), where the highest density of shellfish aquaculture occurs, is a semi-enclosed estuary that is home to the majority of BC’s shellfish aquaculture sites (Haigh et al., 2015).

Shellfish cultivation in BC started in the early 1900s with the importation of the Pacific oyster and Manila clam from Asia (Ketchen, Bourne & Butler, 1983). Seed importation continued through to the 1930s, until stocks naturally began to establish themselves in suitable areas such as Pendrell Sound and Ladysmith Harbour, where local temperatures were found to be conducive for breeding (Ketchen, Bourne & Butler, 1983). Reliable breeding grounds led to an industry accepted shellfish aquaculture
sector by the 1960s (Ketchen et al., 1983). Prior to cultivation, records show that First Nations people have been harvesting shellfish from the intertidal coastal waters of BC for at least ten thousand years (Fedje, 2005). Currently, shellfish aquaculture continues to provide important economic and social benefits to a handful of rural and coastal First Nations communities (Aboriginal Aquaculture Association, 2018).

Along with hosting conditions conducive for shellfish aquaculture, BC has long been associated with widely publicized environmental conflicts. Recognized by the official tourism slogan ‘Super, Natural British Columbia’, BC is a place known across the world by its towering trees, rugged coastlines, and abundant wildlife (HelloBC, 2018). However, in reality BC is a contentious cultural landscape (Braun, 1997). Indeed, BC’s natural spaces have been the focal points of numerous highly publicized environmental debates. For example, Rossiter’s (2004) analysis of newspapers and other texts throughout the 1990’s relating to anti-industrial logging on BC’s central coast (in what is now known as ‘the Great Bear Rainforest’) found that activists used framing strategies to forward their preservationist agenda.

I chose the Baynes Sound and Discovery Island regions as areas of focus for this study for three main reasons. First, these regions contain the majority of BC’s shellfish aquaculture production. The Baynes sound alone contains over 50% of active production in BC (Fisheries and Oceans Canada, 2017). The Discovery Islands region, which contains Okeover Inlet and the Reed, Quadra and Cortes islands makes up approximately 30% of shellfish aquaculture in BC. For the purpose of my study, focusing on the most densely populated shellfish regions in BC allows for a deeper understanding of the diversity of perceptions and experiences in these regions. Second,
the North Coast and Outer Coast regions were not included in my study as they did not have enough respondents to ensure participant anonymity. The third reason that this research includes Baynes Sound and Discovery Islands only is that national and regional media reports tended to focus on communities around the Baynes Sound and Discovery Island regions.

2.2 Objective A: OA & Shellfish in the News

In order to understand when and how OA was presented in National and Regional news media and in what ways, I conducted a systematic search for online regional and national news media stories that discussed both OA and the BC shellfish aquaculture sector. I began with preliminary searches within the Library PRIMO search tool. PRIMO provides access to news publishers either directly or through an intermediate database (PRIMO, 2018). During the preliminary search period I experimented with key search terms “ocean acidification”, “shellfish”, “oyster” and “ocean acid”, and based on a tally of the number of articles returned I concluded that “ocean acidification” and “shellfish” were the most effective terms. Then, based on Mayeda and colleagues (2018) search strategy, I used the search terms “shellfish”, “ocean acid!” to ensure that all potentially relevant articles were returned. Inclusion of the exclamation mark ensured that any term that included “ocean acid” would be identified in the sample (e.g. ocean acidity, ocean acidification) (Mayeda et al., 2018). Then, I used a list of national and regional newspapers (Wikipedia, 2019) to identify and individually search each news provider’s online article database using the same key words. My search revealed 29 articles.

The primary criteria for an article to be considered in my analysis included being from a Canadian or BC regional news media outlet with a professional paid editorial
staff and journalists, having a focus on OA and being written for or about British Columbia. Additionally, articles that were written to address ocean health but mentioned OA at least once were included. This was because articles that discussed ocean health (and mentioned OA) were contextually significant to understand how the media frames OA as an environmental risk. Articles in which OA or ocean health were not the main focus were excluded from analysis, including where OA was noted but was not the predominant theme in the article. Additional articles excluded from my analysis included: (1) letter to the editor or opinion pieces; (2) non-news articles such as advertisements or newspaper content summaries; and (3) duplicate news articles.

2.2.1 Objective A: Thematic analysis

This study employed multi stage coding in NVivo. For the first stage, I used an open coding process whereby I read and reread the articles for common themes and patterns (Cope, 2010). Then, for the second stage and after reflecting on the initial codes I returned to the theoretical literature for analytic coding (Cope, 2010). For this stage of coding, I adopted an analytical framework from Liu, Vedlitz, & Alston’s (2008) paper Regional news portrayals of global warming and climate change. This paper’s relevant themes were: “issue salience and various issue attributes (issue image and issue participants)”. These themes were useful in my second stage of coding because they were closely aligned with my already established open coding themes and therefore verified my pre-existing themes. I also chose this framework due to the study’s relevance in analyzing news media portrayals of environmental change in a North American context. Furthermore, since an analysis of media portrayals of ocean
acidification has not yet been studied, global warming and climate change were an appropriate comparable focus of analysis.

2.3 Objective B: Survey Shellfish Farmers

A survey questionnaire was administered to document shellfish farmers’ awareness of the phenomenon of ocean acidification and their perceptions of its implications for the shellfish aquaculture sector. Questionnaires contain a carefully designed set of questions and are noted to be useful in collecting a large number of responses within a community (Jupp, 2006). It has also been suggested that surveys are useful for evoking a population’s beliefs, attitudes and opinions on a variety of social, environmental or political issues (McLafferty, 2010). Close-ended quantitative questions were either multiple choice or likert scale, and open-ended questions gave space for participants to express strong opinions especially when there was a unknown range of possible answers (Smyth, Dillman, Christian, & Mcbride, 2009). The survey design follows similar protocol to Mabardy, Waldbusser, Conway, and Olsen's (2015) study on the perceptions of U.S. West Coast shellfish farmers. Prior to data collection, this study received institutional approval from the University of Guelph Research Ethics Board (REB) under the approval number 18-03-030 (see appendix 2).

Surveys were conducted using Qualtrics, a secure data collection and analysis software that the University of Guelph has an active license for (Qualtrics, 2018). Whenever possible, questionnaires were administered in-person, but they were also able to be sent through an online link. Face-to-face survey administration is preferred as it generates a higher response rate, more thorough responses, and allowed for the researcher to provide clarification to the participant (McLafferty, 2010). However, participants were also able complete the survey online, which was important to enable
participation for shellfish farmers in remote areas. Qualtrics as a survey platform was designed to provide participants with a progress indication bar, the choice to skip questions, and the option to return later (Qualtrics, 2018). Surveys took an average of twenty-five minutes to complete.

The survey was a shared data collection instrument that was developed together by a team. Specifically, it involved collaboration with Dr. Karen Kohfeld and graduate student Evie Morin from Simon Fraser University and Dr. Debby Ianson from the Department of Fisheries and Oceans Canada. Evie Morin and I administered the survey. In addition to questions focused on ocean acidification and reported on in this thesis, it asked farmers about a broader range of ocean changes that were relevant in the region and went back on a longer time scale; these questions related to Evie Morin’s thesis research, supervised by Drs. Kohfeld and Ianson. This collaboration allowed for more work of relevance to the region and helped to avoid participant fatigue among shellfish farmers. Moreover, the survey questions on a broader set of ocean changes provided context for my interest in discussing the status of ocean acidification, a more recently identified and publicized challenge, among a broader range of issues in the region. An executive summary report of the survey findings was co-developed and sent to participants and stakeholders who had indicated interest in our findings, including the Executive Director of the British Columbia Shellfish Growers Association (BCSGA).

2.3.1 Identifying and Contacting Research Participants

Participants were sought out through purposive and snowball sampling. Purposive non-probability sampling ensured participants fit the criteria to be interviewed (Jupp, 2006), namely, they are a shellfish farm owner and/or worker in BC. Participant
recruitment took place through: the BC Seafood Expo event on June 8-17, 2018; a public online database of shellfish tenure license holders published by Fisheries and Oceans Canada (DFO) (Fisheries and Oceans Canada, 2017), and through personal networks. For the DFO list of tenure license holders there was no indication if the farm was active, and often times the owner would be a numbered company, which made finding a contact person difficult. If we were successful in contacting a potential participant, snowball sampling was conducted at the end of each meeting. This is a process whereby after identifying an appropriate respondent we asked the individual who else might be an appropriate respondent (Jupp, 2006). Participant recruitment was always done with care and consent in order to ensure participant anonymity. Potential participants were initially contacted between June and August 2018 by telephone or email. The phone or email message contained an introduction to the research team, study objectives, and an invitation to participate in our joint research project either in person or through an online link. Concurrently, state agencies and shellfish organizations promoted our research by encouraging their respective members to participate and posting notices of our project.

According to the DFO (2017), as of December 8, 2017 there were 466 valid tenure shellfish aquaculture license holders in British Columbia. Once a potential participant was identified, in addition to fitting the criteria to participate researchers attempted to ensure accurate representation by limiting responses to one participant per tenure. Limiting responses to one per tenure allowed multiple responses from large companies with multiple tenures and one response from small companies with one tenure. This was made clear whenever necessary before the start of every survey.
There are several limitations to this strategy for calculating a response rate. First, it is unclear how many of the tenure licenses are actively farmed. Based on our summer field experience, it appears a great deal of tenure holders do not actively farm their licensed sites, but it was impossible for us to estimate how many. Second, since the survey was anonymous, researchers were unable to share information about previous participants thereby creating an opportunity for more than one participant responding from the same tenure. Nonetheless, the wide variety of demographics and overlapping themes suggests we have captured at least some of the most popular and persistent experiences and opinions in the sector. All survey participants were provided with a hard copy or PDF information sheet and a consent statement was presented on the first page of the questionnaire, as per regulations set out by the University of Guelph REB, which approved this research.

