

VALUES AND PERCEPTIONS OF SHELLFISH MARICULTURE IN COASTAL NORTH  
CAROLINA

by

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## **Abstract**

Declining wild fish populations and an upward demand for seafood contribute to a growing interest in marine aquaculture as a source of fresh, local seafood. This study assessed the values and perceptions associated with the marine shellfish aquaculture industry in coastal North Carolina and perceived impacts of its changes in key areas of historical conflict. It also examines newly emerging concerns associated with the shellfish mariculture industry that have not been documented since a recent uptick in lease applications. Using stakeholder interviews and analysis of relevant news media sources, this study found that key values associated with the shellfish mariculture industry include clean water, tradition/heritage, preference for locally sourced seafood, state pride, job stability, independence, and product quality. Stakeholders and news media sources emphasized clean water as the highest environmental priority and voiced a need for better water quality management. However, impact perceptions varied in that some viewed and discussed greater impacts to the producer, such as price drops and market flooding, while others focused primarily on impacts to consumers, such as health and product quality. The findings also show that discussions about shellfish mariculture vary in their level of ability to differentiate between the types, methods, technologies, and species grown, or in their ability to properly communicate this differentiation. Stakeholders and news media cited higher production yields and enhanced water quality as overall benefits from shellfish mariculture, but different methods of growth, such as off-bottom vs. on-bottom, will likely have different benefits and adverse impacts. Thus, further research should incorporate more detailed analyses of public perceptions through quantitative surveys, and policy makers should compare the economic, social, and environmental impacts of different types of mariculture methods to determine the appropriate percentage of leases for each that maximizes both ecosystem services and production.

## Introduction

A growing appetite for seafood throughout the United States is putting pressure on wild fish stocks. Many seafood industry stakeholders, including scientists and policymakers, are presenting aquaculture, or seafood farming, as an alternative source of protein that may alleviate the environmental and social consequences of overfishing (FAO, 2016). Accordingly, U.S. federal government agencies have taken steps to increase the level of aquaculture production across the country, including shellfish. In 2011, for example, The National Oceanic and Atmospheric Administration (NOAA) released the National Shellfish Initiative with the goal of boosting bivalve shellfish populations, “through both sustainable commercial production and restoration activities,” which has inspired state governments, like that of Washington, to implement state-level shellfish initiatives (NOAA, n.d.).

Bivalve shellfish farmed in the United States include primarily oysters, clams, and mussels. Mariculture operations are often characterized in terms of the methods involved and the farmer’s level of control, and methods range from extensive to intensive. Intensive shellfish mariculture operations require moderate to high levels of gear inputs and may allow the farmer to control some environmental conditions through such things as recirculating water or by keeping the shellfish within bags or cages off the sea floor. Keeping the shellfish in containers may give the farmer more control over production yields by allowing them to minimize mortality and track densities (Epifanio, Srna, & Pruder, 1975). Extensive operations require fewer gear inputs and give the farmer less control over environmental conditions or production levels. These typically involve placing young shellfish directly on existing reefs for grow-out and subsequent harvesting (Swartzenberg & Kemp, 2000).

### Intensive Shellfish Mariculture Examples



**Figure 1:** Rows of oyster bags span the North Carolina coastline. Photo by Chuck Weirich, North Carolina Sea Grant (<https://ncseagrant.ncsu.edu/aquaculture/shellfish-aquaculture-quick-links/>)



**Figure 2:** Big Rock Oyster Farm in New England uses trays to grow oysters. Photo courtesy of Pangea Shellfish Company (<http://www.pangeashellfish.com/blog/the-different-methods-of-growing-oysters>)

### Extensive Shellfish Mariculture Example



**Figure 3:** Clam bottom lease in North Carolina's Core Sound. Photo by Whitney Roberts

Common environmental concerns tied to bivalve shellfish aquaculture include waste production in the benthic zone, addition of gear and structures, and benthic sediment disturbance (Dumbauld, Ruesink, & Rumrill, 2009). Social concerns link shellfish aquaculture development to low job quality, corporate consolidation, privatization of public waters, and questions regarding shellfish aquaculture's ability to alleviate declining coastal economies (D'Anna & Murray, 2015; Garrity-Blake, 2000; Murray & D'Anna, 2015a). If decisions about shellfish mariculture focus solely on potential environmental and economic impacts, without including social dynamics, underlying concerns or negative perceptions could lead to later conflict that inhibits cooperative development. Social science can address these concerns and perceptions prior to costly conflict.

Research on public perceptions of aquaculture is rapidly growing alongside the industry. Schlag (2010) identifies five main categories of risk perception associated with aquaculture: human health, environment, organizational, fish welfare, and social issues. Most negative perceptions – particularly regarding risks to the environment, human health, and fish welfare – are targeted at finfish operations (Schlag, 2010). Public perceptions of aquaculture vary across both time and space (Froehlich, Gentry, Rust, Grimm, & Halpern, 2017). Factors that may contribute to this variation include national or regional socioeconomic status, level of knowledge, and history of local environmental disasters (Freeman et al., 2012; Froehlich et al., 2017).

Keeping in mind that aquaculture is a component of the seafood market and an economic driver, much of the research regarding public perceptions has focused on social acceptability and the level of public education needed to enhance acceptability (Katranidis, Nitsi, & Vakrou, 2003; Whitmarsh & Palmieri, 2009). However, some research has addressed conflicts with other industries, such as with commercial fisheries. Aquaculture and commercial fishing often contend over feed resources, market establishment, and impacts to wild stocks (Natale, Hofherr, Fiore, & Virtanen, 2013). Other researchers are also investigating the viability of transitioning commercial fishers into the aquaculture industry. Findings from a study by Tango-Lowy and Robertson (2002), for example, suggest that commercial fishermen who have less experience and who are not tied to a specific fishery are more likely to embrace aquaculture.

Social comparison studies regarding perceived impacts from aquaculture development suggest that perceptions of the public often differ from those of key stakeholders (Whitmarsh &

Palmieri, 2009). Mazur (2004) classifies these two groups as “lay-persons” and “experts”, respectively, and argues that a lack of participative communication in planning and management can result in “experts” understating the level of risk involved. Mazur and Curtis (2008) also compared public and stakeholder perceptions of aquaculture and found that stakeholders placed a higher value on socioeconomic benefits, while survey respondents – the public – valued environmental quality more. Their findings also suggest that perceptions can vary across stakeholder groups, with topics on environmental impacts and trust in government decisions varying the most.

Several studies on perceptions of aquaculture have used news media as a proxy for public perception, particularly for studies in which gathering data on lay perceptions is either difficult or not possible (Froehlich et al., 2017; Rickard & Feldpausch-Parker, 2016; Schlag, 2011). While much of the media focuses on risk and impact resulting from aquaculture, Rickard and Feldpausch-Parker (2016) report a recent increase in themes of benefit and sustainability, suggesting a shift toward more positive perceptions from the public.

Underlying values and beliefs often play a role in shaping perceptions but are sometimes more difficult to capture (Murray, D’Anna, & MacDonald, 2016). For example, perceived impacts from contextual changes, which have been categorized as economic, environmental, or experiential impacts, shape study participants’ well-being (Murray & D’Anna, 2015b). The values-beliefs-norms (VBN) theory argues that values shape how people perceive the environment around them as well as their ability to resist change or threats associated with their environment (Dietz, Fitzgerald, & Shwom, 2005). Periods of conflict resulting from environmental change, such as shifts in resource-dependent industries, often illuminate these differences in values by bringing them to the table with stronger voice. (Boucquey et al., 2010). Consequently, this study focuses on perceptions and values in a region with historical use conflict over shellfish mariculture.

Social impact analysis represents a means to achieving coastal policy planning that addresses the perceived impacts to community members and the potential impact on their well-being. Using this tool, coastal managers can better avoid or mitigate conflicts that arise during the planning process (Mascia, Claus, & Naidoo, 2010). This study illuminates underlying values based on themes of discussion in both stakeholder interviews and news media to better understand conflicting perceptions that exist in the Crystal Coast region of North Carolina.

### ***Political Context***

Oyster mariculture began in North Carolina in the 1800's when a rising coastal population led to a decline in wild oyster stocks, spurring the U.S. Navy to authorize private leasing of coastal waters for oyster culturing. However, environmental conditions for oyster growth were so ideal that by the 1890's, "oyster pirates" from the states of Virginia and Maryland stole thousands of bushels of oysters a week. Because of this, the state of North Carolina declared war on Virginia and Maryland, which would later be called "The Great Oyster War" (Gerard, 2016).

Since its start in the 1800's, growth in the shellfish mariculture industry remained relatively consistent until, according to the North Carolina Division of Marine Fisheries (NCDMF or DMF), applications for shellfish leases increased by roughly 400% within the past two years (DMF, personal communication). The state legislature of North Carolina has also recently taken an interest in growing the overall aquaculture industry. The NC General Assembly released the Marine Aquaculture Act (Senate Bill 410) in 2017 to "increase the use of suitable areas underlying coastal fishing waters for establishment of marine aquaculture... when the Secretary determines... that the public interest will benefit from issuance of the lease." While S.B. 410 focuses primarily on marine finfish aquaculture, the document defines marine aquaculture as "the propagation and rearing of marine aquatic species in controlled or selected environments," thus implying the inclusion of shellfish.

Several multi-stakeholder groups have recently been established in North Carolina for the development of shellfish mariculture. The North Carolina Coastal Federation, an environmental non-profit focused on coastal conservation, spearheaded the Oyster Blueprint Steering Committee, a group of diverse stakeholders that came together to implement the North Carolina Oyster Blueprint 2015-2020. The Blueprint outlines key target strategies for improving the status of wild oyster stocks and includes oyster mariculture as one such strategy. In March 2017, interested organizations and individuals from across the state convened in Raleigh, NC for the Sound Economic Development Summit, which discussed current efforts to increase state production of oysters and to develop an oyster trail modeled from that of Virginia.

As interest for aquaculture development continues to grow, both the federal government and state governments will need to build stronger channels of communication with both aquaculture industry leaders and communities that rely on the industry for jobs, income, and

food. The current disconnects across these disparate groups, named the “people-policy gap”, creates unequal distribution of economic and social benefits by failing to provide accurate community-level information to policymakers who support the development of aquaculture as a source of sustainable seafood. By bridging this gap, policymakers can better address local needs and ensure that benefits from the industry are maximized for all (Krause et al., 2015). Multi-stakeholder groups serve as an opportunity to build these relationships by bringing multiple perspectives to the table (Siddiki & Goel, 2015; Whitmarsh & Palmieri, 2009). However, while government agencies are establishing more multi-stakeholder groups now than in the past, perceptions of the government sector continue to influence decisions about marine aquaculture development more than those with a direct stake in the industry (Siddiki & Goel, 2015).

### ***Research Objectives***

Throughout most of the social research on perceptions of aquaculture, both stakeholders and the public voice a need for improving community engagement and increasing government transparency during the planning process. The purpose of this study is to address these concerns in a geographic region of North Carolina historically entrenched in spatial use conflict while documenting potential variations in perception across stakeholders and the public using news media as a proxy for public perception. Prior to the current study, this kind of research has not been done in coastal North Carolina.

