NIMBY: A Look into Public Perceptions of Aquaculture

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NIMBY: A LOOK INTO PUBLIC PERCEPTIONS OF AQUACULTURE

By

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Aquaculture has received increased attention globally because as capture fishery production is stagnant, aquaculture remains the fastest growing food production sector (FAO, 2018). Without a change in demand, aquaculture must continue to grow to meet the demand for fish; but where will this growth occur? It is expected that when contemplating a change in an area, residents would decide purely on an evaluation of the costs and benefits of the addition. However, the literature has shown that change does not come as easy for people who prefer the status-quo (Kahneman et al., 1991). With a plethora of benefits, will the addition of an aquaculture site be so contrary to people’s connection to the area, that the change will be met with a Not In My Backyard (NIMBY) reaction? Two things must hold true to observe a real NIMBY reaction and, thus, show a relative preference for aquaculture expansion elsewhere: positive attitudes towards aquaculture and a free rider preference (Wolsink, 2000). Using aquaculture in Maine, we explore whether NIMBY responses are found and what types of people and attitudes are associated with NIMBY.

Aquaculture is largely integrated in Maine’s economy contributing an estimated $137.6 million in sales revenue (including multiplier effects), over 1,000 jobs, and 56.1 million in labor income (Cole et al., 2017). Maine has an opportunity to continue to develop aquaculture; however, there are many other uses for Maine’s coastline. Attention to how regional differences in aquaculture perception and
acceptance is key to crafting and implementing aquacultural policy that is favored by citizens and the industry across Maine. To do this, we must understand the NIMBY reaction to communicate effectively. To understand regional perceptions of the aquaculture industry, we draw from survey data collected by the University of Maine that has 833 respondents and an adjusted-response rate of 15.6%. This research explores how citizens view policy of expansion and restriction on aquaculture in Maine. We draw from a body of literature in economics to inform our model, utilizing a multinomial logit model to analyze our survey results. We find that despite citizen perceptions being quite diverse, there exists a statistically significant difference in support for expansion depending on where the aquaculture is being expanded in relation to where the respondents live. Furthermore, the differences in citizen attitudes are being explored through reported priorities for the Maine economy, environment, and attitudes towards the aquaculture industry. Interestingly, preliminary results have shown that those who had a NIMBY reaction towards the expansion of aquaculture were found to be different than the rest of the population both in demographics and their preferences towards the aquaculture industry. This study’s results highlight unique insights for policy makers and stakeholders to enhance how information is conveyed to citizens and where efforts to relay information would be best pursued.
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CHAPTER 1

INTRODUCTION

1.1 Background

As the world populations increase the demand for food has grown substantially. This increase in demand in food requires more food growth and with this we need to consider how and where this growth should take place. One way to meet the demands of a growing population is aquaculture. Aquaculture production can provide stable economic opportunity. It is important to note that there are many uses for coastal waters so one must take into consideration the perceived impact residents, both positive and negative, have. A variety of attitudinal factors can impact aquaculture’s perceived impact. If this is not well understood aquaculture could be underdeveloped, failing to realize it’s full benefit. By examining the policy preference of coastal residents, this research provides information that can be useful to aquaculture stakeholders.

1.2 Introduction

This research examines coastal preferences and perceptions of coastal residents. Coastal homeowners are one of the largest groups of people affected by aquaculture and could have preferences for aquaculture proximity for a variety of factors. Research to understand these preferences are imperative in constructing appropriate policies for managing expansion for sustainable development. Local opposition is an important topic to understand for both aquaculture stakeholders and residents as it is a complex issue. One goal of this research was to guide the development by providing useful information to aquaculture stakeholders and policymakers when considering how to help farms expand by understanding the concerns of those who may oppose.
1.3 Thesis Organization

The thesis is divided into two studies that examine preference for aquaculture. Both studies use data from the 2018 Maine Marine Aquaculture Survey, administered to coastal Maine residents. The first study, Chapter 2, explores the results from most of the questions presented in the survey. It is written in the form of a technical report to give a broad description of the survey results. The focus being the policy preferences from coastal residents. The second study, Chapter 3, investigates the relationship between a variety of attitudinal factors and awareness/exposure to aquaculture to the respondents preferred aquaculture expansion mix in the state of Maine.
CHAPTER 2

MAINE MARINE AQUACULTURE SURVEY RESULTS

2.1 Executive Summary

A 2018 mail survey targeted Maine coastal residents, as defined by the Department of Marine Resources’ (DMR) Maine Coastal Program assessed public perceptions and opinions of aquaculture as well as aquaculture policy. The key findings from the Maine Marine Aquaculture Survey, with responses from 832 Mainers, are as follows:

2.1.1 Familiarity with Aquaculture:

- A majority (88.5%) of respondents had either seen, heard about, or both seen and heard about aquaculture in Maine. Most of this exposure came from shellfish farms, as 76.5% of people reported having seen or heard of shellfish aquaculture in Maine.
- Only 11.5% of respondents expressed familiarity with the aquaculture permitting process. Of those familiar, 47.8% indicated satisfaction, while 41.1% expressed dissatisfaction.
- Most respondents (79.7%) would like to learn more about aquaculture.

2.1.2 Perceptions of Aquaculture:

- Respondents’ general perceptions of the Maine aquaculture industry are positive.
- 91.2% of respondents think aquaculture can boost the local economy, and most (84.5%) believe it provides a good source of jobs for coastal Mainers.
- A majority of respondents (68.8%) think aquaculture has the same problems as some types of land-based agriculture.
- A majority also feel aquaculture supports working waterfronts (84%), relieves pressure on wild seafood populations (83.7%), and fits well into the uses of Maine’s coast (82.2%).
2.1.3 Structure and Regulation of the Aquaculture Industry:

- 72.8% of respondents support policies that fund aquaculture research.
- Respondents believe the impacts of proposed aquaculture farms on the environment (96.6%), other marine users (94.8%), and aesthetics (83.8%) must be considered before farms are permitted.
- Most respondents want to limit the size (81.9%) and number (65.2%) of aquaculture farms a company can own. A slight majority (53.6%) of respondents also wanted to prohibit corporate ownership of these farms.
- Most respondents (88.1%) want to comment on all proposed aquaculture farms before they are approved.
- Most respondents (61.1%) think aquaculture should continue to develop at its current pace, but 29.3% want the pace of development to increase.
2.2 Introduction

Demand for seafood is increasing worldwide and aquaculture may help accommodate this rising demand from a growing world population (FAO 2018). Maine is known for providing high-quality seafood, including shellfish, lobster, and a variety of finfish. The Maine aquaculture industry has grown substantially over time, with 2014 estimates revealing “a statewide annual economic contribution, including multiplier effects, of an estimated $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income,” (Cole, Langston, & Davis, 2017, p. 9). As of 2019, an estimated 200 coastal aquaculture farms participated in the Maine economy, producing 25 different species of seafood (McEvoy, 2019). Given the rising number of aquafarms in the state, citizens and decision-makers are interested in the current and potential economic, environmental, and social impacts of this industry.

The development of the aquaculture industry in Maine’s coastal waters may have both positive and negative impacts. Commercial fishers and oceanfront homeowners have expressed dissatisfaction with how marine aquaculture has impacted their way of life (Laclaire & Strout, 2019). For example, locating new marine farms near coastal homes may affect property values. However, these impacts vary significantly across the coast (Evans, Chen & Robichaud, 2017). Still, aquaculture may positively impact Mainers by providing full-time jobs and adding to the seafood supply (Cole et al., 2017). This report aims to summarize input from Maine coastal residents regarding their preferences for marine aquaculture as one possible use of Maine’s 3,478-mile coastline.
2.3 Survey Overview

This report uses data obtained from the Maine Marine Aquaculture Survey, administered to coastal Maine residents, and designed by researchers at the University of Maine in the fall of 2018. The Marine Aquaculture Survey received 832 responses, with an overall response rate of 15.6%. Approximately 98.3% of respondents were year-round residents of Maine; the remainder were seasonal residents. Surveys were sent to residential addresses in the coastal zone, as defined by the Maine Coastal Program (shown in Figure 1). Maine’s coastal region was chosen in particular for this survey as Maine coastal citizens would be the primary group affected by changes to the use of the coast. Participants were compensated for their time through entry into a raffle drawing for multiple $50 gift cards.