2.3.2 Survey Analysis

Out of 56 surveys completed, 37 were the focus of my analysis. Survey data were organised and analysed based on whether the response was quantitative or qualitative in nature. Quantitative survey responses were uploaded into SPSS and analysed using descriptive statistics. SPSS is software used to analyze data and can facilitate a number of statistical tests using multiple variables (IBM SPSS, 2019). For this study, I primarily used SPSS to produce descriptive statistics. According to Salkind (2011), descriptive statistics are used to describe the characteristics of data. For my data set, descriptive statistics were sufficient to show trends, patterns and tensions between shellfish farmers and news media reports. More specifically, descriptive statistics were used to describe the number of survey respondents who chose an option
for each question. Then, qualitative data in the form of open-ended survey responses were uploaded into NVivo and coded based on prevalent themes to do with perceptions of OA and preferences for adaptation. In qualitative research, a code represents a word or phrase that relates to a characteristic of the data (Saldaña, 2009). Similar to the coding process in my thematic analysis, textual responses were scanned and coded for prominent themes. Unlike the coding process in my thematic analysis, textual responses from the survey were sorted in NVivo under simple categories and did not undergo an analytic coding stage.

2.4 Objective C: Compare and Contrast Findings from A and B

After analyzing data from Objectives A and B individually, I brought the findings together to identify any connections and tensions between them. To do this, I identified and categorized adaptation priorities from the descriptive statistics and NVivo analysis. Due to adaptation being closely tied with vulnerability (Smit & Wandel, 2006), questions about how shellfish farmers perceive OA in relation to other challenges aided my analysis. I also identified and described connections between farmer perceptions of OA and results from the thematic analysis, using thematic findings, dates, key words, and consistencies or inconsistencies between news media messages and survey results.

Descriptive statistics and open-ended survey responses were analyzed alongside thematic analysis themes. Once findings from Objectives A and B were compared and contrasted, I was able to evaluate and describe how perspectives of OA differed by media and shellfish farmers and priorities for adaptation at various scales. This was an iterative process, whereby the conversation between the results from each objective were interpreted. The findings and conclusions from my analysis can be found in Sections 3.6 and 3.7.
Table 1: Chart demonstrating the methodological process for each research objective

<table>
<thead>
<tr>
<th>Objective</th>
<th>Method</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Thematic analysis on news stories that discuss OA and BC shellfish</td>
<td>Systematic search of Canadian news media providers that mentioned key words “ocean acid!” and “shellfish”.</td>
<td>29 Articles analyzed in NVivo Open &amp; analytic coding using framework from Liu, Vedlitz &amp; Alston (2011)</td>
</tr>
<tr>
<td>B) Survey shellfish farmers in BC shellfish aquaculture sector</td>
<td>Survey shellfish farmers in the BC aquaculture sector using purposive and snowball sampling</td>
<td>37 surveys analyzed from Baynes Sound and Discovery Island Regions SPSS descriptive statistics</td>
</tr>
<tr>
<td>C) Develop priorities for adaptation and discuss how media may politicize OA</td>
<td>Interpret results from A&amp;B iterative process</td>
<td>Describe connections, tensions, discuss politicization</td>
</tr>
</tbody>
</table>

2.5 Limitations of Study Design

There were several limitations to the study design. First, a limitation in the survey design was that options 2, 3 and 4 on the likert scales were not assigned values. For example, for the question: How informed do you feel you are about OA? Options 1 and 5 were labeled “not at all” and “very well”, however, values 2, 3, and 4 went without labels. This was concerning because likert scales sometimes assign a “neutral” or “I don’t know” label to option 3. However, this limitation was minimized due to the majority of surveys being completed alongside a member of the research team, who kept track of any questions posed by respondents. Since there is no record of respondents asking about the meaning of option 3, it is reasonable to assume that respondents were somewhere between the labeled choices when they selected option 3. Options 2 and 4 were interpreted as “slightly more than” and “slightly less than” the labeled option – ie, for the question: How informed do you feel you are about OA? Option 2 was interpreted as “slightly more than not at all”.
Another limitation observed in the field was the language of the survey instrument being only in English. During field work we found that many potential respondents, especially of Vietnamese descent, did not identify English as their first language and felt that the survey’s lack of translation was a barrier to their participation. This limitation was due to the scope and scale of our projects, and a lack of contextual background information available about the industry. We tried to overcome this limitation by inviting potential respondents to take the survey with us so we could answer any survey-related questions they might have.

One limitation of thematic analysis portion of this study was in the sole use of news media as the sample. While news media sources provide excellent insight into how environmental issues are being discussed in the news, they do not necessarily represent the wider media landscape. Further research could analyze television, radio, and social media messages about OA to gain a clearer picture into the challenges and opportunities facing OA communication.

Finally, this study was limited by the survey instrument’s quantitative nature. According to Paschen and Ison (2014), qualitative research allows for a more participatory design and for local knowledge to emerge: “narrative research offers an innovative, holistic approach to a better understanding of socio-ecological systems and the improved, participatory design of local adaptation policies” (p.1083). This suggests that a future analysis of this population could advance this topic with in-depth qualitative research.
3 Manuscript

Shellfish aquaculture, an important cultural and economic activity in British Columbia, is under threat from increased ocean acidification (OA). Media representations can influence the ways in which the public and politicians understand OA and the scope of adaptive policies and supports developed to address the issue. Conversely, shellfish farmers have first-hand knowledge and experience with ocean change and policy to address OA should reflect this. This research explores media representations and shellfish farmer perceptions of OA in the BC shellfish aquaculture sector. I conducted a thematic analysis of 29 news media articles and a survey of 37 shellfish farmers. Thematic analysis results indicate that media representations presented a narrow perspective of the issue. Results from the survey indicate that shellfish farmers do see OA as a threat, but it is one of many they are facing. Findings suggest that media representations may introduce opportunities and challenges for shellfish farmers and the shellfish farming sector.

3.1 Introduction

This paper explores newspaper representations and British Columbia (BC) shellfish farmer perceptions of ocean acidification (OA). The analysis identifies key messages and actors conveyed through news articles and compares/contrasts them with results of a survey with shellfish farmers about their shellfish farms and OA. In 2003, Caldeira and Wickett hypothesized that the ocean as a carbon sink was effectively full, and profound changes to the chemistry and biology of the ocean would occur over the coming decades as a result. Just four years later, shellfish hatcheries in Washington state and Oregon experienced unprecedented oyster mortality resulting in sizable financial losses and production setbacks throughout the Pacific Northwest. Ocean chemistry monitoring networks revealed that OA, amplified by coastal upwelling, was a key contributor to the die-off events (Eudeline et al., 2015; Hauri et al., 2009). Soon after, some shellfish farmers and hatchery operators in British Columbia (BC) started reporting shellfish mortality or ‘die-off’ events.
Just as with climate change more broadly, the ways that information about OA is presented in the media shapes public understanding and can influence the direction of supports, programs and policy (Kelly, Cooley & Klinger, 2014). Members of the public rely on media representations of OA to help make sense of the issue and its potential implications (Boykoff & Boykoff, 2007). Specifically, media coverage may notify about potential threats, introduce scientific expertise and evidence, identify different opinions, and foreground particular mitigative or adaptive behaviors (Peterson & Thompson, 2009). Politicians and policy makers also rely on cues from the media to gauge public opinion and prioritize potential responses (Nisbet, 2009). However, news media alone is insufficient to understand complex environmental issues and the myriad ways in which they are experienced by people (Boykoff, 2011; Paschen & Ison, 2014). Notably, OA and programs and interventions to address it will directly impact shellfish farmers; to be effective, they need to reflect and incorporate their perceptions, assessments and capacities (Audefroy & Sánchez, 2017; Dekens, 2007; Lebel, 2013; Martens et al., 2009; Sujakhu et al., 2016).

The findings of this paper show that media representations of OA do not fully represent the perspectives and experiences of all shellfish farmers. Specifically, thematic analysis shows that news stories often sensationalize the issue and include interviews with a narrow selection of people. Contrasted with the results of a survey with shellfish farmers, this paper demonstrates that the diverse perspectives and challenges being faced by BC’s shellfish farming population are not fully and meaningfully raised in news coverage. Though operating in accordance with journalistic norms, news coverage simplifies the story of OA in BC. As I will raise in the discussion, economic
drivers and constraints within the news sector encourage coverage where certain narratives dominate, and others are silenced. In the conclusion I argue that the simplification of issues creates challenges as well as opportunities for BC shellfish farmers and the organization that represents them, and I posit that OA is best addressed as one concern among many that will affect coastal communities and economic sectors.

3.2 Literature Review

3.2.1 Agenda setting and media framing

The role of news media in characterizing and spreading information about environmental issues is widely recognized and it plays an important role in shaping public opinions and policy agendas (Karlberg, 1997; Nisbet, 2009; Scheufele & Tewksbury, 2007; Soroka et al., 2012). According to these studies and many others, news media generally interacts with public and policy agendas in two ways: agenda setting and media framing. First, by repeating coverage over time, news media shapes public understanding and perceptions of an issue (Downs, 1972; Scheufele & Tewksbury, 2007; Soroka et al., 2012). Second, and more importantly, news media can portray an issue in a certain way, effectively highlighting some aspects over others, influencing how the public and policy makers prioritize and seek action (or non-action) on an issue (McComb & Shaw, 1972; Nisbet, 2009). The way news media portrays an issue can also influence the scope and type of solutions or policy interventions perceived as possible and appropriate (Carvalho, 2007).