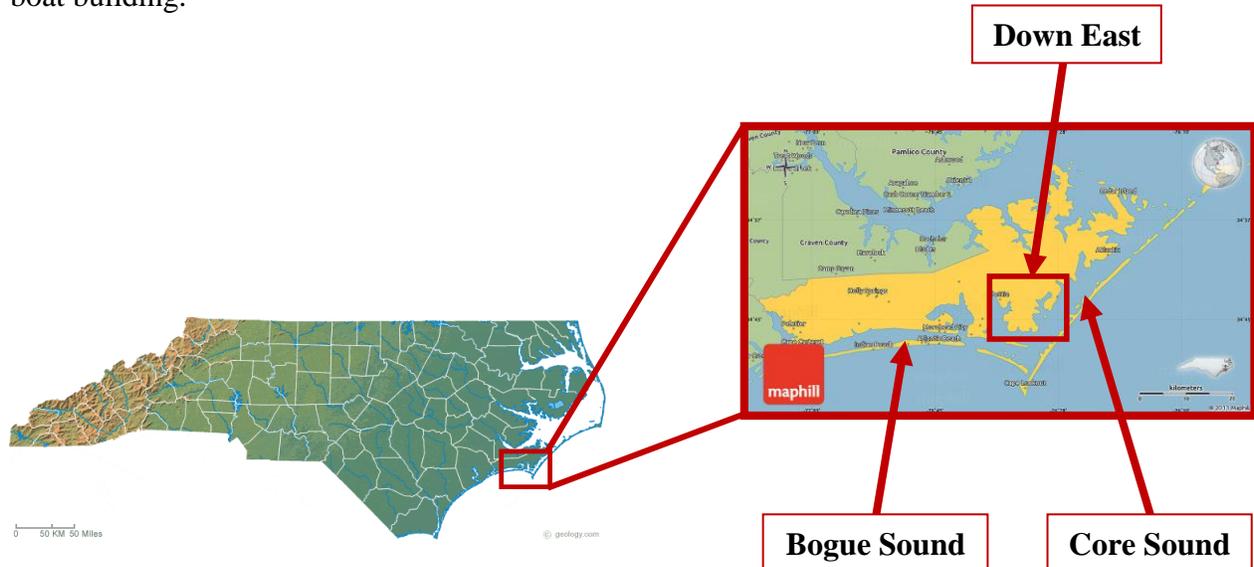
This study aims to inform decision makers involved in the development of shellfish mariculture both within and outside of coastal North Carolina to better address or prevent future public concerns. For this study, I used stakeholder interviews and news media analysis to assess the perceptions toward shellfish mariculture development along the Crystal Coast region of North Carolina. To understand these perceptions, I addressed the following three research questions:

- 1. What is the range and structure of values and perceptions associated with shellfish mariculture development across stakeholder groups and relevant news media sources?*
- 2. Are there any themes of concern for shellfish mariculture arising from both stakeholders and relevant news media that have not been previously documented, specifically following a recent uptick in lease applications?*

## Methods & Procedures

### *Site Selection & Contextual Background*

This study is focused in a region of coastal North Carolina that borders Bogue and Core Sounds often referred to as the “Crystal Coast”. Thirteen communities along Core Sound make up an area called “Down East” that boasts a long heritage of commercial fishing, hunting, and boat building.



**Figure 1:** Map of North Carolina (left) with map of study site, The Crystal Coast, (right) scaled up for clarification. Images courtesy of Geology.com and Maphill (<https://geology.com/topographic-physical-map/north-carolina.shtml>) (<http://www.maphill.com/united-states/north-carolina/carteret-county/simple-maps/savanna-style-map/>)

The history of this area is dotted with periods of spatial use conflict, as a changing economy has shifted the composition of local industries and livelihoods from primarily resource dependency to tourism and recreation (Boucquey et al., 2010; Campbell & Meletis, 2011). Researchers who have investigated these conflicts have found that different groups interpret key information in different ways, leading to a diversity of perceptions on how change will impact them and of the roles that science and government play in managing local water quality (Boucquey et al., 2010; Campbell & Meletis, 2011)

There has been some opposition to specifically the shellfish mariculture industry in this area in recent decades. In 1993, for example, over 800 community members from the Down East

region petitioned to oppose the leasing of public waters in Core Sound for shellfish mariculture. Their petition succeeded, and since 1993, a moratorium on shellfish leases has limited production in Core Sound waters to a handful of leases that existed prior to 1993. Several attempts by DMF to reopen Core Sound to shellfish leasing were repeatedly met with strong opposition (Young, 2016). An analysis completed in 2000 on the Core Sound shellfish moratorium reported that conflict stemmed from opposition to privatization of public trust waters as well as strong connections to religion. Opponents, for example, expressed reluctance to surrender waters given by God and alluded to the environment's sacredness (Garrity-Blake, 2000).

I chose to conduct my study in this region, because the area's history of use conflict may shed stronger light on underlying values associated with the shellfish mariculture industry. Also, its diversity of stakeholder groups may offer a wide range of perspectives on the issue. Three academic research institutions – Duke University, University of North Carolina, and North Carolina State University – reside within the region, along with state government offices and a booming tourism industry. These and other various groups all have a stake, or at least some interest, in the mariculture industry. To ensure that the group identified as “stakeholders” for this study is diverse and represents variations in perception, I chose an area that includes these many groups.

### ***Data Collection***

To select relevant news media articles, I conducted two phases of the article search: [1] a broad search using Google/Google News Search Engine and [2] an ‘internal’ search using search bars within selected news media source websites. For this study, I chose to only analyze sources classified as “news” by Google News, because these were most relevant to my research objectives.

For the first phase, I entered key phrases into the Google News Search Engine (news.google.com) and organized results by relevance. I used the following 8 search phrases: “shellfish aquaculture North Carolina”, “shellfish mariculture North Carolina”, “oyster aquaculture North Carolina”, “oyster mariculture North Carolina”, “clam aquaculture North Carolina”, “clam mariculture North Carolina”, “shellfish aquaculture NC”, and “shellfish mariculture NC”. I limited locations of news sources to either coastal North Carolina (Carteret

County, Morehead City, Wilmington, New Bern) or the Research Triangle (Raleigh, Durham). When selecting specific articles, I opened the article, used Control-F for a keyword search, and searched for “shellfish” and “aquaculture”. I excluded any potential article that did not have keywords in more than one paragraph. I used “aquaculture” instead of “mariculture” for this keyword search, because the term “mariculture” is less commonly used in public news when referring to marine aquaculture.

Once I could no longer pull any articles from a page of results in Google News Search, I repeated the process using the next search phrase. I repeated this whole process until I had used all 8 pre-determined search phrases. To supplement the Google News search, I repeated the process in the main Google Search Engine to pick up any articles that Google News did not formally classify as “news”. When doing this, I added the term “news” to the end of each search phrase (i.e. “mariculture North Carolina news”).

From the results of the first search phase, I identified three news media sources that most commonly discussed shellfish mariculture: Carteret County News-Times, Wilmington Star News, and Raleigh News & Observer. I chose these three based on their geographic proximity to the research site and on the number of relevant articles pulled from each. I then searched for relevant articles within each news source’s website using the same keyword phrases as the Google News search. To access certain archives, I purchased a month-long subscription to all three.

Within the websites of each of the three sources, I accessed the “news” or “articles” section and set the period to [10 years ago – current]. I used search strings of “shellfish aquaculture”, “aquaculture”, and “mariculture”. I opened each article and conducted a keyword search of “shellfish” and “aquaculture” using the Control-F function. I excluded articles that did not mention shellfish at all, but rather solely discussed finfish aquaculture, since this was not the focus of my study. I also excluded articles that focused their discussion on other states and did not address North Carolina. As in the first phase, I ended my search and moved to the next search string once I reached a page from which I could no longer pull at least one article.

Once I completed both the Google/Google News search and the internal source search, I transferred all articles from an Excel spreadsheet to NVivo 11 Pro software for analysis. In total, I collected 37 news media articles.

### ***Interview Procedure***

To collect data for stakeholder perceptions, I identified key stakeholder groups through both document analysis and interviews, including:

- Commercial Fishers
- Shellfish Farmers
- NGOs – Culture-focused
- NGOs – Environmental
- State Government
- Local Government
- Academic Researchers
- Realtors
- Seafood Distributors  
(Mongers)
- Homeowners
- Mixed

In total, I conducted 11 stakeholder interviews. I interviewed exactly one representative from all identified stakeholder groups except *academic researchers* and *mixed*, of which I interviewed two representatives from each, and *homeowners* and *local government*, of which I did not interview any representatives. Due to time restrictions and unresponsiveness, I was unable to interview representatives from the stakeholder groups of *local Government* or *homeowners* (highlighted above). Prior to conducting any interviews, the research protocol was approved by the Duke Ethics Committee’s Internal Review Board (IRB).

Each interview lasted for an average of 30 minutes and consisted of open-ended interview questions within the categories of ecological/social changes or concerns, environment and ecology, culture/heritage, benefits/negative impacts, and planning and conflict. I modeled these categories from the interview structure that Murray and D’Anna used in a study on values and perceptions of shellfish mariculture in British Columbia, Canada (Murray & D’Anna, 2015b). Standard questions used across all stakeholder groups included background information regarding how long they have been in the area, their overall perception of shellfish mariculture, their perceptions of overall change in the area, their perceptions of how growth in the shellfish mariculture industry will impact either themselves or their community, and any relationship that exists between shellfish mariculture and the tradition or culture of the area. Generally, towards the middle of the interview, I asked participants about the ecology of the area, including what features of the local environment they perceive to be the most important and what relationship these features have with the shellfish mariculture industry. Towards the end of the interview, I

asked questions about their perception of the current planning process for shellfish mariculture, including any community engagement processes. Based on this general framework, I tailored each set of questions to the specific interviewee, and a list of interview questions used for each stakeholder group can be found in Appendix B. I ended each interview with an option to include any information they would like to add that had not been discussed already and asked if they would like to recommend anyone to interview. The latter technique is called snow-balling and allowed me to locate other potential interviewees (Patton, 1990). Immediately following each interview, I contributed to a post-interview research journal, noting main themes of concern or perception the interviewee discussed as well as my perceptions of their overall position on the topic (i.e. proponent, neutral, or opponent).

With participant permission, I recorded each interview on my personal, password-protected phone and uploaded them to my similarly protected computer..

### *Analysis*

I transcribed 5 interviews by hand and used a transcription service to transcribe the remaining 6. Once transcriptions were completed, I uploaded each transcript and the news articles into NVivo 11 Pro for analysis. I analyzed both news media articles and stakeholder interviews through a round of free coding, during which I freely created nodes of information and perceptions as they appeared in the text, while creating memos to comment as I coded. From these comments and interpretations, I created 9 parent nodes and 3-7 daughter nodes under each parent node, with most containing only 4. I then re-coded all sources of data within this new coding framework.