The survey included four sections. Section 1 solicited information about Maine coastal residents’ general opinions and awareness of marine aquaculture. In section 2, respondents provided information on their preferred mix (i.e. species, location and size of farms) of coastal aquaculture development. This section also included an embedded information experiment, reporting the economic impact of the Maine aquaculture industry to one-half of respondents (randomly assigned). Section 3 contained questions that asked respondents about their willingness to donate to expand/restrict aquaculture in Maine. Finally, section 4 solicited respondents’ demographic information and contained questions that targeted perceived community resiliency.
Section 1: Knowledge and Opinions of Marine Aquaculture

- Knowledge of (or exposure to) marine aquaculture farms and products
- Tendency to seek information about aquaculture.
- Frequency of seafood consumption.
- Opinions regarding issues surrounding the aquaculture industry, the quantity and rate of growth of aquaculture farms, and overall views.
- Seafood’s effects on the market.
- Perceptions regarding: (1) the coastal job-market, (2) the ownership of aquaculture farms, (3) the impacts of aquaculture on the environment, and (4) support for aquaculture development.

Section 2: Aquaculture Permitting and Development

- Familiarity with, and stipulations for, the permitting process.
- Preferences for research on aquaculture.
- Preferences for expanding the aquaculture industry within and without the state of Maine.

Section 3: Revealing Preferences for Aquaculture Expansion or Restriction by Donation Behavior

- Respondents had an opportunity to vote on a proposed scenario that varied across four variables: (1) expansion or restriction of aquaculture in Maine, (2) type of seafood product, (3) location of development, and (4) price of donation.
- Respondents were provided with a text box for explanation of their choice in the donation scenario.

Section 4: Demographics

- Demographic information.
  - Gender, age, household size, and education level of respondents.
Employment and income statistics.

Place of Residence information.

- Community satisfaction, economic stress, and political orientation.

Figure 1: Coastal Zone Map. This map displays Maine’s coastal zone as defined by the Department of Marine Resources’ Coastal Zone Program. For a full list of towns and cities included in the zone, please see the DMR website (2016a).

2.4 WHO RESPONDED TO OUR SURVEY?

2.4.1 Gender, Age, Household Size, & Education Level

Respondents were predominantly male (63.37%), with 36.3% identifying as female and less than 1% not identifying as either male or female. The median age of respondents was 63 years, with ages ranging between 18 and 100 years old. The average household size was 2.28, with most respondents (76.9%)
indicating no one under the age of 18 was a member of their household. The majority (66.1%) of those that answered our survey had an education level of at least a bachelor’s degree (see Table 1). Roughly 30.7% of respondents said they had a master’s degree or higher, while 33.9% did not have a college degree. We compare survey respondents to Maine’s coastal population in Table 1.

Table 1. 
Comparison of Maine coastal population to survey participants.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Gender (% female)</th>
<th>Median age</th>
<th>Median household</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 Maine coastal population†</td>
<td>51.2%</td>
<td>44.1 yrs.</td>
<td>$57,123</td>
</tr>
<tr>
<td>Marine Aquaculture Survey respondents</td>
<td>36.3%</td>
<td>63.0 yrs.</td>
<td>87,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Ed. (bachelor’s +)</th>
<th>Unemployment rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 Maine coastal population</td>
<td>31.3%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Marine Aquaculture Survey respondents</td>
<td>66.1%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

*Note.* The coastal population is composed of residents from counties Cumberland, Hancock, Kennebec, Knox, Lincoln, Penobscot, Sagadahoc, Washington, Waldo, and York.

† Calculated using data from the 2017 American Community Survey 5-year estimates. See United States Census Bureau (n.d.) in references.

### 2.4.2 Employment & Occupational Information

The employment status of respondents is as follows: roughly 56.7% of respondents indicated being employed, with 10% saying they were employed part-time and another 46.7% saying they were employed full-time; approximately 1.6% indicated being a student; 41.4% were retired; and roughly
1.5% indicated being unemployed. Of note is the large percentage of retirees, consistent with the high median age of our sample. On average, respondents indicated they had spent 14.5 years with their employers at the time they filled out our survey. However, it is important to note the standard deviation for this question was 12.1 years, revealing substantial variability. As for occupational information, we asked respondents if they (or a member of their household) make a living from the sea. Only 7.4% of respondents answered “yes” to this question. The median household income of respondents is approximately $87,500.

2.4.3 Residence Information, Ocean Access, and State Regions

On average, respondents lived in Maine for 38.5 years (standard deviation = 21.5 years). Almost all respondents (98.3%) are year-round residents. Respondents also stated having owned these homes for an average of 17.1 years (with a standard deviation of 13.7 years). Similarly, around 87.5% of respondents answered that they plan on staying in their current residences for the foreseeable future.

We also wanted to know whether respondents could see or access the ocean from their residence; 81.1% said they could not see the ocean from their residence, 79.4% could not access the ocean and 68.2% could neither see nor access the ocean.

A picture of Maine broken up into four regions was included on the front cover of the survey and was used by respondents to answer questions (Figure 2). There were 421 (response rate=13.4%) respondents in the Southern region, 236 respondents in the Mid-Coast region (response rate=14.8 %), and 139 respondents in the Acadia region (response rate=13.9 %). Administration of surveys was reflective of Maine population by regions, however we only heard from 36 respondents (response
rate = 14.3\%) in the Downeast region despite oversampling the Downeast region in our survey administration. Due to limited populations and the varying demographics for each region, the response rates by region were statistically different.

Figure 2: A map of Maine showing the coastal region. The four regions going from the bottom left to the top right of the map are the Southern region, the Mid-Coast region, the Acadia region, and the Downeast region.

2.5 Findings

2.5.1 Familiarity with Aquaculture

We measured respondents’ familiarity with aquaculture in Maine based on three criteria: (1) familiarity with aquaculture farms, (2) familiarity with the selection process for these farms, and (3) familiarity with seafood and aquaculture products.
2.5.1.1 Familiarity with Aquaculture Farms

To measure familiarity with aquaculture farms, we asked a series of questions beginning with whether respondents had heard about or seen “any marine aquaculture farms in Maine.” Almost 75.5% of respondents said they had “heard of” aquaculture farms in Maine, while 45.2% said they had “seen” them. 32.2% had both seen and heard about aquaculture. In total, 88.5% of respondents had experienced at least one of these types of exposure. As another way of measuring familiarity with Maine aquaculture farms, we asked respondents to select the type of aquaculture being produced by the farms they had seen and/or heard about in the state. Respondents’ level of exposure to shellfish aquaculture was higher than their level of exposure to any other type: 76.5% reported having seen or heard of a shellfish aquaculture farm. Another 52.5% of people reported exposure to finfish aquaculture, while 27.5% reported exposure to sea vegetable aquaculture; 6.3% of people reported being unaware of the type of seafood that was being produced at a particular Maine farm. When presented with the statement, “Maine aquaculture farms are not owned by local people,” 60% of respondents selected relatively neutral responses (on a scale of 1 to 6 where 1 = strongly disagree and 6 = strongly agree). An additional 25.7% were confident that Maine aquaculture farms are owned by local people (circled a 1 or 2), and the remaining 14.3% were confident that farms in Maine are not owned by local people (circled a 5 or 6).

2.5.1.2 Familiarity with the Siting Process

In both farm siting and the permitting processes, respondents’ familiarity with aquaculture was comparatively low. In fact, when asked if they were familiar with how aquaculture farms are selected and permitted in Maine, roughly 88.5% said they were not familiar. To further gauge familiarity in this area, we also asked respondents to tell us what entity is responsible for permitting Maine’s aquaculture farm sites. Survey respondents were presented with four options: (1) “local municipality,” (2) “state
agencies,” (3) “federal agencies,” and (4) “don’t know.” A significant percentage of respondents (60.3%) selected “don’t know,”. These results are consistent with other work: Mazur and Curtis (2008) found residents in the Eyre Peninsula and Port Phillip Bay regions of Australia also had moderate to low levels of familiarity with the “government’s role in aquaculture,” (p. 606).