The agenda-setting literature tends to analyze how media coverage can focus public attention by prioritizing particular stories over others. According to Cohen (1963),
mass media “may not be successful much of the time in telling people what to think, but it is stunningly successful in telling its readers what to think about” (p.13). Mass media channels, such as newspapers, exercise power in what they do and do not cover, thus directing the reader’s attention to certain issues over others (Nisbet, 2009). Furthermore, like the public, decision makers and politicians rely on cues from the media to direct their focus on key issues (Boykoff, 2016; Brunet, Dagenais, Breux, & Handa, 2018; Mayeda, Boyd, Paveglio, & Flint, 2018; Soroka et al., 2012). Indeed, even though mass media often go unrecognized as a policy player, they are in the unique position of having frequent contact with the public and decision makers (Soroka et al., 2012). As such, the number of articles published during a timeframe is an indicator of issue salience, also referred to as the issue-attention cycle (Downs, 1972). Downs suggests that issues move through media focus and public consciousness incrementally and ultimately fade out after attention shifts to other issues (Downs, 1972). Stoddart, Haluza-DeLay, and Tindall (2016) found that the ‘issue attention cycle’ helped explain peaks and ebbs in reporting of climate change in Canadian news.

Like agenda-setting, the framing literature is concerned with media influence on public opinion and policy. However, while agenda-setting theory looks at story selection as a determinant of public opinion more broadly, framing theory looks at the way an issue is characterized and how that influences an audience (Scheufele & Tewksbury, 2007). According to Nisbet (2009), “there is no such thing as unframed information” (p.15). In other words, stories are tailored to a specific audience and medium, using metaphors, examples, and references known to attract and/or encourage an audience to think about a topic in a certain way (Scheufele & Tewksbury, 2007). In addition, the
central organizing ideas or frames a journalist uses in a story to describe an issue can make certain attributes of an issue appear more or less important (Scheufele & Tewksbury, 2007). Therefore, although they are literary, framing processes have real-world impacts and can "erect 'strong' boundaries around places - in both imagination and practice" (Castree, 2004, p. 163). However, it is important note that framing is not equivalent to falsifying information, although some experts, politicians and journalists do tilt facts to encourage an audience to think about an issue in a certain way (Nisbet, 2009). Rather, framing is necessary for communication and media as it allows people to understand and relate to an issue.

Agenda setting and framing theories have been widely applied to investigate how the media discusses environmental issues such as climate change (Schäfer & Schlichting, 2014), water issues (Mayeda et al., 2018), and sea level rise (Covi & Kain, 2016), among others. News media has a unique role in communicating information about science and environmental issues to the public, and as such, messages can be tailored to encourage the public to think about an issue in constructive ways. For example, certain local governments in the UK have used media and other communication methods to reframe climate change in order to address adaptation (Romsdahl et al., 2017). To be comprehensible and persuasive, messages must be appropriately framed and must take into account risk perceptions and diverse viewpoints.

### 3.2.2 Journalistic norms

Behind media representations of an environmental issue lie structural and foundational standards that govern how news media approaches and reports on an
issue. News media operations are under considerable pressures from economic drivers and constraints (Boykoff, 2011; Boykoff & Boykoff, 2007; McChesney, 2000). The profit motivated companies who are driven by self-interests and who own the majority of news media outlets result in ‘inherent limitations of journalism’ (McChesney, 2000, p.430). In addition, the global economic downturn of 2008 lead to the consolidation/closure of many media organizations and departments, including the entire science, technology and environment news staff at CNN (Boykoff, 2009). Economic constraints influence everyday journalistic decisions, such as how to efficiently frame a story with limited word counts and time to press (Boykoff, 2009). Furthermore, funding for investigative journalism is less prevalent, and reporters are expected to be fluent in a broad range of subject matter (Bennett, 1996). Journalists are being pushed to comprehend and communicate complex environmental science with mounting deadlines and space constraints (Weingart et al., 2000).

Stemming from the work of Bennett (1996, 2002), Boykoff and Boykoff (2007) suggest that news coverage of anthropogenic climate change is shaped by “first-order journalistic norms: personalization, dramatization, and novelty”(p. 1192). The personalization norm posits that human-interest stories that highlight individual trials and tribulations are favored over those that report on power, context and process. In other words, macro, structural or institutional analysis are foregone in favor of micro, individuals and personalities (Boykoff & Boykoff, 2007). Dramatization refers to trivializing a story so that it is exciting and surface level: “news dramas emphasize crisis over continuity, the present over the past or future, conflicts” and “downplay complex policy information, the workings of government institutions, and the bases of power
behind the central characters” (Bennett, 2002, quoted in Boykoff & Boykoff, 2007, p. 1192). Novelty is sought by journalists, who are constantly driven to report on something new (Boykoff & Boykoff, 2007; Lee, 1993). The preference for novelty results in coverage of crisis rather than other persistent problems that have already been presented by news media (Boykoff & Boykoff, 2007). In the case of climate change reporting in the US, first order journalistic norms have been demonstrated to highlight political quarrels, amplify the crisis narrative over the long-term anthropogenic nature of climate change, and ignore certain events when first-order requirements were not met (Boykoff & Boykoff, 2007).

3.2.3 Stakeholder perceptions of environmental issues

Here, I will briefly touch on the literature associated with social science frameworks to explore stakeholder perceptions of climate change and related issues; often, these are ‘local’ views informed by personal beliefs, understanding and experience (Wolf & Moser, 2011, p.562). In this study stakeholders are defined as commercial shellfish growers in British Columbia. Although there are many shellfish stakeholders, (i.e., processors, consumers, restaurants), commercial shellfish growers are immediately impacted by outcomes of OA and form the base of the larger commercial shellfish industry (Mabardy et al., 2015). People who live and work closely with the land have long been documented observing and tracking climate changes and effects on socioeconomic and biophysical systems (Audefroy & Sánchez, 2017; Dekens, 2007; Ford et al., 2010; Grabherr, 2009; Hiwasaki et al., 2014; Knapp et al., 2011; Marin, 2010; Nakashima et al., 2012). These studies, and others, have demonstrated that stakeholder populations are at the front lines of environmental
change and have nuanced perspectives of their local environment. Moreover, research has found that financial dependence and first-hand experience leads to a greater awareness of environmental change and motivation for conservation behavior (Sakurai et al., 2011). Indeed, the ability of BC’s shellfish industry to adapt to OA related risks is contingent on their acknowledgement of OA as an environmental issue (Byron et al., 2011; Ekstrom et al., 2015). Therefore, understanding how shellfish farmers perceive OA, its impacts, and how it affects behavioral changes has become increasingly critical for determining policy to advance adaptation strategies (Byron et al., 2011).

A small number of studies have been completed on other marine-dependant stakeholder groups affected by OA in the regions surrounding BC. In their study on how shellfish growers and hatchery workers in the US West Coast shellfish industry perceive OA, Mabardy and colleagues (2015) found approximately half of respondents had personally experienced negative impacts from OA. In general, their sample had a fairly advanced understanding of OA, were concerned about the problem, and were cautiously optimistic about adaptation (Mabardy et al., 2015). Similarly, Frisch, Mathis, Kettle and Trainor (2015) surveyed fishery-dependent Alaskan residents on their level of literacy regarding OA. This region is particularly vulnerable to OA due to the ocean circulation pattern and a strong reliance on subsistence and commercial fisheries. Researchers found that many respondents had heard of OA and could identify its dominant drivers, but there was a low level of confidence regarding OA science and fisheries-related risks. Frisch and colleagues (2015) also highlighted the opportunity for OA communication to be pointed and strategic in order to educate Alaskans about OA.
and reinforce the interconnectedness of human activity and environmental issues (Frisch et al., 2015).

In this section we have seen that news media plays an important role in informing the public and policy makers about environmental issues, and, therefore, that media framing and agenda setting theories will help to unpack the ways in which OA has been represented in the news (Boykoff, 2011; Downs, 1972; Nisbet, 2009; Scheufele & Tewksbury, 2007; Soroka et al., 2012). However, to communicate clearly and concisely and to draw in and keep readers, journalism about OA may conform to journalistic norms (Boykoff & Boykoff, 2007). Conversely, literature about stakeholder perceptions and experiences suggests that shellfish farmers will have more nuanced, diverse and personalized experience than media coverage portrays and that policy to address OA should reflect this (Frisch et al., 2015; Kelly et al., 2014; Mabardy et al., 2015). The studies presented in this literature review suggest that media representations and shellfish farmers’ perceptions of OA related issues may intersect in unexpected ways; this indicates that pairing a thematic analysis of media articles with a survey of BC shellfish farmers is valuable.