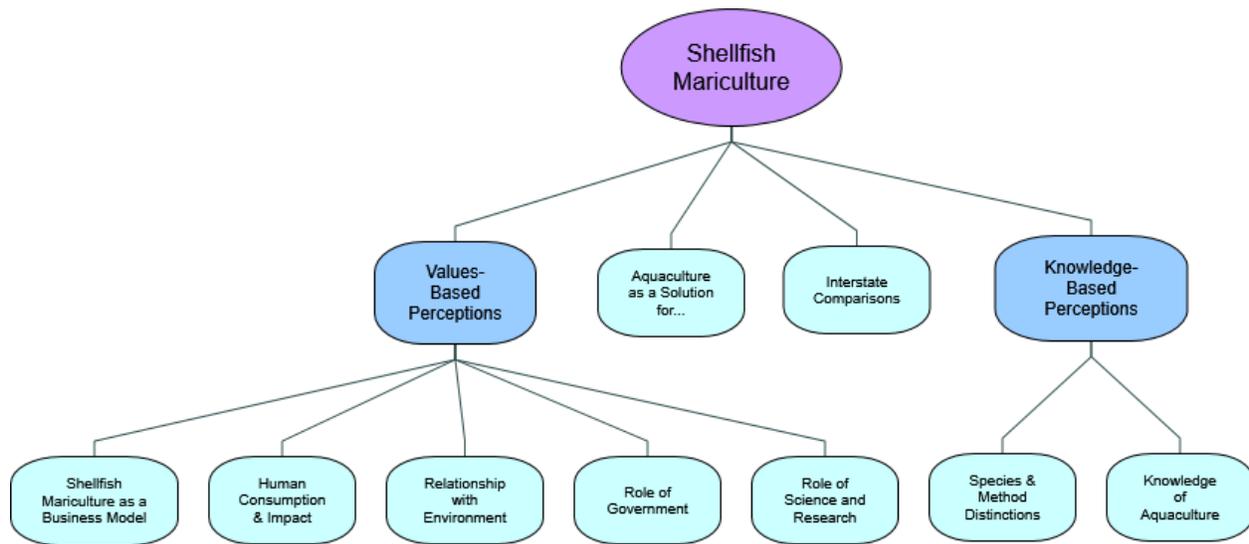
After creating the 9 parent nodes and recoding them, I reviewed each node, summarized overarching themes of contention, and deduced the associated values based on context within interviews and articles. If I was able to qualitatively identify underlying values within a theme of perception, such as positive references to North Carolina's environmental resources pointing to values of state pride and environmental quality, I filed that parent node under the category of "values-based perceptions". If I was unable to qualitatively identify underlying values within a theme of perception, such as acknowledgment of a public lack of understanding about aquaculture, I filed that parent node under the category of "knowledge-based perceptions." This category also encompasses perceptions that were shaped by the stakeholders' or the public's

level of knowledge, such as references that conflated impacts from shellfish mariculture with those of finfish mariculture. For these, perceptions did not appear to be predominantly shaped by any underlying values but rather by the participant's or news media source's level of knowledge about aquaculture. Along with deduced values, I also recorded any general variations between stakeholder perceptions/values and news media perceptions/values.

## Results

### *Themes & Subthemes*

The following section outlines the perceptions and values identified from both news media and stakeholder interview analysis. Figure 4 depicts the 9 parent nodes categorized as either “values-based perceptions” or “knowledge-based perceptions” according to discussions within each node and inferences about the underlying values or level of knowledge that shape these discussions. The two themes “Aquaculture as a Solution for” and “Interstate Comparisons”



**Figure 4:** Mind map of the final node structure. Node themes are divided into “values-based perceptions” and “knowledge-based perceptions”. The two themes “Aquaculture as a Solution for...” and “Interstate comparisons” are classified as both values-based and knowledge-based perceptions, so they lie between these categories.

appeared to include perceptions that were shaped by both underlying values and the source’s level of knowledge, so they are categorized as both “values-based” and “knowledge-based” perceptions. For example, a reference to aquaculture’s ability to combat the high percentage of global seafood imports by increasing the local seafood supply point to values of sourcing food locally and growing the local economy but also appear to be shaped by the source’s level of knowledge about the global seafood market.

Table 1 below summarizes the themes and subthemes found throughout the study, along with the number of references per subtheme. Within each theme, subthemes with the highest number of references are highlight in green.

**Table 1:** Summary of Results

<i>Themes</i>	<b>Subthemes</b>	<b># of Ref.</b>
<i>Aquaculture as a solution for ...</i>	Depletion of wild stocks	34
	Global food security	18
	Lack of community jobs	17
	Seafood imports	13
	Tighter fishing regulations	14
<i>Shellfish mariculture as a business model</i>	Business language	41
	Capital investment	52
	Public trust vs. privatization	63
	Training & skill required	42
	Transitioning from commercial fishing	53
	Type of demographic entering the industry	38
	Versus aquaculture as a way of life	18
<i>Role of government (legislative and state agencies)</i>	Faith in governance	65
	Funding & level of support	50
	Organic vs. forced growth	71
	Streamlining leasing process	33
	Water quality management	29
<i>Role of science and research</i>	Advancements in technology	30
	Efficient production	23
	In-state hatcheries development	25
	Lack of inclusion in policy making	13
<i>Interstate comparisons</i>	Virginia as a model	21
	Ideal conditions for growth	20
	NC market differentiation	43
	Lessons of failure (i.e. Florida)	2
<i>Relationship with environment</i>	Connection to environment	13
	Ecosystem services	26
	Good water quality	86
	Ideal conditions for growth	34
	Population density	11
<i>Human consumption &amp; impact</i>	Population density	20
	Product quality	51
	Human health	34
	Market value	46
<i>Knowledge of aquaculture</i>	Public education efforts	37
	Stakeholder engagement	61
	Lack of knowledge	34
<i>Species and method distinctions</i>	Extensive vs. intensive methods	65
	Aquaculture vs. wild harvest vs. habitat restoration	77
	Mariculture vs. inland aquaculture	3
	Shellfish vs. finfish	37

### ***Aquaculture as a Solution for...***

Both news media and stakeholders expressed interest in aquaculture's opportunity to serve as a solution for perceived problems. I identified five subthemes of perception: [1] depletion of wild stocks, [2] global food security, [3] lack of community jobs, [4] seafood imports, and [5] tighter fishing regulations. Stakeholders and news media discussed *depletion of wild stocks* more than other subthemes in this category.

[1] *Depletion of Wild Stocks*: Stakeholders and news media sources both seemed to value a once thriving industry by referencing a "golden age" of shellfish mariculture with admiration and by noting that current shellfish stocks are not as pronounced as they have been in the past. Stakeholder interviewees discussed aquaculture's ability to supplement wild stock depletion more so than other perceived problems/solutions. The distinction between oysters, other types of shellfish, and finfish were sometimes unclear when discussing this perceived benefit, but regardless of type discussed, most attribute the recent decline in stocks to pollution and overharvesting.

[2] *Global Food Security*: References to the growing depletion of wild stocks related closely to the perceived problem of global food insecurity, which news media sources appeared to discuss in greater detail than stakeholders. The study revealed mixed opinions about whether aquaculture can be situated as a solution to this problem. One interviewee voiced concern that the new type of half-shell market that shellfish mariculture serves means that the industry cannot address the need for greater seafood production.

"...If you try to present shellfish mariculture as a solution to the seafood industry you're wrong because it's a very limited market. It's a high-end market. There's a lot of risk of disease and viruses. I mean, I know people who are growing oysters that have lost a whole season." (stakeholder interview #5, Culture-Focused NGO)

[3] *Lack of Community Jobs*: Interviewees also showed mixed perceptions about the shellfish mariculture industry's ability to address the lack and decline of coastal jobs. While many news media sources expressed clear optimism towards shellfish mariculture's ability to create local jobs and spur economic growth, some stakeholders were skeptical. These skeptics tended to attribute their concern to the level of financial risk involved in shellfish mariculture, which is discussed in greater detail in Theme #2: Shellfish Mariculture as a Business Model.

[4] *Seafood Imports*: News sources often pointed out that most of the farmed seafood consumed in North Carolina is imported and that this stifles growth of the local seafood economy. These sources also expressed the perception that the local shellfish mariculture industry may be able to combat this problem. Only one stakeholder discussed seafood imports, and this participant also viewed it as a perceived problem that shellfish mariculture can address.

[5] *Tighter Fishing Regulations*: The fifth subtheme refers to concern from both stakeholders and news media that commercial fishermen will not be able to make a living off wild-caught fisheries amid increasing regulatory oversight. For some, however, shellfish mariculture presents an alternative path in which fishermen can remain.

“...working on the water and producing more seafood in the face of more stringent regulations and environmental problems.” (news media, *Carteret County News-Times*)  
Skeptics, however, voiced concern that the shellfish mariculture industry is not a feasible option for displaced fishermen because of the level of investment, the financial risk involved, and the training and skills required to viably enter the industry. These concerns are discussed in more detail in the next theme, Shellfish Mariculture as a Business Model.

### ***Shellfish Mariculture as a Business Model***

One of the most common themes was that of aquaculture as a business model, and the ways in which aquaculture is discussed in terms of its business-relevant characteristics. I identified seven subthemes: [1] business language, [2] capital investment, [3] training and skill required, [4] transitioning from commercial fishing, [5] type of demographic entering the industry, [6] public trust vs. privatization, and [7] versus aquaculture as a way of life. Of the seven subthemes, stakeholders and news media discussed *public trust vs. privatization* most.

[1] *Business Language*: The dialogue around shellfish mariculture commonly uses words and phrases such as “branding”, “industrial”, “target market”, “business-savvy”, “entrepreneurs”, and the most common “business[es]”. This was the case for both news media and stakeholders; however, news media sources appeared to use these phrases more often than stakeholders. Several of the news headlines contained at least one of the two phrases “entrepreneur” or “entrepreneurial”. The business language also referred to investments in the shellfish mariculture industry, using words and phrases like “investors”, “venture”, and “startups”.

Acknowledging the business qualities that the mariculture industry holds, such as financing or marketing, several stakeholders voiced concern that its competitive, industrial nature may grow so large that small farmers become pushed out of the industry.

“I think one of the concerns folks have is the outside investors coming in and just taking over. We don’t want to do to the farmer what the industry would do to the farmer twenty years ago with corporate agriculture coming in and running the family farmer out of business.” (stakeholder interview #2, Environmental NGO)

Some stakeholders, however, spoke to the “business opportunity” that shellfish mariculture provides in a more optimistic tone, such as about current efforts toward differentiation of product.

News media sources tended to reference the possibility of creating a more environmentally and economically sustainable industry by promoting the business-relevant characteristics of the industry such as investment and partnership development.

“That competition offers cash prizes as well as the opportunity for businesses to gain visibility and – potentially – investors for promising ventures... a global business competition that connects seafood-related businesses with investors to grow the sector in a more sustainable, environmentally friendly way, according to the release. (news media, *Wilmington Biz*)

Thus, different uses of such language held differing connotations for stakeholders and news media. Words like “corporate” and “industrial” appeared in references of concern or skepticism, while words like “entrepreneurial” and “business-savvy” tended to appear in references of optimistic opportunity.

[2] *Capital Investment*: The capital investment required for shellfish mariculture operations is frequently discussed by both stakeholders and news media as well. According to one news media source,

“In a smaller-scale investment, a farmer could spend between \$30,000 and \$70,000 in initial costs” (news media, *Wilmington Biz*).

With this type of investment in capital, sources discussed the level of risk involved, and the many ways in which a shellfish farmer could lose a large initial investment. Interviewees and news sources raised concerns associated with theft, disease, pollution, and storm events that could harm farm operations or prevent farmers from investing at all. To stakeholders, the degree

of capital needed to start an operation, and the amount of natural and human-caused risk that farmers face, equates to a level of financial risk that they are not willing or able to take on. This seems to be a common perception among stakeholders despite some public optimism that the shellfish mariculture industry could serve as a source of new jobs.