### 2.5.1.3 Familiarity with Seafood and Aquaculture Products

Familiarity with the siting and permitting processes is an important indicator of one’s overall familiarity with the aquaculture industry, but so is one’s familiarity with the seafood products they purchase. Results are summarized in Figures 3 through 5 below.

*Figure 3:* Knowledge of having consumed Maine aquaculture. A majority of all respondents (53.3%) circled a 1 or a 2, implying high confidence in having consumed Maine aquacultured seafood. In contrast, only 25.4% circled a 5 or a 6, implying high confidence in having never consumed Maine aquacultured seafood.
Figure 4: Information-seeking behavior concerning seafood production method. 51.8% of respondents expressed a tendency to seek such information.

Figure 5 Information-seeking behavior for production location of seafood purchases. 59.8% of respondents tend to seek such information.

Familiarity with seafood may also be determined by the frequency with which one consumes these products. Most respondents (63.1%) said they eat seafood on a weekly basis, but 23.9% reported eating it only once a month. Just 12.1% said they rarely or never consume seafood. Searching for information about where seafood is produced and how seafood is produced was positively correlated with people who believed they consumed Maine aquaculture seafood.
2.5.1.4 Desired Familiarity

While some respondents expressed familiarity with aquaculture, we also wanted to see if respondents had a desire to increase their familiarity with aquaculture. To this end, respondents were asked (on a six-point scale) how likely they would be to seek more information on aquaculture (1 = highly unlikely and 6 = highly likely). The level of likelihood indicated by respondents varies but is relatively high overall: roughly 79.7% answered a 4 or higher, meaning a majority desire to increase their level of familiarity with aquaculture. We explore differences across respondents in section 5.1.5.

We also asked respondents how important it is for them to be aware of new marine aquaculture farms being considered in their community. Since most respondents are willing to seek more information on aquaculture, it is not surprising that this desire to increase familiarity extends to being informed about new farms. In fact, 69.5% of respondents indicated that being informed was at least somewhat important to them (circled a 4 or higher on a six-point scale where 1 = not at all important and 6 = very important).

2.5.1.5 Summary & Comments

Respondents revealed high familiarity with having heard of or seen aquaculture farms and most were familiar with having consumed aquacultured products. However, a low level of familiarity with the aquaculture selection or permitting process simultaneously exists. Most respondents tend to seek information concerning the origin of—and production method used for—their seafood purchases. However, given that desire to learn more about aquaculture was so high, there is potential for respondents’ information-seeking tendencies to increase. Searching for information about where
seafood is produced and how seafood is produced was positively correlated with people who believed they consumed aquacultured seafood. Similarly, those who felt it was important to be informed about new aquaculture sites and desired to increase their familiarity with aquaculture were on average more likely to have reported consuming aquaculture. Those with little interest in increasing their familiarity with how aquaculture is produced were statistically more likely to be respondents who had already expressed having negative views on aquaculture. Statistical significance was found using an ANOVA test with a F-value equal to or less than 0.001.

2.5.2 Perceptions of Aquaculture

Measuring public perceptions of aquaculture “is an important part of aquaculture management and planning.” (Bacher, 2015, p. 5). As aquaculture continues to develop in Maine, familiarizing ourselves with residents’ perceptions can help identify potential issues with increased aquaculture capacity. Once these issues are known, policymakers can make meaningful and informed decisions about how to move the state forward.

2.5.2.1 General Perceptions

Respondents’ general perceptions of aquaculture were overwhelmingly positive: when asked about their views of Maine’s marine aquaculture, approximately 83.5% expressed positive views (i.e., circling either a 5 or higher out of 7). In contrast, only 8.7% of respondents expressed negative views (i.e., circling either a 3 or lower out of 7), with 7.8% remaining neutral with a response of a 4 (see Figure 6). Our results differ by region within Maine (Figure 7) where the Downeast region showed the least positive views with a mean response of 5 followed by the Acadia region with an average response of a
5.4, then the Southern and Mid-coast region with an average of a 5.6. Thus, respondent’s region and views on aquaculture are statistically correlated. Our results diverge from reports that suggest citizens hold largely negative perceptions of aquaculture worldwide (Bacher, 2015).

Figure 6: Responses to “Overall, your view of Maine’s marine aquaculture are...?” (1 = very negative, 6 = very positive), 83.5% had somewhat positive to very positive views, while 8.7% had somewhat negative to very negative views. 7.8% of respondents remained neutral.

Positive views may not ensure coastal residents support additional aquaculture growth and development. About 72.3% of respondents tended to agree that other Maine residents support expanding aquaculture in the state (i.e., circled a 4 or higher on a scale of 1 to 6 where 1 = strongly disagree and 6 = strongly agree); however, roughly 70.2% circled a 3 or 4 themselves. This might imply either that other Maine residents were perceived by respondents to sit on the fence when it comes to developing aquaculture in the state, or that respondents were largely unsure of how Mainers feel about development. Those who did respond that Maine residents did not support expanding aquaculture
disproportionally were from the Acadia and Downeast region with average responses of 4.4 and 3.9 respectively while the Southern and Mid-Coast regions both averaged closer to 4.6. These variations by region are statistically significant.

In addition to our questions about Maine residents, we also asked respondents if they agree or disagree that visitors to Maine support further developing aquaculture in Maine. We found 60.6% of respondents tended to feel visitors support development in the state (i.e., circled a 4 or higher on a six-point scale where 1 = strongly disagree and 6 = strongly agree).

Looking deeper into perceptions of aquaculture expansion in Maine, we asked respondents to rate their level of agreement with the following statement: “There is no room in Maine to add more aquaculture farms.” An overwhelming percent of respondents (approximately 86.3%) tended to disagree with this statement (i.e., circled a 3 or lower where 1 = strongly disagree and 6 = strongly agree), meaning most feel Maine has more room for aquaculture. Using a T-test, those who did not feel that there was room for aquaculture were statistically more likely to consume less Maine aquacultured seafood while the opposite was true for those who felt that there was room, with a P-value of less than 0.05. In fact, 82.2% of respondents agreed aquaculture “fits well into the uses of the Maine coast”.
Figure 7. Responses to “Overall, your view of Maine’s marine aquaculture are...?" (1 = very negative, 6 = very positive) split up by region. You can see a consistent positive view of aquaculture with a slightly higher percentage of Acadia and Downeast citizens responding with either a Neutral or Negative view of aquaculture in Maine.

We also asked about respondents’ sensory perceptions of aquaculture (noise level, smell, and appearance). About 78.8% of those that answered this question tended to disagree that aquaculture is noisy/smelly/ugly (i.e., circled a 3 or lower on a scale of 1 to 6 where 1 = strongly disagree, 6 = strongly agree). Given Maine’s large commercial fishing fleet it is important to know if respondents view aquaculture as complementary to current coastal activities or pose new challenges. When asked “Does aquaculture limit commercial fishing areas?” many respondents (68.3%) tended to disagree, circling a 3 or lower on a six-point scale. However, 59.6% of respondents tended to think “there is a lot of conflict related to aquaculture development” in Maine. This was also answered differently by region with 70.5% of residents from the Downeast region agreeing with the statement while only 55% of respondents from
the Southern region agreed that there is a lot of conflict related to aquaculture development (a statistically significant difference according to a Chi-squared test with a P-value of less than 0.01), while both the Mid-Coast and the Acadia region were somewhere in the middle. Thus, it’s hard to say how respondents view aquaculture in relation to commercial fishing from these questions. Interestingly a majority of respondents (68.8%) felt aquaculture “has the same problems as some types of land-based agriculture.”