### 3.3 Study Regions

The study region is shown in Figure 2. BC shellfish aquaculture is Canada’s top producer of cultivated oysters, clams and scallops (Fisheries and Oceans Canada, 2016). In 2016, BC’s shellfish aquaculture industry harvested 9,300 tonnes of product worth approximately CAD $53.3 million in wholesale value (BC Ministry of Agriculture, 2016). According to the DFO (2017), as of December 8, 2017 there were 466 valid tenure shellfish aquaculture license holders in British Columbia. For this study, BC was divided into 5 regions based on the biophysical conditions in each region. The Baynes
Sound and Discovery Island regions were chosen as areas of focus for this study for three main reasons. First, these regions contain the majority of BC’s shellfish aquaculture production (Fisheries and Oceans Canada, 2016). For the purpose of my study, focusing on the most densely populated shellfish regions in BC allows for a deeper understanding of the diversity of perceptions and experiences in these regions. Second, the North Coast and Outer Coast regions were not included in my study as they did not have enough respondents to ensure participant anonymity. The third reason that the research includes Baynes Sound and Discovery Islands only is that national and regional media reports tended to focus on communities around the Baynes Sound and Discovery Island regions.
Figure 2: the BC shellfish aquaculture sector divided into 5 regions. Regions 2 & 3, where the majority of shellfish aquaculture takes place, were the focus of my analysis.

Shellfish cultivation in BC started in the early 1900s with the importation of the Pacific oyster and Manila clam from Asia (Ketchen, Bourne & Butler, 1983). Seed importation continued through to the 1930s, until stocks naturally began establish themselves in suitable areas such as Pendrell Sound and Ladysmith Harbor, where local temperatures were found to be conducive for breeding (Ketchen et al., 1983). Reliable breeding grounds led to an industry accepted shellfish aquaculture sector by the 1960s (Ketchen et al., 1983). Prior to cultivation, records show that First Nations people have been harvesting shellfish from the intertidal coastal waters of BC for at
least ten thousand years (Fedje & Mathewes, 2005). Currently, shellfish aquaculture continues to provide important economic and social benefits to a handful of coastal First Nations communities in a way that respects and supports their culture and values (Aboriginal Aquaculture Association, 2016).

3.4 Methods

This study is based on a mixed-methods approach. More specifically, this study pairs a thematic analysis of news media articles with a survey of shellfish farmers. In this section I will first present the methods related to the thematic analysis followed by the methods related to the survey.

I conducted a thematic analysis on news articles that discussed both OA and BC shellfish aquaculture. Thematic analysis is a systematic but flexible approach to identifying recurring topics, ideas, topics, or patterns (themes) that appear in data related to communication (Morey Hawkins, 2018). Thematic analysis is especially useful when investigating a phenomenon that has not yet undergone critical analysis (Morey Hawkins, 2018). According to Morey Hawkins (2018), to identify themes within data, the researcher repeatedly reads the language and content in the data to locate themes. Since OA in news media has not yet been analyzed in communication studies, a thematic analysis provided me the flexibility to read into the themes presented by news media inductively (Lapadat, 2012), and then apply an analytic coding stage whereby themes were assessed in relation to existing literature (Cope, 2010). Indeed, the language and content situated in media representations about OA may reveal how society understands OA as a threat and appropriate solutions. Therefore, I conducted a thematic analysis in order to understand when and how OA has been represented in Canadian news media.
First, to gain a sense of the scope of articles that exist, I began by experimenting with key search terms “ocean acidification”, “shellfish”, “oyster” and “ocean acid”, and I concluded that “ocean acidification” and “shellfish” were the most effective search terms. Then, based on Mayeda and colleagues (2018) search strategy, I used the search terms “shellfish” and “ocean acid!” to ensure that all potentially relevant articles were returned. Inclusion of the exclamation mark ensured that any term that included “ocean acid” would be identified in the sample (e.g. ocean acidity, ocean acidification) (Mayeda et al., 2018). Next, I identified all national and regional news media providers and individually searched each news provider database using the same key words. The primary criteria for an article to be considered in my analysis included was that it had to appear in a print or online version of a major national (Canadian) or BC regional print news media article, having a focus on OA and being written for or about British Columbia (rather than the Pacific Northwest more broadly). Articles that were written to address ocean health but mentioned OA at least once were included. These articles were contextually significant to understand how the media frames OA as an environmental risk. Articles in which OA or ocean health were not the main focus were excluded from analysis, including where OA was noted but was not the predominant topic in the article. Additional articles excluded from the final analysis included: (1) letter to the editor or opinion pieces; (2) non-news articles such as advertisements or newspaper content summaries; and (3) duplicate news articles. In total, this process yielded 29 articles. Data analysis involved open and analytic coding for themes (Cope, 2010). Analytic coding consisted of assessing my codes in relation to Liu, Vedlitz, and
Alston’s (2008) content analysis of news articles that discussed global warming and climate change in the US.

The framework adapted from Liu, Vedlitz, and Alston (2008) was appropriate due to similar research motivations in trying to understand news media representations of an environmental issue in North America. A description of each theme can be found in Table 2. The relevant themes in this framework were issue salience, issue image, and visible participants (Liu et al., 2008). Issue salience relates to agenda setting, whereby the number of articles published over time can focus attention and make certain stories seem more or less important (Nisbet, 2009; Soroka et al., 2012). Policy and decision makers are also affected by agenda setting, often relying on cues from the media to prioritize attention on key issues (Downs, 1972; Soroka et al., 2012). Therefore, similar to Liu and colleagues (2008), to explore the salience of OA in news media, I counted the number of articles that were published each year. Next, Liu and colleagues (2008) used the theme ‘issue image’ to understand how climate change was characterized by news media. This theme relates to media framing, and was useful to understand how news media framed OA and how it was understood by the public and politicians (Scheufele & Tewksbury, 2007). As such, like Liu and colleagues (2008), I evaluated each article and used multi-stage coding to discern how news media framed the issue. Lastly, Liu and colleagues (2008) identified the visible participants in each article to “present a snapshot of the key forces in the debate over climate change as portrayed by the media” (p.386). Thus, I identified and tallied the visible participants in the articles about OA and BC shellfish aquaculture to interpret who the media identifies as active speakers in the conversation, and who may be left out.
Table 2: Description of thematic analysis themes adapted from Liu, Velditz and Alston (2008).

<table>
<thead>
<tr>
<th>Thematic analysis themes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue salience</td>
<td>Relates to agenda setting. Repeated coverage of an issue equates to higher prominence in readers minds. Issue salience was measured by counting number of times issue appeared per year.</td>
</tr>
<tr>
<td>Issue image</td>
<td>Relates to how the issue was framed. Articles were evaluated to discern how the issue was characterized by the media to the reader.</td>
</tr>
<tr>
<td>Visible participants</td>
<td>Identifying visible participants is key to understanding elements of framing and agenda setting – who is included and not included demonstrates how the media portrays the scope of participation in a debate</td>
</tr>
</tbody>
</table>

While analyzing media representations of environmental issues is useful, Boykoff (2010) argues “they provide only partial explanations for these wider interactions that comprise ‘climate communication’” (p.10). Additionally, Paschen and Ison (2014) observe that thematic analysis is limited in its ability to fully understand how a complex issue is understood by researchers. This suggests that other methodologies paired with a thematic analysis could lead to a clearer understanding of the way that an environmental issue like climate change or OA is presented and experienced. Since shellfish farmers are often discussed in the news media and are at the front lines of ocean change, their perceptions may contribute valuable insight into the state of OA communication in BC. Indeed, people who have daily interactions with an environment and whose livelihoods are threatened by changed climatic conditions tend to have a sophisticated understanding of an environmental issue (Nakashima et al., 2012).

I therefore also administered a survey to document BC shellfish farmers’ impressions of OA communication and their perceptions of its implications for the
shellfish aquaculture sector. The construction of survey questions followed Smyth and colleagues (2009) techniques for conducting an online survey within small communities. The survey design followed similar protocol to Mabardy, Waldbusser, Conway, and Olsen's (2015) study on the perceptions of U.S. West Coast shellfish farmers and hatcheries. The survey was conducted using an online interface called Qualtrics. Whenever possible, questionnaires were administered on a tablet in-person, but they were also able to be sent through an online link. This flexibility and accessibility was important to enable participation in remote areas. Participants were sought out through purposive and snowball sampling. Purposive non-probability sampling ensured participants fit the criteria to be interviewed (Jupp, 2006), namely, they are a shellfish farm owner and/or worker in BC. If we were successful in contacting a potential participant, snowball sampling was conducted at the end of each meeting. This is a process whereby after identifying an appropriate respondent we asked the individual who else might be an appropriate respondent (Jupp, 2006). Researchers attempted to ensure accurate representation by limiting responses to one per tenure. According to the DFO (2017), as of December 8, 2017 there were 466 valid tenure shellfish aquaculture license holders in British Columbia. Since there is currently no available data on the numbers of actively farmed tenures or shellfish farmers employed in the industry, limiting responses to one per tenure allowed multiple responses from large companies with multiple tenures and one response from small companies with one tenure. This was made clear whenever necessary before the start of every survey. There are several limitations to this strategy for calculating a response rate. First, it is unclear how many of the tenure licenses are actively farmed. Based on our summer
field experience, it appears a great deal of tenure holders do not actively farm their licensed sites, but it was impossible for us to estimate how many. Second, since the survey was anonymous, researchers were unable to share information about previous participants thereby creating an opportunity for more than one participant responding from the same tenure. Nonetheless, the wide variety of demographics and overlapping themes suggests we have captured as least some of the most popular and persistent experiences and opinions in the sector. Survey analysis was conducted in SPSS using descriptive statistics.