“I mean, in mariculture, it’s a very volatile thing. Something can happen as far as maybe some runoff from a chemical pesticide that was used on a farm and come through that estuarine water and kill all those oysters. There’ve been people that lost huge amounts of growth in mariculture, so it’s going to be a very volatile industry. And it’s going to be one that the average fishermen can’t afford to be in...” (stakeholder interview #4, Commercial Fisherman)

[3] *Training and Skill Required*: Stakeholders also voiced concern that the shellfish mariculture industry requires a level of skill and training different from that of commercial fishing, subsequently creating a barrier to entry. While stakeholders tended to discuss this with concern, news media sources tended to comment on the efforts being done to train displaced fishermen or others interested in entering the market. One news media source outlines some of the skills in which groups, particularly university institutions, are working to train interested parties.

“Participants will receive information on topics such as leasing and siting their operations, culture gear and techniques, harvest and storage regulations, marketing strategies including the potential of forming grower co-ops, and USDA programs available to producers.” (news media source, *Ocracoke Observer*)

[4] *Transitioning from Commercial Fishing*: There were mixed perceptions across stakeholder groups as to whether the shellfish mariculture industry is a viable option for displaced fishermen, but proponents of this alternative noted that the type of fishermen entering the market tend to be younger and less “traditional”. Stakeholders tended to discuss this topic more often than news media sources. When discussed by news media, however, the statements appeared to be more optimistic about the opportunity for commercial fishermen to enter into the shellfish mariculture industry. While most news media statements appeared vague and nondescript about how the transition would succeed, some highlighted license buyback programs or other measures to ease the transition for commercial fishermen.

Skeptical stakeholders argued that, despite training programs and government support, many traditional fishermen simply do not want to change industries and would prefer continuing what they have always done.

“It’s just that it depends on how willing the potential shellfish mariculture grower is.

How willing they are to learn a new skill and compromise what they really want.”

(stakeholder interview #5, Culture-Focused NGO)

[5] *Type of Demographic Entering the Industry*: Many concerned stakeholders noted that the type of individual already entering the shellfish mariculture industry tends to have an academic background, entrepreneurial characteristics, or are outsiders looking for an extra hobby, rather than locals who have been working in the area for long periods of time. For example, two different stakeholders stated that,

“You can’t just do one thing... [There are] two people that I know of that make their living entirely just off of mariculture. Everybody else I know has state jobs or something else and they do this on the side.” (stakeholder interview #7, Mixed [commercial fisherman and shellfish farmer])

and...

“Unfortunately, more people that aren’t from the coast are getting into it. It’s a lot of people from Raleigh out west that are getting into this.” (stakeholder interview #3, Shellfish Farmer)

News media sources tended to demonstrate the same perception of a new type of demographic but with seemingly more optimistic language, highlighting the innovative nature of new aquaculture techniques and the ability of new entrants to introduce that innovation. For example:

“He and other officials say the future of North Carolina’s oyster aquaculture industry will be shaped by the success of a small group of farmers using new techniques.” (news media source, *Wilmington Star News*)

News media sources commonly referenced innovation and new technology with a positive tone, which is discussed in more detail in Theme #4: “Role of Science and Research”.

[6] *Public Trust vs. Privatization*: The public trust doctrine, and use conflict or privatization concerns arising from it, was a common theme. Those who expressed concerned highlighted the fear that leasing private areas of water will take away from other public uses,

such as recreation, navigation, and commercial fishing. The primary use conflict concern that arose was that of navigational hazards for boats and other maritime operations. Much of the dialogue more specifically tied this concern to newly growing intensive methods of aquaculture in which the entire water column is leased to private individuals or corporations, whereas bottom leases were primarily used in the past.

“...that’s been heightened because the technology for growing, particularly oysters in the water column, has become more intensive. Most of the leases were traditionally on the water bottom but now people [are] wanting to grow more intensive in the water column and that really does preclude other uses of those waters.” (stakeholder interview #2, Environmental NGO)

In most themes and subthemes identified, concerns were often associated with these new intensive techniques. The lack of distinctions made between intensive and extensive techniques in dialogue is discussed in more detail in Theme #9: “Species and Method Distinctions”.

[7] *Versus Aquaculture as a Way of Life*: Stakeholders often contrasted this notion of aquaculture as a private, business model with that of aquaculture as a way of life or a tradition. Like the heritage of commercial fishing that communities in the study site are often associated with, interview participants described the heritage of shellfish mariculture, particularly of traditional, extensive methods.

“There’s been a long tradition of what the locals call clam gardens, shellfish gardens. It goes back to at least the 19th century... And these are, again, relatively small areas that people used to not only grow their shellfish, but I think the fishermen harvest...”  
(stakeholder interview #9, Academic Researcher)

The shift toward more intensive methods in a business context and away from traditional methods is voiced with concern by another stakeholder:

“...So this is a whole new aspect of Core Sound of growing 1) a quality half shell oyster and 2) doing it year-round and actually having a business out of it.” (stakeholder interview #3, Shellfish Farmer)

This stakeholder also highlighted that, until recently, the purpose of shellfish leasing in the state has predominantly been for “their own consumption or their families consumption” rather than for a business. Other stakeholders expressed concern that this recent transition away from traditional leasing poses a risk to the culture of these coastal communities.

“...now you’ve made it more [about] Corporate America, not so much as cultural heritage of the community in the eastern part of the State of North Carolina.”

(stakeholder interview #4, Commercial Fisherman)

The topic of aquaculture as a way of life or tradition is rarely discussed in news media. The instances in which it is discussed mostly refer to traditional oyster mariculture as a key economic piece of North Carolina’s history.

### ***Role of Government (Legislative and State Agencies)***

Mixed perceptions were expressed about the role that state government should play in the shellfish mariculture industry and its development. I identified 5 main subthemes: [1] faith in governance, [2] funding and level of support, [3] organic vs. forced growth, [4] streamlining the leasing process, and [5] water quality management.

[1] *Faith in Governance*: Stakeholders commonly expressed a lack of faith in state government and their ability to address concerns, but those few who did express faith tended to note the state’s effectiveness at stakeholder collaboration and community outreach. Both stakeholders in support of aquaculture and those who appeared more skeptical of the industry’s growth expressed low faith in governance but with different reasons for this lack of faith. Proponents of shellfish mariculture voiced concern that the state is not doing an effective job of fulfilling the industry’s potential in the area.

“I think it’s time for it to be repealed personally. You’ve got a water body that’s probably the highest water quality in the state and you’re not allowed to grow any shellfish there and it would probably grow some of the best shellfish in the state.” (stakeholder interview #3, Shellfish Farmer)

Proponents also showed concern that state policymakers do not sufficiently include objective scientific research. This concept is discussed in greater detail in the following section titled “Role of Science and Research”.

Stakeholders who were more skeptical of shellfish mariculture development expressed concern that the state is biased towards wealthy interested parties and that the state conducts back door deals when governing. Both proponents and opponents of shellfish mariculture development suggested that the state government has done an insufficient job at protecting the state’s natural resources such as wild fisheries and water quality.

“Unfortunately for political reasons the coastal habitat protection plans... never had any political or legal teeth. And I think that failure is now coming home to roost with fewer places that... are adequately supporting historic fisheries resources...” (stakeholder interview #6, Academic Researcher)

News media sources tended to express a generally positive faith in government, such as an admiration for the state’s efforts to grow the industry and for effective stakeholder engagement. However, news media also addressed concerns over the complexity of the leasing process and the state government’s inability to either address conflicts over water resources or provide sufficient support. Like stakeholder interviewees, news media sources also expressed concern that the state is not growing the shellfish mariculture industry to its full potential.

[2] *Funding and Level of Support*: News media sources tended to discuss the state government’s role in providing funding and support for shellfish mariculture development. Stakeholders, however, expressed mixed opinions about the level of support needed. Proponents of industry growth seemed to perceive a need for increased government support for those working in the industry, particularly regarding financial support, while skeptics did not seem to view current or future support benefitting those on the receiving end. Even with financial support from the government, some stakeholders pointed out that many commercial fishermen are simply not willing to accept state money regardless of intent.

“But that’s met the distance just because the fishermen here are very independent. They get suspicious when state money gets involved in something. They don’t want a handout.” (stakeholder interview #5, Culture-Based NGO)

News media sources commonly discussed financial support, often referring to specific monetary values of government support. News media sources also frequently discussed the work that the state government has done, or is currently doing, with the funding that is already in place. Most of this work seems to be research on developing new technologies or conducting habitat studies. Some news media sources addressed concern over budget limitations and a need for more funding, but these concerns did not appear as common as references to research being done with funding.

“With funding help from Sea Grant, the UNCW Oyster Hatchery is developing special lines of seed oysters that should be used for farmers to use in specific areas.” (news media, *WECT Wilmington*)

[3] *Organic vs. Forced Growth*: Stakeholders and news media expressed mixed opinions on whether the government should intentionally grow the shellfish mariculture industry or whether the industry should grow organically. Stakeholders seemed to understand that a new type of market, namely the higher priced half shell market, has increased interest in entering the industry and that environmental benefits have created state interest in industry growth. However, stakeholder perceptions also showed concern that too much growth in the industry could lead to price drops and create difficulty in getting product on the market.

“I look at what’s happening now with the gold rush mentality on the oyster farming, especially south of the Fifty-Eight bridge, and at some point you’ll have so much product on the market that everybody’s becomes worthless.” (stakeholder interview #7, Mixed [commercial fisherman and shellfish farmer])

Stakeholders who support intentional growth by the state government seemed to perceive that this type of growth is justified by the fact that the state owns coastal waters.

News media sources also tended to mention state efforts to grow the industry, but despite this, also seemed to perceive the industry as already growing organically. A single news source provided the following two comments:

“More farmers are catching on... This year, the number of applications is already at 30.”  
and...

“N.C. Sea Grant recently submitted a proposal to NOAA to expand oyster farming in the state by improving production methods and developing business planning models.” (news media, *Wilmington Biz*)

News media sources also tended to discuss intentional state growth in terms of both shellfish mariculture and oyster restoration projects, sometimes ambiguously. Stakeholders, however, seemed to primarily discuss shellfish mariculture. News media sources also tended to discuss the “growth potential” of the shellfish mariculture industry and often referred to it as a “sustainable industry.”

[4] *Streamlining the Leasing Process*: Both stakeholders and news media discussed a need for streamlining the NC leasing process for shellfish mariculture, as well as some current efforts to do so. Stakeholders, while confident in the public engagement portion, tended to perceive that the spatial siting component of the leasing process needs improvement. News

media sources also discussed this perception but tended to be more ambiguous by simply commenting on attempts to streamline the process without details as to how.

“Other legislative efforts are aimed at helping to streamline requirements on both oyster restoration and shellfish harvesting.” (news media, *The Outer Banks Voice*)

[5] *Water Quality Management*: This is the last subtheme under “Role of Government” and was discussed less frequently than other subthemes in this category. The subtheme “Good Water Quality” under the theme “Relationship with Environment”, however, discusses the environmental value of clean water and was discussed more frequently than all other subthemes in the study. This topic will be discussed in greater detail in the section for that theme.

Stakeholders tended to comment that shellfish mariculture is dependent on good water quality and that it is the state’s responsibility to maintain clean waters. However, stakeholders also tended to show little confidence in the state’s ability to keep waters of certain areas clean.