2.5.2.2 Perceived Impacts of Aquaculture on Use of the Coastal Area

In our survey, we asked respondents to rate how their “use of Maine’s coastal area” had “been impacted by marine aquaculture” on a scale of 1 to 7. A rating of 1 to 2 indicated some degree of negative impact, a 3-5 indicated a fairly neutral response to the question, while a 6 to 7 indicated some degree of positive impact. We found that 15.2% of respondents tended to feel aquaculture positively impacts their use of the coast, with only 5.7% stating negative impact. The remaining respondents (79.1%) believed aquaculture has relatively little impact on their coastal usage. Taking a closer look at the neutral responses however, more respondents answered with a 5 (289), which is closer to negative, than those who responded with a 3 (119), closer to positive. Responses varied when viewed by level of exposure to aquaculture, respondents who had seen aquaculture averaged slightly higher (i.e., more negative) on their Likert scale responses. When looking at how regions of the state responded differently to this question Downeast respondents averaged a neutral response of a 4.0, respondents from the Acadia region averaged a response of a 4.13 and respondents from the Southern and Mid-Coast regions were significantly higher with an average response of a 4.5 and 4.6 respectively
2.5.2.3 Perceived Impacts of Aquaculture on the Economy

We asked respondents to answer a total of six questions about their perceptions of the economic effects of the aquaculture industry. The first two questions targeted general perceptions, while the last four dealt with aquaculture’s direct impacts on economic phenomena.

When asked whether they agree or disagree that aquaculture has a positive economic impact on the local community, around 87.5% of respondents tended to agree (i.e., circled a 4 or higher on a scale of 1 to 6 where 1 = strongly disagree and 6 = strongly agree). Responses were even more striking when we asked whether aquaculture could serve to “boost the local economy.” Roughly 91.2% of respondents tended to agree that it could (i.e., circled a 4 or higher on the same scale).

In addition to these broad questions about the economic impacts of aquaculture, we also wanted to learn whether respondents perceive an impact on various other economic phenomena such as: (1) seafood prices, (2) coastal property values, (3) jobs, and (4) working waterfronts. Statements about various potential economic effects of aquaculture were provided to respondents, who were asked to select their level of agreement on a scale of 1 to 6. The first statement was: “aquaculture lowers the price of seafood.” Most respondents (roughly 60.3%) selected a 4 or higher, indicating they tend to agree with this statement. Of note is that 65.3% circled more neutral answers of 3 or 4. This could mean either respondents perceived minimal effects on the price of seafood or were otherwise unsure about said effects. Those who reported that they were likely to have consumed Maine aquacultured seafood (i.e., having responded to the question “Have you ever consumed Maine aquacultured seafood?” with a 3 or lower out of 6, with 1 being definitely yes and 6 being definitely no) were statistically more likely to have agreed that aquaculture lowers the price of seafood.
While survey respondents tended to believe aquaculture affects the price of seafood, they tended to perceive the contrary with regard to property prices. When presented with the following statement, “aquaculture decreases coastal property values,” about 69.3% of those who answered this question selected a 3 or lower, indicating overall disagreement. If these results seem surprising, remember that 78.8% of those surveyed do not believe aquaculture is noisy, smelly, or ugly—all factors which may potentially decrease property values (Evans, Chen, & Robichaud, 2017).

Another important economic effect of aquaculture is its impact on the job market. Thus, we asked respondents to rate their level of agreement, from 1 to 6, with the following statement: “aquaculture provides good jobs to those living on the coast.” About 84.5% of those surveyed selected a 4 or higher, revealing a significant majority of respondents believe the aquaculture industry is a good source of jobs (see Figure 8). Our findings are consistent with the results of a study performed in Canada finding similarly that a majority of respondents agreed that aquaculture creates good jobs in communities and is an important economic activity (Flaherty, Reid, Chopin, & Latham, 2019, p. 25). Interestingly, these results varied significantly by region. The Acadia region reported the highest level of agreement with an average response of a 4.6, the Southern region and Acadia region responded with next highest both with an average of 4.3 and last the Downeast region responded with an average response of 4.0.

We also wanted to inquire about coastal residents’ perceptions regarding aquaculture’s economic effect on Maine’s working waterfronts. §1132(11) of Title 36 in the Maine Revised Statutes defines “working waterfront land” as a parcel of land for which the majority is designated to “provide access to or support the conduct of commercial fishing activities,” (2007). When asked to communicate their level of agreement with the statement, “aquaculture supports working waterfro...
expressed some level of agreement (i.e. circled a 4 or higher on a 6 point scale where 1 = strongly disagree and 6 = strongly agree) consistent with the 82.2% of respondents mentioned earlier who tended to feel that aquaculture fits well into the uses of Maine’s coast. There was a statistical difference in responses by region with the Southern (4.6) and Mid-Coast(4.7) regions averaging a more positive response as opposed to the Acadia (4.4) and Downeast(4.2) regions using a ANOVA test with a F-value of less than 0.05.

![Figure 8: “Aquaculture supports working waterfronts”](image)

Figure 8: “Aquaculture provides good jobs to coastal residents.” Respondents tended to agree with this statement, as 84.5% selected a 4 or higher on a six-point scale.

2.5.2.4 Perceived Impacts of Aquaculture on the Environment & Ecology

Maintaining the health of the environment and ecology play a central role in keeping Maine’s coastal areas vibrant. Since marine aquaculture has the potential to affect the environment (Mazur & Curtis, 2008), we asked coastal residents a series of questions about their perceptions on this matter.
These questions were presented as a set of statements for which we asked respondents to rate their level of agreement on a scale of 1 to 6 (1 = strongly disagree and 6 = strongly agree). Our first statement was “aquaculture improves the environment.” Approximately 25.3% expressed varying levels of agreement (i.e. circled a 5 or higher), while about 14.6% of respondents expressed disagreement with this statement (i.e. circled a 2 or lower), and a majority, 60.1%, responded relatively neutral (i.e. circled a 3 or 4). Our next statement was “aquacultured seafood is less damaging to the environment than wild harvested.” Only a slight majority (around 54.7%) of those surveyed expressed some level of agreement with this statement, while roughly 45.3% tended to disagree. Our final statement was “aquaculture is a good way to relieve pressure on wild seafood populations.” 83.7% of respondents expressed some level of agreement with this statement, while only 16.3% felt otherwise. Research by Flaherty et al. (2019) supports this finding, as 60% of their respondents also believed “aquaculture relieves pressure on wild stocks,” (p. 27).

2.5.2.5 Summary & Comments

Most of the respondents entertain positive views of the aquaculture industry and its effects. For example, respondents tend to believe aquaculture positively affects the economy, lowers seafood prices while not lowering property prices, provides good jobs, supports working waterfronts, improves the environment, and relieves pressure on wild fish stocks. Respondents also tend to think aquaculture minimally affects aesthetics and fits well into the uses of Maine’s coast. While these perceptions of aquaculture are positive, our study did reveal potentially negative perceptions. Many respondents perceived aquaculture development in Maine as a conflict-ridden issue. They also felt agriculture and aquaculture have similar, undesirable features. Some respondents are concerned about aquaculture and its effects on the environment (e.g., 41.8% tended to feel aquaculture does not improve the
environment and 45.3% tended to feel the damage it does is greater than that done by wild harvest practices). Therefore, future research should examine more closely the specific environmental concerns Mainers have about aquaculture. Such research would provide decision-makers with the knowledge necessary to design effective reconciliation and communication strategies.

2.5.3 Implications for Policy and Regulation

The following subsections provide information on (1) respondents’ desired attributes for the aquaculture industry, (2) some potential considerations for its future expansion, as well as (3) respondents’ preferred structure for the industry.

2.5.3.1 Desired Attributes for the Aquaculture Industry

Survey questions about coastal Mainers’ preferences for the aquaculture industry can be sorted into two groups: preferences for farm size and for farm ownership. For both, we presented a set of statements and asked respondents to rate their level of agreement on a scale of 1 to 6 (1 = strongly disagree and 6 = strongly agree).

The following statement was aimed at capturing respondents’ preferences for aquaculture farm size: “there should be a limit on how big an aquaculture farm can be.” Overall, respondents expressed overwhelming agreement with this statement: roughly 81.9% circled a 4 or higher with a mean and standard deviation of 4.59 and 1.3, respectively. This means most respondents may want the size of aquaculture farms to be regulated.
In addition to farm size, respondents also expressed preferences for farm ownership. When presented with the statement, “I don’t think aquaculture farms should be owned by corporations,” only a slight majority (53.6%) of respondents revealed their agreement by circling a 4 or higher. Also, worth noting are the values for the mean and standard deviation, which are approximately 3.7 and 1.61, respectively. In addition, we asked respondents whether they would like to place restrictions on the number of farms aquaculture companies can own. Overall, about 65.2% of respondents agreed that there should be such restrictions (65.2% circled a 4 or higher). The mean and standard deviation are 4.04 and 1.58, respectively.