3.4.1 Survey Respondent Characteristics

In total, 55 surveys were completed. The Baynes Sound and Discovery Island regions shown in Figure 2 -- where approximately 80% BC’s shellfish farm tenures are located -- were the areas of focus for this study. Survey respondent characteristics can be found in Table 3. Of the 55 completed surveys, 37 respondents were from the Baynes Sound and Discovery Island regions; surveys from these respondents were analyzed in this paper. Over half (21 or 54%) of respondents had been actively farming for at least 11 years, and almost two thirds (23 or 62.1%) of respondents were from farms that had been in operation for over 21 years. The majority (24 or 64.8%) of respondents were from small or medium sized farms, and large and extra-large farms were represented by 11 respondents.\(^2\) This indicates that a broad range of farmers responded to the survey, with a slight majority represented by small and medium scale farms.

\(^2\) Small sized farms were defined as farms with 1-3 employees that produced up to 25,000 dozens of oysters (or equivalent) per year. Medium sized farms were defined as farms with up to 8 employees and up to 50,000 dozens of product per year. Large farms were defined as farms with up to 16 employees and up to 175,000 dozens of product per year. Extra-large farms were defined as farms with more than 16 employees and exceeding 175,000 dozens of product per year.
shellfish farmers and farmers who had been farming for over 11 years. Twenty-four or 64.9% of respondents reported they were members of the BC Shellfish Growers Association (BCSGA), and 13 or 35.1% of respondents indicated that they were not members of the BCSGA. Shellfish products were represented as oyster (89.2%); clams (70.3%); scallops (27%); mussels (27%); and geoduck (18.9%). Participant distribution reflected the general distribution of BC, where the majority of participants were oyster growers from the Baynes Sound and Discovery Islands regions. Furthermore, all species were grown in both regions, with many respondents farming multiple species at a time.

Table 3: Survey respondent characteristics - Percentage of respondents

<table>
<thead>
<tr>
<th></th>
<th>Baynes Sound</th>
<th>Discovery Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents by region</td>
<td>48.6</td>
<td>51.4</td>
</tr>
<tr>
<td>Age of farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 5 years</td>
<td>0</td>
<td>10.8</td>
</tr>
<tr>
<td>5-10 years</td>
<td>10.8</td>
<td>24.3</td>
</tr>
<tr>
<td>11-20 years</td>
<td>24.3</td>
<td>32.4</td>
</tr>
<tr>
<td>21-30 years</td>
<td>24.3</td>
<td>29.7</td>
</tr>
<tr>
<td>More than 30 years</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Amount of time farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>Extra-Large</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>Size of farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oysters</td>
<td>89.2</td>
<td></td>
</tr>
<tr>
<td>Clams</td>
<td>70.3</td>
<td></td>
</tr>
<tr>
<td>Scallops</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Mussels</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Geoduck</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>BCSGA Membership status</td>
<td>64.9</td>
<td>35.1</td>
</tr>
</tbody>
</table>
To complement the thematic analysis, this research surveyed shellfish farmers about their perceptions and experiences with OA. Survey questions reported in this section include: (1) What do you consider to be a trusted source of information about OA?; (2) How informed do you feel about OA?; (3) To what extent do you consider OA to be a threat to the BC shellfish aquaculture industry?; (4) Has the farm ever had a die-off event?, and; (5) Has the farm ever had a die-off event you attribute to OA? Then, to find out how farmers perceive OA in relation to other challenges, this section ends with the results of open-ended questions: (6) What is your biggest challenge with shellfish farming?, and; (7) What do you think is the main cause of shellfish die-off events within the BC shellfish farming sector? Results of these questions are presented in section 3.5.2, followed by a discussion and conclusion.

3.5 Results

This section presents results from the thematic analysis and survey. The thematic analysis results have been organized thematically around a framework adapted from Liu, Vedlitz, and Alston (2008) analysis of news articles that discussed global warming and climate change in the US. Key findings from each theme can be found in Table 2 on page 54. Then, survey results represent shellfish farmers perceptions and experiences related to OA. Results are organized by type of data, starting with quantitative results and finishing with qualitative, open-ended responses.

3.5.1 Thematic analysis Results

3.5.1.1 Issue salience

As seen in Figure 3, by repeating news coverage over time, news media has a role in affecting an issue’s salience (Downs, 1972; Soroka et al., 2012; Stoddart et al.,
News articles that discussed OA were first published by Canadian outlets in 2008. These early articles reported on a landmark paper in *Science* that described the advance of OA onto the Pacific Northwest continental shelf (Feely et al., 2008). At this point, scientists were still unsure how acidic water might interact with the well-established shellfish industries in the region. The spike in media articles in 2014 corresponded with a reported mass die-off event at Island Scallops, a large-scale scallop hatchery and farm near Qualicum on Vancouver Island. During this time, seven of the ten articles published included a widely known shellfish industry stakeholder who discussed losses experienced on his farm and tied them to OA. News reports declined in the years 2015 and 2016, and there were none at all in 2017.

![Figure 3: number of articles about OA and BC shellfish aquaculture published in Canadian news media outlets in relation to significant OA events.](image)

### 3.5.1.2 Issue Image

Issue image is the basic impression of an issue and has powerful implications for shaping public understandings and political agendas (Liu et al., 2008). Two prominent and often interlinked themes were constructed and communicated in the articles: uncertainty and crisis. Articles that focused on die-offs and production losses were clear that OA was suspected, but due to the ambiguous nature of scientific language (Boykoff & Boykoff, 2007), news media portrayed it with uncertainty. For instance, UBC scientist
Chris Harley was quoted in Hume (2014) as saying “it's an interesting puzzle. I’m not sure what's killed all those scallops out in the Strait of Georgia… It might have been low pH but I’m not sure we can say that with much confidence”. Here we can see that uncertainty is portrayed by quoting a scientist who suggests that it is difficult to pinpoint the cause of shellfish die-offs. In addition, the metaphor that die-off events are ‘an interesting puzzle’ alludes to a mysterious challenge.

The other prominent image theme presented was crisis. The majority of articles represented OA as an urgent and negative crisis, with impacts on jobs, the economy, ecosystems, First Nations, BC’s wild salmon, and seafood affordability, among others. For example, Glenda Luymes in the *The Province* wrote “I’d say it’s full-scale panic mode (for scallop farmers),” said Rob Saunders, CEO of Qualicum Beach-based Island Scallops”. The editors of the *Times Colonist* (2014) take this further in saying “The ocean water that should feed shellfish has become so acidic it is killing them. Near Qualicum Beach, 10 million scallops have died, the latest casualties of our increasingly acidic seawater. Nanaimo’s Island Scallops, which grows the shellfish over about 500 hectares, has closed its processing plant and laid off 10 people”. These quotes illustrate that crisis is an important part of image presentation when OA is discussed in news media. Crisis is developed by suggesting that culturally and economically vital components of BC’s ocean environment are threatened by OA.

It is also interesting to note that crisis and uncertainty were not mutually exclusive in the articles, and in fact, were often interwoven. For instance, Vass (2014) stated in the *CBC* “More research is urgently needed to keep the shellfish industry
afloat”. This statement suggests uncertainty and crisis by implying that immediate research is needed to resolve the problem, and that the shellfish industry is at risk.

3.5.1.3 Visible Participants

According to Liu et al. (2008), identifying the ‘visible participants’ in the discussion of an issue is key to exploring framing and agenda setting dynamics. Who are the key speakers in the ocean acidification debate as portrayed by the media? Thematically, the articles represented four interest groups: scientists, shellfish farmers, the shellfish farming industry association: British Columbia Shellfish Growers Association (BCSGA), and other stakeholders. Visible participants are shown in Figure 4.

![Visible Participants](image)

**Figure 4: Representation of visible participants in news media articles.**

References to scientists from universities and professional organizations were represented in many of the articles. Scientists were often interviewed and quoted to add context to OA’s biophysical process and explain OA science in news reports. For example, Dr. Colin Brauner was quoted in *The Globe and Mail* saying: “The acidity of water along the West Coast is especially high because deeper water, which tends to be
more acidic, often wells up to the surface, Prof. Brauner said” (Xiong, 2016). In addition, in *The Vancouver Sun*, Shore (2014) wrote “Human-caused carbon dioxide emissions in the atmosphere are being absorbed by the ocean and may have pushed local waters through a “tipping point” of acidity beyond which shellfish cannot survive, said Chris Harley, a marine ecologist at the University of B.C”. These quotes demonstrate the ways in which news media included scientists in their stories about OA. Scientists were primarily used in the articles to explain OA science and communicate the status of OA in local waters. Scientist quotes also supported image themes of crisis and uncertainty by using the “tipping point” metaphor and in using non-definitive language.

Certain shellfish farmers were also present in the articles as visible participants. Specifically, an exclusive group of large-scale shellfish farmers, primarily from the Baynes Sound region were included in 13 of the media reports. Rob Saunders, a large scale farm/hatchery representative from Island Scallops was especially visible. He was quoted in 10 of the 13 articles and was very vocal about his farms experiences with OA die-offs. For instance, in *The Globe and Mail*: “I’m convinced the ocean is getting much more acidic, and much more acidic than anyone anywhere believed it could happen that fast” (Hume, 2014). The select group of farmers included in reports suggests that the reports were dominated by their stories and perspectives. It is also worth noting that news media articles did not quote any small-scale or First Nations shellfish farmers, with the exception of one small-scale farmer who was also President of the BCSGA at the time.