“I think that our failure to adequately control storm water runoff, nonpoint source pollution, specifically pollution related to bacterial runoff has also resulted in closing a lot of waters to shellfishing ground that would otherwise be appropriate.” (stakeholder interview #6, Academic Researcher)

News media sources tended to discuss both shellfish mariculture and finfish aquaculture regarding water quality, while stakeholders appeared to focus primarily on shellfish mariculture. News media sources also tended to discuss state strategies to monitor and regulate water quality, including the use of oyster mariculture to clean state waters, subsequently demonstrating optimism toward the state government’s ability to properly manage water quality. Overall, both stakeholders and news media sources seemed to perceive the state as having a key role in maintaining clean water for the sake of both natural fisheries and shellfish mariculture.

### ***Role of Science and Research***

Stakeholders and news media sources discussed the role that science and research plays in shellfish mariculture development somewhat less than other themes. However, both still emphasized that it as an important component. I identified four subthemes: [1] advancements in technology, [2] efficient production, [3] in-state hatcheries development, and [4] lack of inclusion in policies.

[1] *Advancements in Technology*: This was one of the most commonly mentioned sub-themes in news media sources, and it predominantly included references with an optimistic tone. News media sources, for example, tended to use positive or pro-environment language, such as “success” and “environmentally friendly”. News media sources also tended to link technological advancements with an opportunity for business growth in shellfish mariculture.

“...the future of North Carolina’s oyster aquaculture industry will be shaped by the success of a small group of farmers using new techniques.” (news media, *Wilmington Star News*)

A small handful of stakeholder references demonstrated this optimistic perception as well.

[2] *Efficient Production*: Regarding efficient production of shellfish, I only coded one reference from a stakeholder. This reference is a comment on public interest in higher shellfish production numbers, so I could not deduce perceptions or values of stakeholders on this topic other than that stakeholders did not discuss it.

News media sources, however, discussed efficient growth in production in detail. This discussion was mostly centered around development of more efficient strains of oysters, which are faster growing and disease-resistant.

“We also hope to develop disease resistant oysters, selected for fast growth.” (news media, *Wilmington Star News*)

[3] *In-State Hatcheries Development*: Like efficient production, news media sources commonly discussed in-state hatcheries development. Stakeholders that commented on this topic showed mixed perceptions toward whether the state should develop hatcheries, but all that commented expressed a need for more in-state hatcheries.

News media sources tended to express concern over a lack of in-state hatcheries but tied this to insufficient funding, which was generally not brought up by stakeholders.

“Ideally, the hatchery would operate on an annual budget of about \$500,000. For the past 18 months, the facility has consistently made do with a fluctuating pool of funding typically comprised of less than \$100,000.” (news media, *Wilmington Star News*)

News media sources also frequently discussed current research efforts to grow the number and quality of in-state hatcheries using optimistic language. Both stakeholders and news media tended to discuss these topics with a sense of state pride.

[4] *Lack of Inclusion in Policies*: Stakeholders frequently discussed a lack of inclusion of research and science in state policies, but I only coded two references from news media sources for this subtheme. Stakeholders expressed concern that legislators do not have the scientific expertise required to make the management decisions needed to protect marine ecosystems. Because of this, stakeholders raised concern that objective scientific analysis is often not included in policies relevant to shellfish mariculture.

“...a tendency to legislate by anecdote rather than by analysis. And legislating by anecdote is very dangerous in the mariculture situation because mariculture... is a big picture question for the future of our planet.” (stakeholder interview #6, Academic Researcher)

Stakeholders also discussed the important role that social science can play in the development of mariculture policies.

The two references coded from news media sources discussed recent efforts to bridge the gap between policymakers and scientists.

### ***Interstate Comparisons***

Stakeholders and news media frequently compared North Carolina’s shellfish mariculture industry with that of other states. Most compared it with Virginia’s industry. Under this theme, I identified four subthemes: [1] Virginia as a model, [2] ideal conditions for growth, [3] NC market differentiation, and [4] lessons of failure (Florida). Stakeholders and news media discussed NC market differentiation the most.

[1] *Virginia as a Model*: Stakeholders and news media tended to share many of the same perceptions when comparing NC with VA. Both discussed the large amount of commercial scale operations in VA as well as the level of investment VA has allocated. Both frequently expressed the perception that NC has great potential to meet or even surpass VA’s industry. News media sources tended to attribute VA’s success with policies that are conducive to industry growth as well as effective restoration and wild stock management. News media sources also commonly referenced the revenue that VA has received from their growth in comparison to the NC industry’s monetary value.

“In 2014, North Carolina's oyster income was just under \$350,000. But in Virginia, that figure exceeded \$17 million, leading Tar Heel officials to quickly expand aquaculture operations in our coastal waters.” (news media, *WECT Wilmington*)

Yet, news media sources maintained optimism toward NC’s potential for similar growth.

“While the state’s oyster industry may not have the revenues of its neighboring state, the landscape is similar, and North Carolina has a lot of it.” (news media, *Wilmington Biz*)

[2] *Ideal Conditions for Growth*: This potential for growth is heavily discussed and deserved its own subtheme. Stakeholders and news media often discussed NC’s ideal conditions for growth in terms of environmental conditions, political conditions, and market conditions. Stakeholders tended to focus primarily on environmental conditions, commenting on the amount of viable waters that are currently blocked from shellfish mariculture.

“...in NC we’ve got the largest estuarine system captured within a single state on the east coast. We have the water to grow these oysters in.” (stakeholder interview #3, Shellfish Farmer)

News media sources also focused primarily on NC’s good environmental conditions for shellfish mariculture growth and often specifically mentioned water quality. Like stakeholders, news media sources frequently commented on the blockage of waters that would serve as a viable opportunity for shellfish mariculture.

“As of September 2015, only 1,931 acres of water in N.C. were being used for shellfish leasing... that’s less than one percent of our waters that are capable of supporting shellfish growth.” (news media, *North Beach Sun*)

[3] *NC Market Differentiation*: NC market differentiation was the most commonly discussed subtheme, and news media sources frequently referenced this topic. Both stakeholders and news media sources focused primarily on the need to increase in-state sourcing and to grow the local market for oysters. For stakeholders, the topic on NC market differentiation seemed to overlap with that of shellfish mariculture as a business model in both the language and the context used in interviews.

“So, from our ability to compete, it's going to be important to try and develop some brands coming out of North Carolina that are recognizable... ones that should compete with some of the best oysters out there.” (stakeholder interview #10, Mixed [academic researcher and shellfish farmer])

While news media sources focused mostly on the local NC market, several also expressed interest in situating NC within the global export market. Many sources also explicitly stated NC's potential to be the "Napa Valley of Oysters". References under this subtheme tended to demonstrate prominent state pride and an interest in growing the locally-sourced market for shellfish. However, news media sources tended to also discuss NC's niche in the global seafood market.

[4] *Lessons of Failure (Florida)*: I only coded two references in this subtheme, but I chose to keep the node because of its relation to the subthemes "transitioning from commercial fishing" and "organic vs. forced growth", as well as its contrast to "Virginia as a model." Both nodes, which were derived from separate stakeholders, explicitly outlined a case from Florida during which a state-backed push to transition displaced fishermen into the shellfish mariculture industry resulting in a drop in market price for their product. Both references point to risk aversion within the shellfish mariculture industry and the value of learning from past examples of industry growth in other states.

### ***Relationship with Environment***

Stakeholders and news media frequently discussed perceptions of how shellfish mariculture relates to the coastal environment. They referenced impacts on the environment from aquaculture and impacts on aquaculture from the environment, as well as the role that humans play in both. I identified five subthemes within this topic: [1] connection to environment, [2] ecosystem services, [3] good water quality, [4] ideal conditions for growth, and [5] population density.

[1] *Connection to Environment*: Stakeholders and news media sources both expressed the importance of living or working on or near the water as well as the opportunity that shellfish mariculture provides to maintain this. Both sources also commented on aquaculture's ability to create links between seafood consumed and the environment.

"Oysters are good for the environment and oysters are good on the plate as well. And this is a good way for people to essentially improve both things right here at home." (news media, *Public Radio East*)

Stakeholders commented on the importance of the coastal environment to local heritage, particularly in Down East communities, which news media sources did not appear to mention.

[2] *Ecosystem Services*: Although the title of this subtheme is “ecosystem services”, only one reference used this specific phrase. However, I included references about water filtration of shellfish, habitat enhancement, shoreline stabilization, and benefits to wild fisheries, because I interpreted these as falling under the subtheme of ecosystem services whether or not the phrase was explicitly mentioned. Both stakeholders and news media sources primarily referred to the benefit of water filtration, leading back to the value of clean water. One stakeholder argued that intensive methods of growth will not provide equivalent benefits to those of bottom-grown shellfish.

“I think it's over sold... as to how much additional benefits you're going to get out of it if you're growing those sort of intensive off bottom methods.” (stakeholder interview #10, Mixed [academic researcher and shellfish farmer])

While news media sources also frequently discussed water filtration services, they also mentioned other services such as habitat creation and shoreline stabilization.

“The bottom line is that healthy oysters aren't only important ecologically speaking — they're vital. Not only do they provide an essential habitat for a number of other aquatic species, but they also do a tremendous job of filtering water.” (news media, *North Beach Sun*)

Two news media sources also highlighted financial and economic benefits that shellfish mariculture provides alongside ecosystem benefits.

[3] *Good Water Quality*: The subtheme “good water quality” contains the most references of all subthemes. Stakeholders often expressed the importance of clean water for the sake of the product consumed. They primarily attributed low water quality to high population density, increased housing development, and poor storm water runoff management.

“We're growing a product that's meant to be eaten straight out of the water that's minimally processed, most of the time alive, so you want the water absolutely clean and generally the cleanest water is in the areas with the lowest human populations so they kind of go hand in hand.” (stakeholder interview #3, Shellfish Farmer)

Interviewees addressed both water quality impacts on shellfish and impacts that shellfish have on water quality, suggesting a two-way perception. Stakeholders tended to argue that the concern is not only with the use of public trust waters but also with water quality.

“We certainly need to be as protective of water quality as we do to water access. It’s not going to do the public very much good to be able to freely boat around an area that is too bacteriologically contaminated to be used.” (stakeholder interview #6, Academic Researcher)

Like stakeholders, news media sources discussed the importance of good water quality to shellfish growth but also discussed concerns associated with harmful effluent and efforts to treat it. Environmentalists generally associate effluent with finfish aquaculture, but several news sources did not clarify this distinction between finfish and shellfish aquaculture. This lack of distinction is discussed in greater detail in the last theme titled “Species and Method Distinctions”. Different references to water quality tended to focus either on the producer experience or the consumer experience. For example, a reference to the producer experience mentioned the need for clean waters to have a successful shellfish farm, while a reference to the consumer experience mentioned the need for clean waters to avoid consumer illness when consuming shellfish. Consumer experience references also address product quality and taste.

“Runoff from developed areas can lead to elevated levels of bacteria that can temporarily shut down an oyster farm after periods of heavy rain. The state’s Department of Shellfish Sanitation monitors water quality, testing thousands of samples each year, and closes areas with high levels of fecal coliform bacteria.” (news media, *Wilmington Star News*)

News media sources tended to also discuss current efforts to improve water quality management and seemed to perceive the effectiveness of these efforts with a positive tone.

[4] *Ideal Conditions for Growth*: Stakeholders expressed mixed perceptions on ideal conditions for growth. Most perceive the current environmental conditions to be ideal, while some highlight historically ideal conditions that have since been degraded. News media sources, on the other hand, tended to primarily express the perception that NC currently has ideal conditions for shellfish growth. News media sources also discussed current strategies to take advantage of those conditions, such as siting tools, with optimistic language.