2.5.3.2 Considerations for Industry Expansion

We asked respondents to rate on a scale of 1 to 6 how likely they would be to support policies funding research on aquaculture (1 = highly unlikely and 6 = highly likely). Most respondents (56.5%) circled a 5 or 6, indicating they are quite likely to support such policies. In contrast, only about 8.3% of respondents circled a 1 or 2, indicating they are not very likely to support such policies. A large portion of respondents were neutral (35.2% circled a 3 or 4). Overall, research would be welcomed by most respondents, as 56.5% circled a 5 or higher (see Figure 9). SEANET’s national survey also found that more research may be desirable, as 72.8% of respondents indicated being at least somewhat likely to “support policies that fund research on aquaculture,” (Murray et al., 2017, p. 21).
Figure 9: Support for policies that fund research on aquaculture. 82.7% of the respondents indicated support for such policies by circling a 4 or higher on a 6-point scale.

Respondent’s value being able to comment on the siting and licensing of aquaculture farms before they are approved. When asked to rate their level of agreement with the statement, “the public should be able to comment on all proposed aquaculture farms,” 88.1% circled a 4 or higher on a scale of 1 to 6 (where 1 = strongly disagree and 6 = strongly agree). It is clear respondents appreciate this opportunity.

As reported previously, very few of respondents were familiar with this process (roughly 11.5%). However, we asked those who were familiar to rate their satisfaction with the permitting process on a scale of 1 to 7 (1 = very unsatisfied, 4 = neutral, and 7 = very satisfied). Care must be taken with the answers we received given that so few respondents were eligible to answer this question, but overall, more people were satisfied than were dissatisfied: roughly 47.8% circled a 5 or higher, 41.1% circled a 3 or lower, and 11.1% of respondents indicated being neutral. In addition, we did not ask respondents what they like or do not like about the current aquaculture permitting process, which leaves this issue open-ended.
Public comment processes allow respondents to voice potential concerns about aquaculture development. For example, 96.6% of the respondents tended to agree that “impacts on the environment should be considered when deciding if a proposed aquaculture farm is allowed,” (i.e., circled a 4 or higher on a scale of 1 to 6 where 1 = strongly disagree and 6 = strongly agree). An additional 83.8% felt aesthetics should be considered, and 94.8% felt impacts on other marine users should be considered.

The considerations above do not reveal which types of aquaculture respondents are most likely to support. We asked respondents to rate their level of support for developing all or specific types of aquaculture on a scale of 1 to 6 (1 = strongly oppose and 6 = strongly support). Not all respondents found these options to be mutually exclusive. For example, about 66% of respondents circled a 4 or higher when asked if they support “setting aside certain areas of the coast for all types of aquaculture development.” Similarly, roughly 68.9% circled a 4 or higher when asked if they support doing the same for “only specific types of aquaculture.” To gain a deeper understanding on this matter, we turn next to questions about respondents’ desired structure for aquaculture expansion.

2.5.3.3 Desired Structure for Industry Expansion

Here we consider whether survey respondents support expansion of aquaculture, as well as at what speed expansion should take place. We conclude with a look at the various regions in Maine for which respondents are most likely to support expansion.
Our findings indicate that a majority of respondents support aquaculture in Maine. (In fact, only 2.2% expressed desire to ban aquaculture from Maine waters). Some of this support also extends to aquaculture expansion: when asked to state their likelihood of supporting “policies that expand aquaculture operations in Maine” on a scale of 1 to 6 (1 = highly unlikely and 6 = highly likely), around 83.5% of respondents circled a 4 or higher. To test the veracity of this finding, we can look at another question asking respondents to rate their agreement with the following statement: “Instead of aquaculture, Maine should focus on better management of wild species.” On a scale of 1 to 6 (1 = strongly disagree and 6 = strongly agree), about 58.5% of respondents tended to disagree. It is important to note that by disagreeing with the statement respondents are showing support for Maine aquaculture. Thus, some respondents would be satisfied with both expanding the aquaculture industry and better managing wild fish stocks (per previously reported information that 83.7% of respondents thought “aquaculture is a good way to relieve pressure on wild seafood populations.”)

In addition to questions about aquaculture development in Maine, we also asked respondents how likely they would be to “support policies that expand aquaculture operations in the U.S.” more generally. Similar to our previous findings, the majority of respondents felt that they would be likely to support such policies, as 80.6% circled a 4 or higher (on a scale of 1 to 6 where 1 = highly unlikely and 6 = highly likely).

Importantly, we wanted to capture “How much expansion is desirable?” We asked respondents what percentage of Maine’s coast they would like to allocate to aquaculture given that approximately 1,200 acres (1%) is currently allocated for this use. Respondents who previously wanted to ban all aquaculture in Maine (2% of our sample) were asked not to answer this question. Our findings are as follows:
• Only 1% of respondents wanted to maintain the current level of aquaculture or else scale it back.

• 24% wanted between 1 and 5 percent of Maine’s coast allocated to aquaculture.

• 25% wanted between 5 and 10 percent allocated to aquaculture.

• The remaining 50% of respondents wanted above 10 percent of the coastline allocated to aquaculture.

While these numbers indicate that respondents want an increase in aquaculture as a coastal use, it’s important to note that it isn’t easy to visualize what 5 to 10 percent of the coast being used would look like, nor do we have data on citizen perceptions of how the Maine coast is currently used (for example, what percent is working waterfront now).

When thinking of aquaculture expansion, another consideration must be the rate at which this expansion is to take place. We asked respondents to tell us how they feel about aquaculture’s current rate of development near their local community. On a scale of 1 to 5 (1 means aquaculture is developing far too slowly and 5 means aquaculture is developing far too quickly, a 3 indicates aquaculture is developing at an appropriate pace), respondents gave a mean value of approximately 2.78 with a standard deviation of .724. Particularly notable is most respondents (61.1%) who felt the current rate of aquaculture development is satisfactory.

Determining the pace at which we should set future aquaculture development is an important consideration, but we must also know where such development ought to take place. Therefore, we asked respondents to indicate for which regions of Maine they would support either the expansion or restriction of aquaculture development. Respondents were shown a table similar to Table 2 and were asked to “check one box for each row.” A majority of respondents indicated support for expansion
across all regions—Southern, Mid-coast, Acadia, and Downeast—but some received more support than others. For example, the Downeast region received the most support for aquaculture expansion, with 92.6% of respondents checking the “expand” box. 81.3% of respondents supported expanding aquaculture in the Mid-coast region, followed by 73.7% expressing support in the Acadia region. The Southern region received the least amount of support, with just 55.3% of respondents checking the “expand” box.

These numbers could be skewed due to a disproportionate number of responses by region. To account for this, we distinguished between internal (intraregional) and external (extra-regional) support for aquaculture expansion in Figure 10. Importantly, we found that regional support differed significantly for two regions—Acadia and Downeast—where more support for aquaculture expansion came from outside these regions than from within them.

<table>
<thead>
<tr>
<th>MAINE COASTAL REGIONS</th>
<th>RESTRICT</th>
<th>EXPAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOUTHERN REGION (York and Cumberland counties)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>MID-COAST REGION (Lincoln, Knox, Waldo, and Sagadahoc counties)</td>
<td>☐</td>
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</tr>
<tr>
<td>ACADIA REGION (Hancock county)</td>
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<tr>
<td>DOWNEAST REGION (Washington county)</td>
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*Table 2*: Maine coastal regions. Table provided respondents with the option to select either “restrict” or “expand” for each of the four regions listed. A list of counties that make up each region were also included in the table.
Figure 10: Maine’s support for Aquaculture Expansion by region. A majority of respondents support expansion across all regions, however residents from Acadia and Downeast express comparatively less support for expansion inside these regions than do residents from outside these regions.

2.5.3.4 Summary & Comments

In general, survey respondents expressed preferences for expanding aquaculture and were willing to allocate more of Maine’s coast to this purpose. They felt current expansion of the aquaculture industry is taking place at a mostly satisfactory rate, if not too slowly. The Mid-coast and Downeast regions are
the most highly preferred locations to carry out this expansion, notwithstanding differences in internal and external support for the Downeast region.