Representatives from the BCSGA were also visible participants in the articles within the dataset. The BCSGA represents approximately 70% of shellfish growers in
BC, and works with various levels of government, According to their website, the BCSGA’s mission is “To advance the sustainable growth and prosperity of the BC shellfish industry in a global economy by providing leadership, communication and advocacy to members, government, the public and other stakeholders while maintaining and improving the integrity of the marine environment” (BCSGA, 2018). Based on this, it was no surprise to see the BCSGA supporting and advocating for visible shellfish farmer participants in the media. For instance, in *The Vancouver Sun*, Shore (2014) wrote “The B.C. Shellfish Growers Association is asking Fisheries and Oceans Canada to take part in a study with B.C. growers to work out potential solutions to the problem”. This demonstrates that the BCSGA supported shellfish farmer claims in news media and advocated for their membership.

Other stakeholders included restaurant owners who carried BC shellfish in their businesses and the Association of Denman Island Marine Stewards. These other stakeholders were the least of all visible participants in the news pieces and were included to support the story image and offer a wider perspective on the issue.

Table 4: key findings from thematic analysis based on framework adapted from Liu et al. (2008).

<table>
<thead>
<tr>
<th>Analytical themes</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Issue salience</strong></td>
<td>OA emerged in news media in 2008, peaked in 2014, and was no longer discussed in news media outlets in 2017. Peak in news coverage in 2014 corresponds with highly publicized die-off event.</td>
</tr>
<tr>
<td><strong>Issue image</strong></td>
<td>Framing of OA is dominated by messages of crisis and uncertainty.</td>
</tr>
<tr>
<td><strong>Visible participants</strong></td>
<td>Articles represented: scientists, shellfish farmers, industry representatives, and other stakeholders. Most importantly, an exclusive group of large-scale shellfish farmers were represented in media stories along with the BC Shellfish Growers Association.</td>
</tr>
</tbody>
</table>
3.5.2 Survey Results

In order to understand how shellfish farmers perceive OA in relation to how it is represented in news media, respondents were asked what sources they trust for information about OA. As seen in Table 5, over half of respondents chose ‘Universities’ (19 or 51.4%) followed by ‘Research institute’ (18 or 48.6%). These first two ranking choices relate to trust in science and scientists. ‘Aquaculture Organization’ (17 or 45.9%) and ‘other shellfish farmers’ (14 or 37.8%) were selected third and fourth most often, which can be interpreted as trust in sources internal to the shellfish aquaculture industry. ‘Newspaper” was selected by two respondents and was tied in 14th place along with “Television”. Next, in order to understand how farmers thought about OA, respondents ranked to what degree they feel informed about OA, and the likelihood they feel OA is a threat to the industry. When respondents were asked how informed they felt about OA (see Figure 5), eight (21.6%) felt ‘not at all’ informed and nine (24.3%) felt slightly more informed. Only two (5.4%) respondents felt ‘very well’ informed. When asked about the extent to which they thought OA is a threat to the BC shellfish aquaculture industry (see Figure 6), four (10.8%) respondents thought the industry was ‘not at all’ threatened, and 10 respondents (27%) thought the industry is ‘a great deal’ threatened. Finally, when asked if the farm had ever had a die-off event on their farm, 26 (70.2%) had. When asked if the farm had ever had a die-off event that they attributed to OA, only three (8.1%) had. Twenty (54.1%) respondents had never experienced a die-off event and 14 (37.8%) responses were missing, which may be so high because this question did not have a “don’t know” option.
Open-ended survey questions invited respondents to share their challenges with shellfish farming and suspected causes of die-offs. When survey respondents were asked about their biggest challenge with farming, the most commonly cited challenges related to cash flows, markets, and labour. For example, one respondent wrote “Good help is […] hard to find, and because it is difficult to get a good price for the shellfish it makes it difficult to pay someone to help a decent wage”. Another respondent wrote “Cash flow is probably the most challenging for most growers”. The second most common challenge related to oyster seed, namely, accessing quality seed, affordability of seed, and keeping seed alive: “the initial cash outlay to purchase outside-sourced seed (as opposed to natural recruitment), and the uncertainty of the survivability of this seed”. Several farmers also wrote about survival of stock: “Getting oysters to survive in certain areas”; “Keeping them alive and making sure there is enough food in the water so they grow”. It is interesting to note that no respondent mentioned OA in relation to the biggest challenge they are facing with shellfish farming, but rather, shellfish farmers are experiencing a wide range of challenges.

Table 5: Shellfish Farmer Trust in Sources for Information about OA
Figure 5: How informed respondents felt about OA

Figure 6: Likelihood respondents felt the BC shellfish aquaculture industry was threatened by OA

Table 6: Shellfish die-off events reported by survey respondents

<table>
<thead>
<tr>
<th>Has the farm ever had a die-off event?</th>
<th>Yes</th>
<th>No</th>
<th>Did Not Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70.3%</td>
<td>29.7%</td>
<td>0</td>
</tr>
<tr>
<td>Has the farm ever had a die-off event attributed to OA?</td>
<td>8.1%</td>
<td>54.1%</td>
<td>37.8%</td>
</tr>
</tbody>
</table>
Finally, respondents were asked what they suspect to be the main cause of shellfish die-offs within the BC shellfish farming sector. Suggested causes clustered by theme are shown in Table 7. After uncertainty, temperature was the most common suspected cause of die-offs, followed by genetics and ocean acidity. A few farmers acknowledged the complexity of the issue by writing multiple reasons. Other suspected causes included changing oceanic conditions, food availability, species (such as crab and tunicate) predation, harmful algae, and farmer practices, among others. These results demonstrate that OA is one of many challenges perceived by shellfish farmers.

<table>
<thead>
<tr>
<th>Suspected cause of shellfish die-off</th>
<th># of times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsure</td>
<td>9</td>
</tr>
<tr>
<td>Water temperature</td>
<td>7</td>
</tr>
<tr>
<td>Shellfish genetics</td>
<td>6</td>
</tr>
<tr>
<td>OA</td>
<td>5</td>
</tr>
<tr>
<td>Environmental conditions</td>
<td>4</td>
</tr>
<tr>
<td>Food availability/timing</td>
<td>4</td>
</tr>
<tr>
<td>Predation</td>
<td>4</td>
</tr>
<tr>
<td>Harmful Algae</td>
<td>4</td>
</tr>
<tr>
<td>Handling practices</td>
<td>3</td>
</tr>
<tr>
<td>Husbandry practices</td>
<td>3</td>
</tr>
<tr>
<td>Cocktail of factors</td>
<td>3</td>
</tr>
<tr>
<td>Virus</td>
<td>3</td>
</tr>
<tr>
<td>Extreme weather</td>
<td>2</td>
</tr>
<tr>
<td>Pollution</td>
<td>1</td>
</tr>
<tr>
<td>Timing of natural events</td>
<td>1</td>
</tr>
</tbody>
</table>
3.6 Discussion

This study analyzed media representations and surveyed shellfish farmers about OA in the BC shellfish aquaculture sector. I sought to compare and contrast the amount of attention paid to OA and how it was characterized in news media with shellfish farmer perspectives about OA related threats in connection with their expertise as front-line observers of ocean change.

In terms of how the media framed the issue image, or, the basic impression of the issue (Liu et al., 2008), OA communication appeared to have the same key aspects as climate change communication; crisis and uncertainty (Slovic, Fischhoff, & Lichenstein, 1985). Crisis is also a key component of journalistic norms, whereby dramatization is a necessary component of reporting (Boykoff & Boykoff, 2007). These key aspects were demonstrated by news reports of catastrophic losses and ‘an interesting puzzle’ (Hume, 2014) from OA. Furthermore, by comparing news media articles to survey results my analysis revealed that the themes of crisis and uncertainty intersected with shellfish farmer perceptions of OA in compelling ways. First, the survey results showed that some shellfish farmers may relate to feelings of uncertainty. When respondents were asked how informed they felt about OA, almost half of respondents selected options 1 and 2 or “not at all” and slightly more than “not at all”. Furthermore, most farmers are unsure of what is causing die-off events. This suggests that many farmers are feeling uninformed about OA facts and are uncertain what to conclude about OA with the information they do have. In addition, many farmers can relate to the crisis image presented by the media, but while the media sensationalizes OA as an immediate threat, survey results suggest shellfish farmers perceive OA as a distant threat. For example, when asked about the extent to which they perceive OA as a threat
to the BC shellfish aquaculture industry, almost half of respondents felt the industry is ‘a great deal’ threatened or slightly less than ‘a great deal’ threatened. However, of the 37 respondents, 26 had experienced a die-off on their farm and only three farmers had a die-off that they attribute to OA. Also, when asked “How much have you thought about OA in the last 6 months?” the most commonly selected option was 1 for “not at all” (10 respondents). This suggests that contrary to sensationalized media reports, most shellfish farmers had not personally experienced OA on their farms and could not relate to the immediate sensationalized crisis narrative put forth by the media, but nonetheless perceive OA as a threat to the industry. These findings also suggest that feelings of crisis and uncertainty are not mutually exclusive in shellfish farmers, just as they are not in news media reports (Slovic et al., 1985).

Moving on to visible participants, or the key speakers in the OA debate (Liu et al., 2008), the most active speakers were scientists, certain shellfish farmers, and shellfish industry representatives. Scientists were included as a framing strategy to add context to the story and explain science (Nisbet, 2009). In terms of shellfish farmer active participants, a few large-scale farmers were successful in attracting media attention, but there are a wider range of business models and tenure sizes in the Baynes Sound and Discovery Island regions. The survey shows that small and medium sized farmers were very active in the regions, making up 24 or 64.8% of survey respondents with small sized farms being the most selected option. However, large scale farmers were the only farmers who were quoted in news media reports, which suggests their social and economic interests were represented while others may not have been. This also relates to Boykoff and Boykoff’s (2007) “individualization” point, whereby individual human
interest stories were favored over a large-scale industry analysis. In addition, the news stories did not actively seek representation from a First Nations shellfish farming organization, of which there are several in the area. By framing the story with only a select group of large-scale farmers, media reports may have effectively silenced the ability of other shellfish farmer perspectives to reach the public realm.