“One other major study could result in the lifting of a longtime ban on shellfish bed leasing in Core Sound, the state’s most pristine coastal waters.” (news media, *The Outer Banks Voice*)

This subtheme overlaps with the subtheme “ideal conditions for growth” under the theme “Interstate Comparisons” but differs slightly in that the former pertains to environmental

conditions more so than the latter, which refers more to North Carolina's ideal positioning within the global market. Thus, perceptions regarding ideal conditions for growth varied from optimism toward the state's environmental potential and current proactive strategies to concern that the current conditions are not what they were in the past due to habitat degradation.

[5] *Population Density*: As mentioned before, several stakeholders at least partially attributed low water quality to high population density and a recent uptick in housing development. However, some acknowledged the tradeoff between growing the population of seafood consumers and overpopulating the environment, thus demonstrating mixed perceptions. For example,

“So yeah, they're here willing to pay for the seafood, but they're mere existence here is threatening water quality habitat in the market.” (stakeholder interview #5, Culture-Focused NGO)

News media sources also voiced concern that rising population densities are leading to lower water quality and subsequent shellfish closures, subsequently impacting industry growth.

### ***Human Consumption & Impact***

Under this theme, I identified four subthemes: [1] population density, [2] product quality, [3] human health, and [4] market value. Stakeholders and news media discussed “product quality” the most.

[1] *Population Density*: This subtheme overlaps with that of *population density* under Theme #6: Relationship with Environment, but it refers to general perceived changes in population density and impacts to other human-environment interactions such as the commercial fishing industry. Stakeholders and news media commented on a general increase in population density along the coast but did not always tie it to environmental problems. The main concerns are associated with low water quality and a shift from traditional fishing to recreational fishing and tourism. Stakeholders also commented that the new housing industry is mostly composed of retirees and second-home residents. Stakeholders and news media expressed concern that these new stakeholders now have a stronger voice in the shellfish mariculture planning process.

[2] *Product Quality*: Both stakeholders and news media discussed a growing “niche” market for higher-priced oysters on the half shell and the potential for NC shellfish growers to meet this new demand. Both source types also commented on the importance of clean water

when creating an oyster of higher quality. News media sources seemed to focus on the taste and overall experience of consuming shellfish more than on market impacts to the producer.

[3] *Human Health*: Both stakeholders and news media sources discussed the importance of clean waters to produce farmed shellfish that are safe for consumption. However, news media sources also commented on the nutritional benefits of seafood and the role of climate change in spreading pathogens. Some news media sources discussed health concerns or benefits associated with both shellfish and finfish in the same article, sometimes even conflating the two as “seafood”. Stakeholders did not seem to mention current research efforts to address dangerous pathogens in shellfish, but news media sources commonly addressed this subject.

[4] *Market Value*: Both stakeholders and news media sources discussed a recent shift towards the higher-priced, “niche” half-shell market and the growing demand for this new type of oyster, but perceptions of this shift’s impact varied. Some stakeholders expressed concern that the growth in farmers resulting from a growth in interest will lead to lower prices per oyster and subsequently harm those who are already in the shellfish mariculture industry.

“It’s the value. I mean as with any commodity, there’s only so much that you’re going to get a high price for before the price starts going down. If I’m the only supermarket that has chickens, I can price my chickens accordingly. When everybody has chickens, the price is low. It’s the same principle.” (stakeholder interview #7, Mixed [commercial fisherman and shellfish farmer])

Some stakeholders tied this to the subtheme *type of demographic entering the industry*.

“People will get into it but not realize how much effort there is or how much risk there is...but then having to go out and market it is a different deal. Just even getting it out of Eastern North Carolina can be a problem.” (stakeholder interview #10, Mixed [academic researcher and shellfish farmer])

News media sources tended to discuss the global market demand and total market value of the industry. News media also tended to discuss the market potential specific to NC, as well as benefits to local restaurants looking to incorporate high quality, “niche” oysters and the taste quality of these oysters. Thus, perceptions toward market value impacts varied between impacts to the producer and impacts to the consumer. References discussing impacts to the consumer seemed to demonstrate a more optimistic tone than those referencing impacts to the producer.

## ***Knowledge of Aquaculture***

Sources discussed the level of knowledge that the public and stakeholders have about aquaculture and the implications of that level of knowledge. I identified three subthemes: [1] public education efforts, [2] stakeholder engagement, and [3] lack of knowledge. Stakeholders and news media discussed *stakeholder engagement* the most.

[1] *Public Education Efforts*: Both stakeholders and news media discussed current efforts to increase public awareness and knowledge of aquaculture in NC, but stakeholders tended to pair this with a concern that there is still significant work to be done, particularly with educating the public on the benefits of shellfish mariculture.

“I think it's important to make sure the information goes out as accurate because there's going to be a lot of misinformation that goes out.” (stakeholder interview #10, Mixed [academic researcher and shellfish farmer])

One stakeholder also expressed skepticism towards the level of public engagement during the development of S.B. 410. News media sources tended to primarily discuss current efforts to increase public awareness, particularly efforts by the state government and research institutions.

“In addition, efforts to increase public awareness of oyster farming and its benefits would occur at regional state aquariums, including the N.C. Aquarium at Fort Fisher.” (news media, *Wilmington Biz*)

[2] *Stakeholder Engagement*: Stakeholders showed mixed perceptions toward the engagement involved, and some expressed faith in the community engagement process through the Blue Ribbon Oyster Panel and other similar initiatives.

“I think that the state actually did a good job when they wrote those rules out, of trying to give everyone as much notice of what's going on. Now we've had to tweak a few things here and there I think, but I think that overall that's been a good policy to get community involvement.” (stakeholder interview #7, Mixed [commercial fisherman and shellfish farmer])

Others felt that the legislative planning process did not include sufficient stakeholder input and that there is more work to be done to appropriately address conflicts.

“It's very clear to me that the facts were not made public like they should. You know, they should have had stakeholder meetings. They should have had presentations as to what's being proposed.” (stakeholder interview #9, Academic Researcher)

News media sources tended to state current stakeholder engagement initiatives and their sustainability objectives with apparent optimism about the benefits of these initiatives.

“...establishes a stakeholder working group to study and advance efforts to ecologically restore the resource and achieve economic stability of the shellfish aquaculture industry.”

(news media, *Beaufort Observer*)

Thus, perceptions about the current level of stakeholder engagement and its sufficiency varied, but all sources pointed to a need for quality engagement throughout the planning process.

[3] *Lack of Knowledge*: Stakeholders and news media discussed the level of knowledge about aquaculture and the implications of a lack of fundamental knowledge. Many stakeholder interviewees pointed out the misinformation permeating communities that offer potential for industry growth. Many also pointed out that aquaculture is too complicated of a topic for the layperson to have a sufficient understanding based on the information they are given. Some even stated an acknowledgement of their personal shortfalls in understanding.

“I’m not an aquaculture expert... so I don’t know how to tell you what the density of striped bass per acre should be or cobia or algae or anything else you want to grow.”

(stakeholder interview #1, State Government)

Stakeholders expressed concern that this leads to opposition based on personal experience and attitude rather than correct information. Concerns were also associated with a misinterpretation of the current information that is known.

“...misinformation like that triploids were going to cause oysters not to reproduce and just bad information that’s out there that needs to be corrected and so that’s all education, but it just shows that there’s a job to be done there. Because we’re using terms that people don’t really understand and because we haven’t educated folks as to what impact using triploid oysters has on the wild population.” (stakeholder interview #2,

Environmental NGO)

Some stakeholders commented that the public will only educate themselves when aquaculture directly impacts their personal lives, either as a threat or as an opportunity.

News media sources again tended to focus on the consumer experience, commenting on the confusion that consumers encounter at the point of purchase.

“The ‘R’ month idea is largely a myth at this point. Oysters may generally be at their plumpest in November and December, but they can be eaten year-round.” (news media, *The Outer Banks Voice*)

Thus, stakeholders tended to perceive the education of the whole community around a shellfish mariculture operation as highly important, while news media sources tended to primarily discuss the consumer experience.

### ***Species and Method Distinction***

Throughout my analysis, I noticed a theme in the lack of distinction between various types of aquaculture, as well as its differentiation from traditional fisheries. Some stakeholders and news media explicitly recognized this lack of distinction, while at other times I noticed an unclear distinction from language and context used. I identified four subthemes of distinction or lack thereof: [1] extensive vs. intensive methods, [2] aquaculture vs. wild harvest vs. habitat restoration, [3] mariculture vs. inland aquaculture, and [4] shellfish vs. finfish. The lack of distinction between aquaculture, wild harvest, and restoration measures appeared most frequently.

[1] *Extensive vs. Intensive*: Stakeholders tended to acknowledge the benefits associated with intensive shellfish mariculture methods, such as faster growth to market size and higher production yields, but also recognized a relationship between these new intensive methods and ongoing use conflict.

“...but there will be more conflict, and more user conflict, because you’ll be utilizing other areas of the water column, or a wider bottom usage of the water column.”

(stakeholder interview #4, Commercial Fisherman)

Stakeholders frequently referenced the historical methods of oyster cultivation, which primarily included placing young oyster on the seafloor and waiting for them to grow out to market size. According to stakeholders, implications for the recent uptick in intensive methods include viewshed concerns, abandoned gear, and navigational hazards for both humans and wildlife.

Like other themes of perception, news media sources tended to optimistically discuss the effectiveness of current research into intensive mariculture. News sources recognize concerns, such as gear abandonment, but also commented on the measures taken to address these concerns.

“The remnants of an old clam-growing operation have littered Harkers Island for decades. Thanks to a matching grant, a clean-up project is set to begin this fall.” (news media, *Raleigh News & Observer*)

Often, news articles are unclear as to which method is being referred. Words like “cages”, “structures”, or “containers” may be the only indicators, and those words can even sometimes refer to restoration projects, which may or may not be considered “intensive” or “mariculture”.

[2] *Aquaculture vs. Wild Harvest vs. Habitat Restoration*: Stakeholders frequently discussed benefits of producing farmed oysters rather than harvesting wild-caught oysters, such as higher profit and faster growth rates. News media sources, on the other hand, tended to discuss the consumer experience by debating on which has a higher taste or quality, farmed or wild-caught. Stakeholders also commented that stronger enforcement of the Coastal Habitat Protection Plan is needed to support successful fisheries and aquaculture, consequently tying the two industries to similar concerns over water quality and habitat loss. Throughout interviews, lines are blurred when discussing the “creation” of “natural” oyster beds that provide ecosystem services but are also considered aquaculture initiatives. Examples of other cases in which distinctions between fisheries, wild-caught oysters, and farmed oysters are,

“...supposed to be marketing wild caught aquaculture and farm-raised.” (stakeholder interview #5, Culture-Based NGO)

wherein “wild caught” and “aquaculture” are used to describe the same method, and,

“I equate shellfish and fishing to pretty much together. I don’t see any significant change.” (stakeholder interview #8, Realtor)

Similarly, news media sources tended to oscillate between farmed shellfish, restoration reefs, and wild shellfish reefs without addressing the differences in implications across each. News media sources again discussed in detail the current research into restoration and aquaculture, commenting that many research initiatives are incorporating both. Disagreement over which of farmed oysters or wild oysters has a higher point-of-purchase quality, such as taste, again points to the common variation between referencing consumer experience/impacts and referencing producer experience/impacts.