One possible explanation for differences in intraregional and extra-regional support for aquaculture is that different regions are exposed to different types of aquacultures. This can be seen clearly by figure 11 where the Downeast regions sees almost all of the finfish aquaculture while the rest of regions predominantly see shellfish and some sea vegetables. Another explanation might be that the Southern and Mid-coast region residents felt the need to support industry in the two regions with the lowest average income (Acadia and Downeast). Another notable difference between regions was awareness of aquaculture, especially in the Downeast region where residents saw comparatively more aquaculture. This is not to suggest that more exposure to aquaculture caused this discrepancy in support (we have found that increased awareness is correlated with increased support for aquaculture). Future research will try to further understand differences in regional support.
Figure 11 is a map of Maine with aquaculture farms color coded to the primary type of aquaculture grown at each of the farms. It is important to point out that many farms have more than one type of aquaculture.

The reported support for aquaculture development shown in this section is accompanied by some important caveats. For example, many respondents want more research to be done on aquaculture which could ultimately substantially change industry practices. In addition, respondents want to set limits on both the number of farms companies can own and the size of these farms. A significant number of respondents (although not a majority) indicated dissatisfaction with the current permitting process, which makes the mandatory public commenting period even more important since policymakers may use this information to amend the current process and tailor it to respondents’ preferences.
2.6 Discussion

How does exposure to aquaculture impact perceptions?

Our results generally show high exposure to aquaculture and this exposure has a statistically significant and positive effect on one’s views of aquaculture. For example, respondents who had seen or heard of aquaculture farms in Maine stated that aquaculture was less noisy, smelly, and ugly than those with no exposure to aquaculture. Similarly, respondents who indicated knowing the type of seafood being produced at the farms they had been exposed to have a more positive perception of aquaculture. Importantly, this effect is consistent across all types of aquaculture farms—shellfish, finfish, and sea vegetables. However, we are uncertain of how exposure to aquaculture would influence preferences if the density of aquaculture in Maine substantially increased.

Factors affecting knowledge of the aquaculture permitting process.

Most respondents (88.5%) stated they were unfamiliar with how the aquaculture permitting process works in Maine. Given this overwhelming lack of knowledge, it is worth looking at what factors affect one’s level of familiarity with the permitting process. We found that if a member of one’s household makes their living from the sea, the likelihood that they will be familiar with this process increases. However, people in this category were still unlikely to be familiar, revealing an all-around lack of knowledge when it comes to the permitting process for aquaculture farms.

The permitting process stands out as the largest knowledge gap in our survey, and much work could be done to inform Maine citizens of how this process works. Of course, this knowledge gap may also suggest that staying informed in this area is simply not important to the average Maine citizen. Of interest, when asked about their satisfaction with the process of selecting and permitting aquaculture
sites in Maine, a substantial percentage (41.1%) of respondents revealed dissatisfaction. Future research should examine the causes for this dissatisfaction in greater detail. Indeed, it would be useful for policymakers and those employed by working waterfronts to know how this process could be improved for all parties.

**Future research**

Survey results indicate that respondent perceptions of aquaculture were positive and e citizens generally see benefits associated with aquaculture—but there is always room for improvement. As discussed above, the more exposure one has had with the aquaculture industry, the more positive their perceptions. Therefore, future research might look at the most effective ways to expose the public to the aquaculture industry. Our research shows that younger, less educated, lower income, and inland citizens all consume seafood products less and are therefore some of the least likely groups to exhibit familiarity with aquaculture.

Finally, there were questions in our survey not discussed in this report. These questions attempted to elicit respondents’ willingness to pay for either expansion or restriction of aquaculture across many variables. The point of these variables was to determine which factors impact respondents’ willingness to pay. Future research will build off the questions in this survey to understand where citizens want to expand aquaculture as well as which aquaculture products are the most desirable. Future research should also examine the extent to which consumers value aquaculture products in the first place.
CHAPTER 3

NIMBY: A LOOK INTO PUBLIC PERCEPTIONS OF AQUACULTURE

3.1 Introduction

Aquaculture development can potentially act as one effective measure to help meet the growing demand for seafood as the world’s population continues to grow, but where does siting of new farms occur? With forty percent of the U.S. population living near a coast (NOAA), if there exists local opposition there could be increasingly little space to house aquaculture. In Maine this number exceeds the national average reaching 55.5% (NOAA). The coast has many uses including food production, nature conservation, ports, and acting as a main attraction for tourists due to its recreational uses and natural beauty. The coastline in Maine is extensive but ultimately finite. Communities must make decisions on the distribution of different types of coastal usage and where each type is to take place. Production of seafood in marine waters, mariculture, is the fastest growing food production sector (FAO), however it is just one use of the coast. When making decisions about expanding aquaculture in coastal waters, Maine residents must evaluate the tradeoffs about locating aquaculture in different areas. It may be that how people arrive at their decision may differ if aquaculture will be expanded near them. Research is important to determine what Maine residents value and why some projects may seem to benefit all but still yield pushback. A Not In My Back Yard (NIMBY) attitude has been commonly cited as a issue for both land and Marine use.

The state of Maine has a reputation for providing high-quality seafood, including shellfish, lobster, and a variety of finfish through a tradition of wild harvest. Adapting to growing seafood demand, the Maine aquaculture industry has grown substantially over time, with 2014 estimates revealing “a statewide annual economic contribution, including multiplier effects, of an estimated $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor
income,”(Cole, Langston, & Davis, 2017, p. 9). As of 2019, an estimated 200 coastal aquaculture farms participated in the Maine economy, producing 25 different species of seafood (McEvoy, 2019). For comparison, “the total value of wild-harvest commercial landings in 2015 was over $627 million” (Department of Marine Resources 2019). Thus, while the economic impact of aquaculture seems relatively small, Maine aquaculture farmers are optimistic the industry will continue to grow over time (Cole et al. 2017). If true, such a forecast would potentially give added stability to the Maine economy and act as a supplement to the wild-harvest industry, alleviating some of the downsides that come with over reliance. Aquaculture has a variety of benefits including improving food security (Bene et. al., 2016), protecting struggling marine species and habitat, and notably shellfish and sea vegetables have been known to improve certain environmental factors (ARI, 2017). While these impacts would have far reaching benefits beyond local communities with aquaculture some of the risks may disproportionately affect communities and citizens closest to aquaculture sites. Negative effects include impacts on the marine environment including biofouling, noise from the farms (Banister et. al. 2019), and potentially negatively affecting housing prices (Evans et al.) .

As the industry continues to grow as too will the impact, which displays the importance of understanding how citizens feel toward the aquaculture industry. There are many things to consider, people have different knowledge about and exposure to aquaculture in Maine, this leads to a wide range of preconceived notions towards the industry. In particular, residents of Maine have been reported as having generally low awareness of aquaculture (Cultivating Benefit and Risk: Aquaculture Representation and Interpretation in New England). While all will have different biases it’s important to understand where concerns could come from as to properly address these issues. Addressing why people resist aquaculture expansion helps communication.

While a lot of research has been done about the public’s perceptions of aquaculture, there is much to be explored about how the relationship between attitudinal factors affect perceptions of
aquaculture and willingness to expand aquaculture and whether this differs for the local population. This paper works to understand the particular factors impacting respondents' support for restriction or expansion of the industry. The key question explored is:
What factors impact Maine coastal residents support for restriction or expansion of aquaculture? Does the potential for a “Not In My Backyard” attitude toward aquaculture exist?

This paper uses a mail survey which sought to elicit coastal Maine residents’ preferences for aquaculture, aquaculture development, and policy. Learning about these preferences are key to informing effective policy to ensure development. Information about coastal residents’ preferences can also assist and developing optimal locations. Demand for seafood is increasing worldwide and aquaculture development could help meet the rising demand from a growing world population (FAO 2018). While the paper uses data particular to Maine which makes the results useful to Maine stakeholders the demand for seafood and the growth of aquaculture are worldwide phenomena making the results of the paper pertinent beyond coastal Maine.

3.2 Literature Review

NIMBY or Not In My Backyard refers to opposition to local developments in industries or projects, which are widely supported (Devine-Wright, 2009) One common example of this is a waste treatment facility, while everyone wants for there to be a treatment facility no one really wants it near them (Portney et. al., 1991).