Media has been shown to influence the social and cultural context for policy making (Boykoff, 2011; Dryzek, 2013; Nisbet, 2009). In this case, it appears that media attention may have shone a spotlight on the industry’s trials with OA for long enough to set the agenda for urgent political attention. I am not suggesting here that media attention was the sole purpose for adaptive policy development, but the generation of political pressure stage of the ‘issue attention cycle’ (Downs, 1972) is reinforced in this case by the announcement of the Ocean Acidification Shellfish Industry Seed Supply (OASISS) (BC Gov News, 2017). OASISS is an adaptive policy, developed collaboratively by the BC Government, Vancouver Island University, the Hakai Institute and the BCSGA in 2017, and aims to “address issues of food supply security and climate change affecting the shellfish industry” (BC Gov News, 2017). The BC government provided initial funding to the BCSGA for new ocean monitoring equipment and the Deep Bay Marine Station at Vancouver Island University to support a selective breeding program aimed at developing oyster seed with improved resistance to environmental change and disease (BC Gov News, 2017). Put another way, OASISS was developed to address OA along with other concerns. These developments confirm Kelly Cooley and Klinger’s (2014) findings that scientific assessments paired with a narrative of loss were dually effective in catalyzing funding and programming for
adaptation. Also noteworthy is that the launch of OASISS was announced through the provincial government’s news release and was not picked up by news media (BC Ministry of Agriculture, 2017). This suggests that adaptive policy development did not conform to “first-order journalistic norms” (Boykoff & Boykoff, 2007), whereby potential stories need to be dramatic, novel, and individualized.

Shellfish farming representatives were also visible participants in news media, which brings up an interesting point of discussion. The BCSGA represents approximately 70% of shellfish farmers in BC (BCSGA, 2018), and as such, was often included in media reports to support their membership. The salience of the issue and the involvement of the BCSGA also suggests the organization used the momentum of the OA story to attract attention to issues facing the industry. Indeed, in attempt to advocate for its membership the BCSGA may have used the spotlight in news media to successfully build a case for the need for adaptive planning. Then, as a key player in the process they may have been able to assist in steering policy development to encompass a broader range of challenges facing the industry, such as selective breeding, ocean monitoring, and food safety improvements (BC Gov News, 2017). However, while the BCSGA may have been successful in using media attention about OA to advocate for its membership with a concrete outcome, it is unclear if benefits from recent policy development will represent the challenges being faced by all shellfish farmers. The broad range of adaptive planning suggests that benefits could reach all shellfish farmers, but if so, effective communication about benefits needs to be accessible to all shellfish farmers whether or not they are members of the BCSGA.
While OA is a very real phenomenon, studies show that understandings of environmental changes are subjective, and that perceptions are developed through experiences and worldviews (Wolf & Moser, 2011). Results from the survey suggest respondents see OA as one concern among many. Similar to other resource workers facing long-term impacts from climate change (see Young et al., 2009), respondents in my study were more concerned with what they perceive as immediate challenges. This is demonstrated by open-ended survey responses on what respondents perceive as their biggest challenge with shellfish farming. Respondents cited challenges related to cash flows, markets, seed access, and product survival, which are all related to day-to-day operational challenges. Adaptation policy and management options to address OA or the sector more broadly should consider these immediate challenges in order to be considered relevant to shellfish farmers.

OA has not gone away but attention to it in the media appears to have declined in recent years – even OASISS, the recent policy developed in wake of the OA story has not been publicized in news media. Findings from my study suggest the way OA is reported does not accurately represent shellfish farmers, who see OA as one of many challenges and are more concerned with other immediate challenges that tend to not be reported. This crisis narrative nature of news media that dominates in journalistic reporting results in OA being discussed with direct and immediate effects, which also does not reflect the long-term nature of OA. Climate scientists hypothesize OA is going to continue to impact coastal marine environments and the communities that rely on them (Caldeira & Wickett, 2003). Therefore, this issue of narrow reporting on environmental issues such as OA is a concern that should be addressed.
3.7 Conclusion

Ocean monitoring networks have revealed that OA amplified by coastal upwelling has made its way into the PNW, where the BC shellfish aquaculture sector is vulnerable (Eudeline et al., 2015; Hauri et al., 2009). Similar to issues around climate change, public perceptions and political supports are influenced by media representations of OA (Boykoff & Boykoff, 2007; Kelly, Cooley, & Klinger, 2014). This paper employed a thematic analysis and a survey to explore news media representations and shellfish farmer perceptions of OA. The results of this study show that media representations of OA are shaped by economic drivers and constraints within the news sector and to journalistic norms and they communicate the issues in a quite narrow way. Moreover, media representations of OA do not represent or communicate the diverse perceptions of shellfish farmers in the BC shellfish aquaculture sector.

The simplification of OA in news media has created challenges as well as opportunities for BC shellfish farmers and the BCSGA. In one sense, media reporting presented a narrow picture of OA specifically and the sector more broadly, which may have limited the potential for the public and politicians to understand OA and the BC shellfish aquaculture sector. However, in another way, media reporting of OA may have allowed for shellfish growers and the BCSGA to use the momentum from media reports to advocate for a broader range of supports for the sector. This is suggested by the formation of OASISS, which was created to address OA along with a broad range of other challenges and could potentially benefit a wide range of shellfish farmers. This is important because survey results show that shellfish farmers do see OA as a concern, but it is one of many concerns impacting their immediate social and economic realities.
Further attention needs to be paid to how, and to whom, opportunities are communicated.

This study demonstrates the importance of looking beyond analysis of an environmental issue to the affected population. Media framing and agenda setting theories were useful in understanding how the public and policy makers are thinking about OA, but surveying shellfish farmers provided a deeper understanding of the effectiveness (or lack thereof) of OA communication in news media. In addition, surveying shellfish farmers provided a means for their voices to be heard where they may have been silenced by journalistic norms in media reporting. Findings from my study demonstrate that newspaper reporting on OA reflects the status quo for newspaper reporting and journalistic norms. Although journalistic norms are unlikely to change, this presents a call to look at the media's role and responsibility in environmental communication. The opportunity exists for OA communicators to be pointed and strategic and not allow misrepresentations to prevail in the public consciousness.
4 Conclusion

4.1 Thesis Summary

Ocean Acidification is a global, long-term problem that is the result of the ocean absorbing excessive human-induced CO₂ (Caldeira & Wickett, 2003; Orr et al., 2005). Mass media plays a critical role in communicating environmental issues like OA to the public and politicians alike (Boykoff, 2013; Boykoff & Yulsman, 2013; Soroka et al., 2012). As such, media representations of OA can influence and inform political actors and decisions, including related supports, programs and policies (Kelly et al., 2014). Alternatively, literature about stakeholder perceptions suggests that shellfish farmers have diverse and distinct experiences and adaptations or policies to address OA should integrate their perspectives (Byron et al., 2011; Nakashima et al., 2012; Sakurai et al., 2011; Wolf & Moser, 2011). Engaging BC shellfish farmers in effort to understand OA related challenges is an important component in developing effective adaptation.

This thesis documents media representations and shellfish farmer perceptions of OA in British Columbia, Canada. Literature on the human dimensions of OA, media representations of environmental issues, and adaptation contextualize the research. Methodologically, the research used a thematic analysis and survey. In turn, three objectives have been met:

- conduct a thematic analysis of stories from Regional and National news media that discuss both ocean acidification and British Columbia’s shellfish aquaculture sector;
- using a survey, document British Columbia shellfish farmers’ first introduction to ocean acidification and their perceptions of its implications for the sector;
• compare and contrast findings from objectives A and B and draw conclusions about how OA is situated amidst a suite of concerns that may demand shellfish sector adaptation.

Key findings were presented in the manuscript chapter and structured around a framework that incorporates media framing, agenda setting, journalistic norms, and stakeholder perceptions of environmental issues.

Thematic analysis results were organized thematically around a framework adapted from Liu, Vedlitz, and Alston (2008) and fell under: issue salience; issue image; and visible participants. Issue salience relates to how repetition of a story can heighten its political profile. I found that OA first emerged in news media in 2008, peaked in 2014, and was no longer discussed in news media outlets in 2017. The peak in news coverage in 2014 corresponded with a highly publicized die-off event. Next, issue image relates to the basic impression of an issue including how the issue is framed. I found that OA framing was dominated by messages of crisis and uncertainty. Finally, the visible participants in the media demonstrates who the key speakers are in a debate. I found that articles discussing OA represented scientists, shellfish farmers, industry representatives, and other stakeholders. Most importantly, an exclusive group of large-scale shellfish farmers were represented in media stories along with the BC Shellfish Growers Association.

A subset of 37 survey responses were analyzed. I found that scientific institutions were the most trusted sources of information about OA followed by sources internal to the industry. When asked about the extent to which they perceive OA as a threat to the BC shellfish aquaculture industry, almost half of respondents felt the industry is ‘a great
deal' threatened or slightly less than 'a great deal' threatened. However, of the 37 respondents, 26 had experienced a die-off on their farm and only 3 farmers had a die-off that they attribute to OA. When asked “How much have you thought about OA in the last 6 months?” the most commonly selected option was 1 for “not at all” (10 respondents), and when asked “How informed do you feel you are about OA?”, the least selected option was 5 for “very well” (2 respondents).