[3] *Mariculture vs. Inland Aquaculture*: I only coded three references for this subtheme, but I kept the subtheme due to its important distinction when discussing aquaculture development. One stakeholder stopped me mid-interview to clarify that I was referring to

“shellfish mariculture” and not just “aquaculture”, demonstrating the importance of making this distinction when considering implications. I coded the two news media sources because of their uniquely explicit distinction between marine aquaculture and inland aquaculture, which was very uncommon in news sources.

“‘Aquaculture continues to be the fastest growing segment of American agriculture,’ he said. ‘However, marine aquaculture has not grown as quickly due to the cost and complexity of coastal development.’” (news media, *Carteret County News-Times*)

Often, either one was implied or the two were conflated.

[4] *Shellfish vs. Finfish*: The same stakeholder who clarified the distinction between marine aquaculture and inland aquaculture also pointed out the importance of distinguishing between types and species of animals farmed.

“Your aquaculture could be fish farming, it could be, you know, molluscan growth, which, you know, are clams and oysters. I’m predominantly talking about clams and oysters, and my assumption is that’s what you’re asking about.” (stakeholder interview #4, Commercial Fisherman)

Stakeholders also frequently commented on the distinct environmental implications between shellfish and finfish, particularly regarding water filtration services provided by shellfish mariculture. There also seemed to be uncertainty as to whether S.B. 410 applies to shellfish aquaculture as well as that of finfish.

News media sources seemed less likely to make a clear distinction between shellfish and finfish when referring to environmental concerns like effluent discharge. Rather, the environmental consequence was often linked to “aquaculture” overall.

“...with the current regulatory atmosphere, rules are becoming more stringent on aquaculture, particularly on effluent from production facilities.” (stakeholder interview, *Carteret County News-Times*)

News media sources also tended to reference other types of shellfish aquaculture, such as softshell crab or crayfish. Distinctions between these different species types often referred to the differences in taste or product quality.

## Discussion

The findings of this study support previous research studies that demonstrate important variations in the ways in which the public and stakeholders perceive aquaculture (Mazur, 2004; Whitmarsh & Palmieri, 2009). Of Schlag's five categories of risk perception – human health, environment, organizational, fish welfare, and social issues – discussions about human health, environment, and social issues occurred most throughout this study (Schlag, 2010). However, this study suggests that the categories of risk perception within the study site may have molded over time in the face of changing environmental, economic, and social patterns.

Past research in the region has pointed to themes of religion and a reluctance to privatize “God’s waters” (Garrity-Blake, 2000). However, religion was very rarely discussed in this study. Perceptions associated with public trust waters and a reluctance to privatize were more commonly tied to a growth in intensive mariculture and its implications for navigational safety and wildlife interaction. Many still expressed concerns that large corporations may drive out small shellfish farmers and that the communal aspect of public trust waters will be sacrificed when leasing out private areas for shellfish mariculture.

New concerns, however, addressed the growth in intensive or water column mariculture methods and argued that these new methods equate to a level of risk and capital investment that may further exacerbate the possibility of “corporate takeover” by creating a barrier to entry for many potential small-scale farmers. Furthermore, stakeholders showed concern that private leasing of intensive mariculture operations will pose a risk to navigation of both humans and marine animals, a concern that has not been documented by past studies on shellfish mariculture in public trust waters of the study site. Thus, new environmental, economic, and social implications may arise as intensive mariculture increases across the state.

Another new perception that appears to be previously undocumented in past studies is that the industry should grow organically, and that the government has no role in forcing its development. Stakeholders already in the shellfish mariculture industry were particularly concerned that with more growers, they would not be able to put their product on the market at a reasonable price. While news media sources paint a picture of a future with number-crunching, tech-savvy farmers with educated backgrounds using terms such as “entrepreneurial” and “innovation”, stakeholders expressed concern that the level of risk and training involved in mariculture, particularly intensive techniques, poses a challenge to fishermen interested in

diversifying their product. This is paired with concerns over the niche type of demographic perceived to be entering the industry. With fishermen worried about tighter fishing regulations and depleting fisheries, shellfish mariculture may only be a viable option for a handful of those who are displaced. Many expressed the perception that shellfish mariculture cannot serve as a sole source of income.

Along with emerging concerns associated with changes to the shellfish mariculture industry, perceptions also appeared to vary regarding impacts to different groups within the industry. News media sources showed a trend of referencing human health and consumer experience, while stakeholders tended to reference experiences and issues pertaining to producers, or shellfish farmers. This suggests that impact perceptions vary based on whether they affect the consumer or the producer, and some sources give greater attention to producer well-being while others focus more so on consumer well-being.

Perceived impacts to the environment, however, appeared to be similar across most sources. Stakeholders and relevant news media along the region appear to value good water quality and perceive proper water quality management to be of the highest importance. Water quality is often tied to many other aspects of shellfish mariculture. For example, interview participants and news media both tied the success of shellfish mariculture to water quality levels and perceived the government as playing a vital role in water quality management to maintain a successful shellfish mariculture industry in the future.

### ***Key Deduced Values***

Although I did not formally search for specific values, the information within themes appeared relevant to several value sets that emerged throughout the study. In relation to shellfish mariculture, sources appeared to value clean water, tradition/heritage, preference for locally sourced seafood, state pride, job stability, independence, and product quality. These values appeared in multiple themes throughout, so I deduced that they were of importance to both stakeholders and news media. As mentioned previously, clean water was the most commonly discussed topic and appeared to be of highest value to both stakeholders and news media across almost all themes and subthemes.

Many references throughout the results compared the current state of shellfish mariculture with its tradition and heritage in the region, referencing topics like environmental

conditions, market conditions, regulations and management, technology, industry demographics, population density, and water quality. These references often demonstrated a value for conditions of the past and a hesitancy to embrace new strategies of shellfish growth, such as intensive techniques or its business-relevant qualities. They often overlapped with an apparent value in state pride wherein references associated with water quality or historical production expressed pride in what North Carolina waters used to provide during the heyday of shellfish mariculture. However, the value of state pride also appeared in discussions about North Carolina's market differentiation and the opportunity to situate it within the global seafood market, suggesting that state pride may lead to positive perceptions toward the industry in terms of its market development and competitiveness.

Many references pointed to a value for locally sourced seafood by discussing the emerging local seafood movement and the opportunity for shellfish mariculture to complement this initiative. However, the value of locality varied between perceptions of the producer experience and those of the consumer experience. For example, "producer experience" references alluded to the importance of ensuring that most shellfish mariculture jobs are filled by locals within coastal communities, while "consumer experience" references discussed the importance of sourcing local seafood in terms of product quality and health as well as the benefits to restaurants when sourcing locally.

Those who focused on the producer experience also expressed a strong value for job stability within the shellfish mariculture industry. References to the level of capital investment, business training, and technological skill needed to succeed in the industry pointed to barriers to entry and to the risks that shellfish farmers face. Many commented on the need to diversify production across commercial fishing and shellfish farming, as well as across species within the mariculture industry. On the other hand, proponents of the industry argued that shellfish mariculture serves as an opportunity to address a lack of jobs within many coastal communities, often resulting from declining wild fisheries. Concerns associated with the niche demographic entering the industry as well as with the potential for corporate takeover represent a value for keeping the industry open to locals who already depend on the waterfront for income.

Concern over large corporations possibly driving out small-scale farmers or preventing entrance of new farmers demonstrates that many value the independence of a farmer within the industry. This value of independence also appears in discussions around government investment

and how much the state should support growth of the shellfish mariculture industry. Stakeholders seemed to strongly value independence from the state and an organic growth of the market.

Lastly, news media sources appeared to place a great deal of value in high product quality and taste when discussing farmed shellfish. This value was tied to both consumer experience and consumer health. To many, poor water quality management was often the cause of a perceived low product quality or poor taste. In contrast, stakeholders tended to primarily associate poor water quality with success or failure of the shellfish mariculture industry and impacts to the farmers who rely on the water for income. These variations again point to the different attentions given to either the “producer experience” or the “consumer experience”.

In considering these findings, a few limitations should be noted. First, this study was conducted over a one-year period, and the number of interviews was relatively small. The interviewee list was also generated through a snowball approach, which can potentially inflate some viewpoints when like-minded individuals are recommended. However, many interview participants recommended interviewees who they claimed disagree with them, which may have diversified the perceptions documented in the study. Due to time constraints and resource limitations, it is also possible that relevant stakeholder groups were either missed or were underrepresented. For example, some stakeholders pointed out recent conflict between homeowners and mariculture developers over spatial use. The current study did not pursue this topic, but it provides an opportunity for further research that investigates the perceptions and concerns held by homeowners and homeowners’ associations. There were possible gaps in data collection from news media sources as well. While I chose not to include editorials because of time constraints, further research should consider including these as they may provide important representation of public opinion. Furthermore, this study did not address the specific component of S.B. 410 that allows an individual farm operation to hold up to 1,500 acres, far exceeding the previous limits. Further research should investigate the perceived impact of this increase through the lenses of both stakeholders and the public.

Finally, within the categories of “stakeholders” and “news media sources”, different individual stakeholders or news sources have unique perceptions or values. Clearly, not every stakeholder or every news media source perceives shellfish mariculture in the same way. The findings and implications are only representative of the particular study site, and no

generalizations can be made outside of the study site, but the research is meant to inform further quantitative studies in North Carolina on this topic.

### *Conclusions*

North Carolina's shellfish mariculture industry is at a tipping point. Rapid growth in both legislative and economic interest is bringing to light various perspectives and potential use conflict. An uptick in leases for intensive techniques is raising questions as to how to manage future development, and key decisionmakers have a responsibility to understand the values and perceptions of coastal communities in response to mariculture development. Through stakeholder interviews and document analysis, this study revealed emerging concerns and perceptions associated with shellfish mariculture development, along with some values possibly driving these concerns. In conclusion:

1. It is important that decision-makers do not conflate the perceptions of public media with those of stakeholders, which can lead to an understatement of concerns. While it may be true that news media is experiencing a shift toward more optimistic discussions around sustainability and benefits of shellfish mariculture, this study demonstrates that news media may tend to present the shellfish mariculture industry in a somewhat more optimistic tone than stakeholders, who tended to focus primarily on concerns and local needs.
2. Discussions about shellfish mariculture vary in their level of distinction between the different types, methods, technologies, and species grown. Growing trends in intensive mariculture and new technologies warrant clearer distinctions that address the various implications associated with each type, method, technology, and species of aquaculture.
3. Several perceptions and concerns appear to have emerged since recent changes to the shellfish mariculture industry. Stakeholders expressed an emerging concern that an intentional push for growth would harm those currently in the industry and would prevent farmers from successfully placing their product on the market. Instead, the perception was that the industry should grow organically like other private industries. Another emerging concern was that the shellfish mariculture industry does not serve as a viable option for commercial fishermen due to necessary skills, capital investment, and level of

risk involved, but rather that it may complement commercial fishing by diversifying product.

4. Water quality management is of highest value to both stakeholders and news media, and most perceive that the state government is ineffectively managing public waters. However, the perception that water quality is closely tied to the success of shellfish mariculture and wild fisheries introduces an opportunity to create more positive perceptions toward the mariculture industry through proper water quality management.