It is expected that when deciding about a change in an area that residents would decide purely on an evaluation of the costs and benefits of the addition. To truly observe this NIMBY phenomenon two things must hold true, positive attitudes (toward aquaculture in this case) alongside a free rider preference (Wolsink, 2000) thus a relative preference for expansion elsewhere. However, the literature has shown that costs may seem larger to local residents as change does not come as easy with people
often preferring the status-quo (Kahneman et al., 1991). Thus, this preference for the status-quo may get larger the longer someone has been around an area as things around them become increasingly normalized. Another important concept is that of place attachment which has been defined as the emotional connection between an individual and place (Low and Altman, 1992; Jorgensen and Stedman, 2001; Raymond et. al. 2017). Place attachment is a positive emotion bond with a location (Manzo, 2005), and is understood to be correlated with time of residence (Brown & Perkins, 1992) When referring to land or the coast a reason why these changes to the status-quo can elicit strong negative reactions could be that it is an attempt to prevent forms of disrupting place attachment (Devine-Wright). Given that one way to interact with the land is to observe it, a concern could be that changes to the aesthetic characteristics that are linked to the identity of that location, which aquaculture could bring. As such we should expect that that even in the face of a plethora of benefits, changes that are contrary to what is formed as their identity would be associated with a Not In My Backyard (NIMBY) reaction or if it is compatible with their identity positive qualities could be enhanced (Williams & Lawson, 2001). Other research has shown that a resident’s satisfaction with their community can impact how they perceive potential impacts of development (Nunkoo, R. & Ramkissoon, H. 2011). This is also similar to how time spent performing recreation on the coast plays a significant role in place identity (White et. al. 2008)

In coastal areas in New Zealand, it was shown that those living closest to proposed marine aquaculture farms were more sensitive to marine farm development and were less positive in their perception of aquaculture, one reason for this reported decreased acceptance was recreation (Shafer, et. al., 2010). Concerns for aquacultures impact on recreation has also been seen as a common concern at Maine lease hearings (Hanes, 2018)

There are many factors which could impact perceptions of aquaculture. One of which is how residents view aquaculture’s effect on the environment. Previous research has shown that the social
acceptability of aquaculture is closely linked to its perceived environmental impact (Whitmash, 2009). Often citizens have tended to associate aquaculture with environmental risk (Mazur and Curtis 2006; Whitmarsh and Palmieri 2011; D’Anna and Murray 2015). While it’s true that there exist negative perceptions of aquaculture in its relationship to the environment it has been observed that this perception is not constant across all types of aquaculture and is more prevalent in finfish as opposed to shellfish and sea vegetables (Whitmash, 2011).

One common factor in support for aquaculture expansion is the effects the industry has on the economy (Flaherty et. al., 2019, p. 25; D’Anna and Murray, 2015). Dalton and Jin (2018) found that in Rhode Island a key attitudinal factor affecting support included shellfish aquaculture’s impacts on the local economy. It has been shown that those who are from “deprived” areas weighted economic benefits over environmental costs in importance, while the converse is also true (Whitmash et. al, 2009). Maine has often used the wild fish industry as an economic source and most likely has ties to the industry. Chu et. al found that those who thought that aquaculture would displace wild fisheries were less likely to be supportive of aquaculture expansion. People perceive differences between wild and farmed seafood (Schlag & Ystgaard, 2013) and it’ll be important to account for how respondents believe the two interact. While wild fish has long been utilized and consumers' awareness of it, aquaculture may seem unfamiliar and novel which may translate to a negative feel of being “unnatural” (Schlag & Ystgaard, 2013). Research has shown that for other Locally Undesirable Marine uses that virtual reality felt more comfortable with development compared to that of a two-dimensional image. (Teisl et. al., 2018)
3.3 Methods

3.3.1 Participants

This study uses data collected in summer 2018 via a mail survey to coastal Maine residents, 18 years old or older. The survey was administered using a modified Dillman method (Dillman, 1978) which included an introductory letter and a reminder letter follow up after the initial mailing. The purpose of this survey was to gather Mainer’s knowledge and perception of Maine’s policy regarding the Aquaculture industry. Surveys were sent to residential addresses in the coastal zone, as it is defined by the Maine Coastal Program (CITE). Participants were compensated for their time through entry into a raffle drawing for multiple $50 gift cards. The survey was mailed to 6,000 residents with 832 responses, yielding an adjusted response rate of 15.6%. When examining the response rate by region we see some evidence that there is variation. An ANOVA test of the four response rates yields a p-value of 0.016. While this could be concerning if we were attempting to describe the perceptions of each region, we are really attempting to describe Maine as a general population.

In comparing the respondents to our target population of coastal Maine residents, we find that our sample is more male, older, educated, and wealthier [Table 1 ]. Approximately 98.3% of respondents were year-round residents of Maine with the remaining respondents indicating the survey had reached a seasonal home. 81.1% said they could not see the ocean from their residence, 79.4% could not access the ocean and 68.2% could neither see nor access the ocean.

On average respondents have lived in the same home for 17 years. The median household income range for respondents was between 75,000-99,999. Roughly 88% of respondents said they eat seafood at least once a month. On a six-point Likert scale question around 64% of respondents thought
they had eaten some form of Maine aquacultured seafood (i.e. reporting a 1-3 where a 1= Definitely yes and 6 = definitely no).

3.3.2 Survey Design

This survey was sent out to coastal Maine citizens as they would be the most aware of aquaculture farms in Maine. This is especially important for this paper as they bear the costs and benefits the most from the expansion of aquaculture farms, however they are not the only people who could benefit. For Maine specifically these respondents could also have a direct impact on how aquaculture expands as in Maine public hearings are necessary for leases to be approved. Thus, understanding public preferences for coastal Maine residents becomes imperative for stakeholders and could make a direct impact on the development of the aquaculture industry.

The survey included four sections. Section 1 solicited information about Maine coastal resident’s general opinions and awareness of marine aquaculture. Questions gauged general awareness and overall views of aquaculture including preferences towards the aesthetics, job provision, economic benefit, and environmental benefit of aquaculture. In section 2, respondents provided information on their preferred mix of coastal aquaculture development, e.g., the location and size of new marine farms along Maine’s coast. This section also included an embedded information experiment (which is controlled for in the model for this paper), reporting the economic impact of the Maine aquaculture industry to one-half of respondents (randomly assigned). Section 3 contained two questions that asked respondents if they were willing to donate to expand/restrict aquaculture in Maine. Section 3 was not used in this paper. Finally, section 4 contained demographics and questions that targeted perceived community resiliency.
Most questions in sections 1 and 2 were asked in the form of Likert scale questions. Likert scale questions are often used in surveys to measure preferences, awareness, etc. Participants were often asked to rate each item on a 6-point scale 1= strongly agree and 6 = strongly disagree, it’s important to note that there was no neutral choice for questions asked in this way.

3.3.3 Study Area

For ease of answering a few of the questions we broke Maine down into four separate regions (figure 12). One region is the Southern region, Maine’s most urbanized area and where most of Maine’s population resides. Portland’s largest city is known as a tourist destination and a hub for business. This region has mostly shellfish and sea vegetable aquaculture. The next region is the Mid-Coast region, just north of the southern region this region contains Maine’s capital and is the second most populated region of the four. This region almost entirely contains various shellfish aquaculture. The third region is the Acadia region, where Acadia National Parks and the coast acts as a large tourist attraction and is the third most populated region. This region also partially overlaps with Maine’s second largest city, Bangor. In the Downeast you will find both shellfish aquaculture and some finfish aquaculture. The least most populated region is the Downeast where most of Maine’s finfish aquaculture farms are located. Despite oversampling this region only contains just over 4% of our sample.
Figure 2: A map of Maine showing the coastal region. The four regions going from the bottom left to the top right of the map are the Southern region, the Mid-Coast region, the Acadia region, and the Downeast region.