Results from the thematic analysis and survey were compared and contrasted to show that news media painted a narrow view of OA and shellfish farmers and may not have accurately represented the perceptions and experiences of all shellfish farmers. This was demonstrated by the crisis narrative central to OA communication in news media, that was often not perceived in the same way by shellfish farmers. In addition, the visible participants in news media reports and the survey demographics did not align. An exclusive group of large-scale farmers were quoted in the articles but small and medium scale farmers, who made up a significant portion of survey respondents, were not included in the articles. Furthermore, shellfish farmers do see OA as a concern, but it is one of many concerns. In fact, the most commonly mentioned challenges by shellfish farmers related to day-to-day operational challenges as opposed to OA, which is perceived as a distant threat. Comparative results also showed that OA’s peak into prominence in 2014 helped generate enough political attention to lead to adaptive policy development, which shellfish farmers indicated should encompass more than just OA.

This thesis’ conclusion further revealed that media representations conform to economic drivers and constraints within the news sector and adhere to journalistic
norms, such as crisis, individualistic reporting. In addition, the simplification of OA in news media led to challenges and opportunities for shellfish farmers and the BCSGA. Challenges related to the narrow purview shared of OA limiting the potential for the public and politicians to understand OA and the shellfish farming sector. However, opportunities may have emerged when the BCSGA was able to use the momentum from media reporting to advocate for a broader range of supports for the sector. Thus, OASISS was developed to address a wider range of issues including food supply security and climate change. Further attention should be paid to how benefits from OASISS and other related supports are distributed and communicated. In the remainder of this chapter I will discuss the main contributions of this work and suggest some directions for future research.

4.2 Research Contributions

4.2.1 Scholarly Contributions

This thesis makes three main scholarly contributions. First, this thesis builds on the growing body of research related to human dimensions of OA. Several scholars have suggested that future OA should focus on management and policy options (Ekstrom et al., 2015; Riebesell & Gattuso, 2015). This research addresses this call by adding a much needed Canadian and British Columbian perspective, as well as a nuanced perspective on stakeholder perceptions of OA. More specifically, management options related to OA should focus on the wide range of immediate and long-term challenges and needs as suggested by shellfish farmers. Policy makers should continue to work with the BCSGA and shellfish farmer stakeholders to work towards meeting the needs of diverse shellfish farmers. Furthermore, this research builds on Mabardy and
colleagues (2015) work on the US west coast shellfishery's perceptions of OA. Like Mabardy and colleagues found, most respondents in my study indicated they are concerned about OA and perceive it as a threat to the industry. My study expanded on their analysis to include sources of information shellfish farmers trust to get information about OA and how informed they feel about OA. I found that farmers are most likely to trust sources related to science and sources internal to the industry, and they were generally less likely to trust popular or social media sources. In addition, over half of respondents in my study did not feel very well informed about OA. This suggests that many shellfish farmers may not have access to exclusive or preferred information sources such as scientific colleagues or journals, or BCSGA membership publications. Therefore, clear, effective communication related to OA should be developed to ensure that adaptation programs, such as OASISS, are accessible to all shellfish farmers regardless of their connection to scientific outlets or BCSGA membership status.

Second, this research also addresses gaps in the literature by contributing an analysis of OA communication in news media. Media representations of climate change (Boykoff, 2011; Schäfer & Schlichting, 2014) and other environmental issues such as water issues (Mayeda et al., 2018) and sea level rise (Covi & Kain, 2016) have shown that media plays an important role in communicating environmental issues, and the way each issue is presented influences public and political attention. This research furthers this literature by exploring how OA is presented in news media. More specifically, my research suggests that news media may have created challenges and opportunities for shellfish farmers and the BCSGA. Canadian news media conforms to journalistic norms and presents a narrow view of OA that may limit the potential for the public and
politicians to understand OA and the BC shellfish aquaculture sector. However, when OA was circulated through the news, opportunities may have opened up for the BCSGA to address a broader suite of concerns for the shellfish farming industry. The salience of OA in Canadian news media correlated with Down’s (1972) issue attention cycle, and the development of the OASISS adaptive program in 2017 is evidence of the opportunity that opened up for the shellfish aquaculture sector when OA was circulated through the media.

Third, this research contributes to the literature on adaptation. The literature on vulnerability and adaptation suggests that bottom-up analytical tools are necessary to ensure local buy-in of adaptive policy development (Schroter et al., 2005; Smit & Wandel, 2006). Findings from my study suggest that despite BC being identified as vulnerable to OA, shellfish farmers feel that other challenges are more pressing. Therefore, my research confirms the value of applying a bottom-up approach to vulnerability/adaptation research. In addition, by querying farmers about OA in relation to other challenges, this research has provided valuable insight into how to best approach OA adaptation as one of many challenges. Namely, respondents in my study indicated that they are most in need of supports related to cash flows, markets and labour. In addition, my study contributes to the literature on social constructions of vulnerability. It supports Kelly, Cooley and Klinger’s (2014) assessment that the narrative of OA in the media paired with scientific monitoring influenced the level of attention paid by politicians and decision makers. Results from my study suggest that vulnerability was socially constructed through the media in ways that created challenges and opportunities for shellfish farmers.
4.2.2 Practical Contributions

This research offers several valuable practical contributions to the shellfish aquaculture industry. Primarily, this research draws attention to the many challenges being faced by shellfish farmers and the shellfish aquaculture industry. Although BC’s shellfish industry has been identified as vulnerable to OA (Ekstrom et al., 2015) and scholars are calling for locally relevant adaptation to OA, this research shows that shellfish farmers are facing a wide range of challenges that need to be addressed. These challenges relate to cash-flows, markets, labour, seed, and stock survival, among others. Therefore, industry decision makers and political actors can take these findings into consideration while developing shellfish industry-related policy.

This research can also provide the shellfish aquaculture industry insight into the reasons behind media representations. During fieldwork many shellfish farmers expressed frustration at how the media continuously published sensationalized stories about their industry, and they might find it helpful to gain a more nuanced perspective of why. Economic drivers and journalistic norms, including framing and agenda-setting practices, create an environment where news media is driven to sell content that is attractive to its readers within constraints. However, these constraints can also be perceived as opportunities if the shellfish aquaculture industry can be proactive about industry communication.

This research also explores the effectiveness of OA communication. It shows that shellfish farmers tend to be more trusting of science, scientists, and sources of information internal to the industry. The less trusted typical sources of information, such as Newspapers and Television, may wish to reflect on why they are less trusted.
Therefore, in order to be inclusive of all shellfish farmers, those communicating strategic development or adaptive programs within the BC shellfish aquaculture industry should be mindful of these popular communication channels and barriers. Furthermore, OA communicators may see this as an opportunity to develop pointed and strategic OA communication strategies in order to effectively spread accurate and informative information.

4.4 Future Research

This thesis has examined media representations and shellfish farmer perspectives of OA in BC, Canada. While many important findings emerged from this research, there are also opportunities for future research.

There is much work to be done in the shellfish industry in order to ensure it is able to continue to provide social and economic benefits to coastal peoples and communities. Respondents in my study suggested that certain growing techniques, especially related to handling and shellfish seed supply, were an ever-present challenge in shellfish growing. As suggested by a survey respondent, future research should focus on alternative/sustainable community-based farming models that encourage community participation, such as shellfish farming co-ops. Often times shellfish farmers have to buy seed from different countries and continents due to a short supply in BC. A co-op model could potentially root seed production back in BC, ease communication within growers, and support local and sustainable shellfish farming development.

My study looked at media representations and shellfish farmer perceptions of OA in order to understand how media stories impact the shellfish farming industry. Social media is a popular communication outlet, but respondents in my study generally indicated that social media is not a trusted source of information about OA. In the future
I would expand on this study by delving deeper into Web 2.0 in order to understand why social media is not as trusted, what kind of messages are circulating on social media, and how to potentially use social media as a facet for effective and accessible OA and ocean health communication.

Lastly, shellfish farming is rooted in a number of diverse and overlapping cultural and social groups in British Columbia, including within First Nations and Vietnamese communities, among others. Future research would benefit from taking a deeper look into the historical and contemporary profiles of these shellfish farming communities, especially in attempt to give voice to the diversity of shellfish aquaculture participants in BC.
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APPENDICES

Appendix 1: List of references for news media articles included in thematic analysis

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Appendix 2: University of Guelph Research Ethics Board Certificate of Approval
The members of the University of Guelph Research Ethics Board have examined the protocol which describes the participation of the human participants in the above-named research project and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement, 2nd Edition.

The REB requires that researchers:
- Adhere to the protocol as last reviewed and approved by the REB.
- Receive approval from the REB for any modifications before they can be implemented.
- Report any change in the source of funding.
- Report unexpected events or incidental findings to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants, and the continuation of the protocol.
- Are responsible for ascertaining and complying with all applicable legal and regulatory requirements with respect to consent and the protection of privacy of participants in the jurisdiction of the research project.

The Principal Investigator must:
- Ensure that the ethical guidelines and approvals of facilities or institutions involved in the research are obtained and filed with the REB prior to the initiation of any research protocols.
- Submit an Annual Renewal to the REB upon completion of the project. If the research is a multi-year project, a status report must be submitted annually prior to the expiry date. Failure to submit an annual status report will lead to your study being suspended and potentially terminated.

The approval for this protocol terminates on the EXPIRY DATE, or the term of your appointment or employment at the University of Guelph whichever comes first.

Signature:                     Date: April 20, 2018

Stephen P. Lewis
Chair, Research Ethics Board-General