Overall, the findings suggest that Legislators and other key decisions makers should consider the value of the state's water quality and its connection to the shellfish mariculture industry. Many references to water quality pointed argued its importance to the commercial fishing industry and that a growing population is to blame. If decision makers seek to enhance positive perceptions toward the shellfish mariculture industry, it may be helpful to frame the industry's growth as a means to complement commercial fisheries via the ecosystem services shellfish provide, such as water filtration and habitat enhancement. These efforts to reframe the narrative, however, should not fail to address local needs and concerns. I recommend increased communication with commercial fishing representatives while presenting a narrative focused on ecosystem benefits to wild fisheries and aquaculture's opportunity to supplement income rather than completely replace income. There is little perception that a complete replacement of income would be viable for most prospective farmers, but in light of heavier fishing regulations and declining stocks, the opportunity for cleaner waters and more productive habitats may allow for more optimistic perceptions toward shellfish mariculture.

The clean water narrative, however, should acknowledge the distinct implications that exist for either extensive or intensive mariculture techniques. Intensive mariculture may not have an equivalent water filtration capacity as extensive mariculture. Similarly, one type may provide more ecosystem services than the other. For these reasons, further studies should compare the economic and social values of extensive and intensive mariculture, using comprehensive factors such as ecosystem services, production yield, market value, and community value. Policy makers may then use the findings from such studies to determine the appropriate proportions of extensive and intensive mariculture in the state to maximize ecosystem services, social value, and production yield.

I also recommend that policies include clearer distinctions when addressing mariculture. Different types, species, methods, and technologies have different environmental and social implications. Education and outreach should make these distinctions clear to the public and highlight their respective implications. News media should also adopt more clear distinctions across type, species, method, and technology when discussing mariculture. The public looks to news sources for updated information, and news seems to be an often-neglected form of public education. By distinguishing between the various implications of each, the public may be better informed to understand real impacts to coastal communities that result from a growth in the shellfish mariculture industry.

While this study is unique to the Crystal Coast region of North Carolina, its findings shed light on steps needed to address future conflicts around shellfish mariculture and opportunities for enhanced collaboration with stakeholders, news media, and the public.

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## Appendices

### A. Interview Recruitment Materials

#### *Email Script:*

##### **Subject:**

Dear Mr./Ms. \_\_\_\_\_,

My name is Whitney, and as a graduate student at the Duke Marine Lab, my research focuses on the ways in which communities perceive aquaculture development in their area and how it may impact their lives.

I'm interested in having a voluntary 30-minute interview with you about your experiences and opinions toward shellfish aquaculture development in your community.

I will never use your name in any report I write, and only my advisor and I will ever see the interview data. The data will be destroyed once I have recorded my results in a formal Master's Project report.

If you are interested in being a part of this study, I will send more information about the interview for you to review.

Thank you,  
Whitney Roberts

#### *Phone Script:*

Hello \_\_\_\_\_. My name is Whitney, and I'm a graduate student at the Duke Marine Lab in Beaufort. I'm conducting a study about community perceptions of shellfish aquaculture development in Carteret County and how these perceptions are shaped through time. I'm interested in having a voluntary 30-minute interview with you about your experiences and opinions toward shellfish aquaculture in your community. The data will only be seen by my advisor and me and will be permanently destroyed after I've written my results in a formal report. Are you interested in being a part of this study? [if Yes...] Great! When would be a good time to call you again so that I can provide more detailed information about the study? [This second call would be the point at which I go through informed consent with the subject.]

## **B. Example Semi-Structured Interview Questions**

Each interview was tailored to the specific stakeholder, based on interest, involvement, and level of understanding. Interview questions were refined after an initial stage of document analysis in which news media articles were coded for themes surrounding the topic of shellfish mariculture.

### **1. Fishing Industry**

- a. How long have you been fishing in (Bogue/Core Sound)?
  - i. I have been told that fishing is an important part of cultural heritage in this area. How do you feel about how the area's cultural heritage relates to aquaculture?
  - ii. In your opinion, how does shellfish aquaculture development impact the community in which you live? (benefits/negative impacts)
- b. *Ecological/Social Changes or Concerns*
  - i. Have you witnessed any changes to the fishing industry in the area in which you live?
  - ii. What relationship do these changes have with shellfish aquaculture development in the area?
- c. *Environment and Ecology:*
  - i. In your opinion, what are the two most important ecological features that (Bogue/Core Sound) has to offer?
  - ii. What relationship do these two features have with the fishing industry?
- d. *Culture/Heritage:*
- e. *Benefits/Negative Impacts*
  - i. How does shellfish aquaculture development impact your personal experiences?
- f. *Planning and Conflict*
  - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
  - ii. If so, what is your opinion of this process?
  - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
- g. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
- h. Is there anyone else I should talk to about this topic?

### **2. Shellfish Industry**

- a. How long have you been farming shellfish in (Bogue/Core Sound)?
- b. *Environment and Ecology:*
  - i. In your opinion, what are the two most important ecological features that (Bogue/Core Sound) has to offer?
  - ii. What relationship do these two features have with the shellfish farming industry?
- c. *Culture/Heritage:*
  - i. In your opinion, what relationship does the shellfish farming industry have with the cultural heritage of the community in which you live?
- d. *Ecological/Social Changes or Concerns*

- i. Have you witnessed any changes to the shellfish farming industry in the area in which you live?
    - ii. How have these changes been shaped over time?
  - e. *Benefits/Negative Impacts*
    - i. How does shellfish aquaculture development impact your personal experiences?
    - ii. In your opinion, how does shellfish aquaculture development impact the community in which you live?
  - f. *Planning and Conflict*
    - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
    - ii. If so, what is your opinion of the planning process?
    - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
  - g. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
  - h. Is there anyone else I should talk to about this topic?
3. **Government**
- a. How long have you been working/living in Carteret County?
  - b. Are you aware of the shellfish farming industry in this area?
  - c. *Environment and Ecology:*
    - i. In your opinion, what are the two most important ecological features that the Carteret County coastline has to offer?
    - ii. What relationship do these two features have with the shellfish farming industry in the area?
  - d. *Culture/Heritage:*
    - i. In your opinion, what relationship does the coastal environment have with the cultural heritage of the Down East?
  - e. *Ecological/Social Changes or Concerns*
    - i. How has the shellfish farming industry changed over the past five years?
    - ii. What is the relationship between these changes and the way in which [government org.] interacts with the Down East?
  - f. *Benefits/Negative Impacts*
    - i. Would an increase in shellfish aquaculture development in the county impact your personal experiences? If yes, how so?
    - ii. In your opinion, are there any other benefits or costs to shellfish aquaculture development in the Down East?
  - g. *Planning and Conflict*
    - i. How do the Down East communities engage in the planning process for shellfish aquaculture development?
    - ii. In your opinion, how does the level of engagement change based on factors such as region and time?
  - h. Is there anything else I should know about shellfish aquaculture development in Carteret County?
  - i. Is there anyone else I should talk to about this topic?

**4. Non-Governmental Organization (NGO)**

- a. How long have you been working/living near (Bogue/Core Sound)?
- b. Are you aware of the shellfish farming industry in this area?
- c. *Environment and Ecology:*
  - i. In your opinion, what are the two most important ecological features that the Carteret County coastline has to offer?
  - ii. What relationship do these two features have with the shellfish farming industry?
- d. *Culture/Heritage:*
  - i. In your opinion, what relationship does the coastal environment have with the cultural heritage of the community in which you live?
- e. *Ecological/Social Changes or Concerns*
  - i. Have you witnessed any changes within your community that relate to the topic of shellfish aquaculture?
- f. *Benefits/Negative Impacts*
  - i. Would an increase in shellfish aquaculture development in your community impact your personal experiences? If yes, how so?
  - ii. In your opinion, are there any other benefits or costs to shellfish aquaculture development in your community?
- g. *Planning and Conflict*
  - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
  - ii. If so, what is your opinion of the planning process?
  - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
- h. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
- i. Is there anyone else I should talk to about this topic?

**5. Local Heritage Organization**

- a. How long have you been working/living near (Bogue/Core Sound)?
- b. Are you aware of the shellfish farming industry in this area?
- c. *Culture/Heritage:*
  - i. What are the most important features of the cultural heritage of the Down East?
- d. *Environment and Ecology:*
  - i. What is the relationship between the local coastal environment and the cultural heritage of the Down East?
  - ii. What is the relationship between the shellfish aquaculture industry and the cultural heritage of the Down East?
- e. *Ecological/Social Changes or Concerns*
  - i. Have you witnessed any changes within your community that relate to the topic of shellfish aquaculture? If yes, what are they?
  - ii. How do these changes interact with the cultural heritage of Down East?
- f. *Benefits/Negative Impacts*

- i. Would an increase in shellfish aquaculture development in your community impact your personal experiences? If yes, how so?
- ii. In your opinion, are there any other benefits or costs to shellfish aquaculture development in your community?
- g. *Planning and Conflict*
  - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
  - ii. If so, what is your opinion of the planning process?
  - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
- h. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
- i. Is there anyone else I should talk to about this topic?

## 6. **Recreational Industry**

- a. How long have you been working/living near (Bogue/Core Sound)?
- b. Are you aware of the shellfish farming industry in this area?
- c. *Environment and Ecology:*
  - i. In your opinion, what are the two most important ecological features that (Bogue/Core Sound) has to offer?
  - ii. What relationship do these two features have with the recreational/eco-tourism industry?
- d. *Culture/Heritage:*
  - i. In your opinion, what is the relationship between the coastal environment and the cultural heritage of the (Bogue/Core Sound) community?
- e. *Ecological/Social Changes or Concerns*
  - i. Have you witnessed any changes to the local recreational/eco-tourism industry in the past five years?
  - ii. Have you witnessed any changes within the (Bogue/Core Sound) community that relate to the topic of shellfish aquaculture?
- f. *Benefits/Negative Impacts*
  - i. Would an increase in shellfish aquaculture development in (Bogue/Core Sound) impact your personal experiences? If yes, how so?
  - ii. In your opinion, are there any other benefits or costs to shellfish aquaculture development in (Bogue/Core Sound)?
- g. *Planning and Conflict*
  - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
  - ii. If so, what is your opinion of the planning process?
  - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
- h. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
- i. Is there anyone else I should talk to about this topic?

## 7. **Realtors**

- a. How long have you been working/living near (Bogue/Core Sound)?
- b. Are you aware of the shellfish farming industry in this area?
- c. *Environment and Ecology:*
  - i. What is the relationship between the local coastal environment and the housing industry in the area?
- d. *Culture/Heritage:*
  - i. In your opinion, what relationship does the coastal environment have with the cultural heritage of the community in which you live?
- e. *Ecological/Social Changes or Concerns*
  - i. Have you witnessed any changes within your community that relate to the topic of shellfish aquaculture?
- f. *Benefits/Negative Impacts*
  - i. Would an increase in shellfish aquaculture development in your community impact your personal experiences? If yes, how so?
  - ii. In your opinion, would an increase in shellfish aquaculture development in your community impact the local housing industry?
  - iii. Are there any other benefits or costs to shellfish aquaculture development?
- g. *Planning and Conflict*
  - i. Are you aware of the current planning process for shellfish aquaculture development, including community engagement processes?
  - ii. If so, what is your opinion of the planning process?
  - iii. In your opinion, is the process equitable and fair for all parties that have a stake in shellfish aquaculture development?
- h. Is there anything else I should know about shellfish aquaculture development in (Bogue/Core Sound)?
- i. Is there anyone else I should talk to about this topic?