3.4 Conceptual Framework

We assume tourist reactions to aquaculture farms reflects their prior knowledge and various attitudinal factors. The literature around aquaculture farms suggests that variation in a respondents’ expansion mix can be described by.

$$ER = f(P, K, D, S)$$
Where $P$ is a vector of pre-existing psychometric factors (e.g., perceptions, place identity), $K$ is a vector of pre-existing knowledge of, and exposure to aquaculture farms, in general, $D$ is a vector of an individual’s socio-demographics (e.g., gender, age, education, income), and $S$ is a vector of the survey administration characteristics (e.g., who/when/where surveyed, adequate random assignment) that may explain differences in tourist reactions.

The process that takes in information and then evaluates to decide on a reaction to expanding aquaculture in a region can be viewed as a utility maximizing process by which an individual uses their priors ($P$, $K$, $D$). Assuming there are no survey issues (i.e., no survey question bias or random assignment issues), then the experimental nature of the data would allow us to test the average effect of the psychometric factors by simplifying the reaction equation to $ER = f\{P\}$.

### 3.5 Data

#### 3.5.1 Dependent Variable

Table 2 shows the primary question of interest. The design of this question allowed respondents to either choose support for expansion (or restriction) of Aquaculture, both in their region and the three other regions in which they do not reside.
Table 2: Maine coastal regions. Table provided respondents with instructions that read “Where would you support restriction or expansion of aquaculture development in Maine? (CHECK ONE BOX FOR EACH ROW)”

<table>
<thead>
<tr>
<th>MAINE COASTAL REGIONS</th>
<th>RESTRICT</th>
<th>EXPAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOUTHERN REGION (York and Cumberland counties)</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>MID-COAST REGION (Lincoln, Knox, Waldo, and Sagadahoc counties)</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>ACADIA REGION (Hancock county)</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>DOWNEAST REGION (Washington county)</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

By answering the question, the respondents made two choices, (1) whether to expand or restrict aquaculture in their own region, and (2) whether to support expansion or restriction in other regions. Thus, respondents will then fall into one of four categories based on their choices.

1. Restrict
2. NIMBY
3. Expand Local
4. Expand All

In the first category those with a ‘Restrict’ preference are simply those who chose to restrict aquaculture expansion in at least half of the region including theirs and at least one other. NIMBY respondents however, support expanding aquaculture in other regions but potentially show a free rider preference by not supporting expansion within their own region. By defining support for aquaculture elsewhere as wanting to expand aquaculture in all three other regions we assure that we get a good
representation of a NIMBY preference as those who have a NIMBY preference chose to restrict aquaculture in their own region and expand in all other regions. In the ‘Expand Local’ category they show the opposite of a NIMBY preference, they support aquaculture within their own region, but they chose to restrict aquaculture in at least one other region. It could be that respondents in this category perceive that the highest marginal benefits of aquaculture expansion could be contained within their own region and potentially one or more other regions. It’s also possible that they felt that other regions wouldn’t benefit or support aquaculture expansion in their own regions as much as theirs. Finally the ‘Expand All’ respondents chose to support expansion both in their own region and all other regions. The frequency of each choice can be found in Table 3.

<table>
<thead>
<tr>
<th>Choice Preference</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrict</td>
<td>114</td>
<td>24%</td>
</tr>
<tr>
<td>NIMBY</td>
<td>61</td>
<td>13%</td>
</tr>
<tr>
<td>Expand Local</td>
<td>87</td>
<td>19%</td>
</tr>
<tr>
<td>Expand All</td>
<td>205</td>
<td>44%</td>
</tr>
</tbody>
</table>

3.5.2 Explanatory Variables

A variety of questions were asked on the survey and subsequently used in the model. None of the questions were answered by all respondents as such our final model with all variables contains fewer respondents than total respondents to the survey.
To understand why respondents made the choice that they did, we used composite variables to capture respondents underlying reasons. Literature discussed earlier indicated these were important concepts to capture but no one question on the survey could capture these concepts by itself. All questions that were included in the composite variables were on the same six-point Likert-scale and asked in the same way. Respondents were asked to rate their level of agreement with questions with 1 being strongly disagree and 6 being strongly agreed. To construct these composite variables, we explored the data using a factor analysis. All Likert scale questions were analyzed while looking at factors with Eigenvalues more than one were focused on to create adequate composite variables. To get an idea of which questions could be together loadings of more than 0.3 were included in a composite variable. 7 such composite variables were loaded (figure 12) . Then the composite variables were tested for reliability where deletion of any question would lower the reliability score of the composite variable. Cronbach’s alpha of around 0.7 indicates reliability of the scale.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychometric Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>1.89</td>
<td>-1.33</td>
<td>3.67</td>
</tr>
<tr>
<td>Economy</td>
<td>4.29</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Wildfish</td>
<td>0.15</td>
<td>-3.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Big Company</td>
<td>-4.10</td>
<td>-6</td>
<td>-1</td>
</tr>
<tr>
<td><strong>Perceptions and Exposure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seen Aquaculture</td>
<td>0.45</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Percent Mainer</td>
<td>0.64</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>See or access the coast</td>
<td>0.32</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Coastal Recreation</td>
<td>6.70</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td><strong>Socio-demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>60.40</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Income (1,000$)</td>
<td>92.23</td>
<td>5</td>
<td>225</td>
</tr>
<tr>
<td>Male</td>
<td>1.64</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Years of Education</td>
<td>15.98</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Urban</td>
<td>0.52</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fiscally Conservative</td>
<td>4.69</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
Figure 12: Depicts all composite variable that loaded from a factor analysis of the Likert-scale questions, 7 composite variables of which had eigenvalues of more than 1.

Real or perceived Economic benefits from aquaculture may impact support for aquaculture expansion. Respondents provided their perspective on the economic benefits across five questions picked for their relevancy and from the factor analysis: (1) “Aquaculture has a positive economic impact on the local community,” (2) “aquaculture supports the local economy,” (3) “Aquaculture provides jobs” (4) “Visitors to Maine support aquaculture development in Maine,” (5) “Maine residents are willing to pay more for aquaculture,”. These questions had loadings of 0.26, 0.48, 0.24, 0.16, and 0.26 respectively. Cronbach’s Alpha test of internal consistency yielded an alpha of 0.79 suggesting a fairly high level of consistency. It is expected that those who perceive more economic benefits from aquaculture would be more likely to expand aquaculture farms everywhere but in particular near themselves.
Environmental concerns are a commonly cited cost of development that may contribute to NIMBY. We used three questions to represent the impact of perceived environmental change: (1) “Aquaculture improves the ecology,” (2) “Aquaculture fits well in Maine’s oceans,” (3) “Aquaculture is noisy/smelly/ugly”. (Cronbach’s alpha = 0.70). These questions had factor loadings of 0.50, 0.39, and -0.07. Thus, those who show environmental concerns of aquaculture can be expected to not want to expand aquaculture anywhere.

How aquaculture compliments wild fisheries has been shown to directly affect people’s decision on aquaculture support (Chu et. al., 2010), where this relationship may be particularly important in Maine, world-renowned for its current wild harvest fishery. Three questions were used to represent respondent’s perception of how complementary aquaculture is to wild fisheries: (1)” Aquaculture limits commercial fishing areas,” (2) “There is no room in Maine to add more aquaculture farms” (3) “AQ helps manage wild species,” (Cronbach’s alpha =0.65) These questions had a factor loading of 0.62, 0.51, and 0.28 respectively.

Distrust towards large companies can play a role in people’s decision to explore any industry especially if it is believed that the economic benefits will not be distributed fairly when a larger non-local company is expanding. To capture respondents preferences for limitation large corporations three questions were used: (1) “I don’t think aquaculture farms should be owned by corporations,” (2) “There should be a limit on how many farms an individual/company can own,” (3) “There should be a limit on how big an aquaculture farm can be,” (Cronbach’s alpha =0.70) These questions had a factor loading of 0.66, 0.48, and 0.63 respectively.

To increase observations in our model the conditional mean (using other questions from the survey to inform) was used to fill missing questions in the composite variables only when a composite variable was missing one question. To accurately fill observations other questions in the survey were used. After filling the questions our model had 467 respondents.
Place attachment may also impact choices about changes to an area’s status quo, including aquaculture expansion. To represent place attachment, we calculate the amount of time (in a lifetime) a respondent has lived in Maine. Percentage of life was used rather than years in Maine as it was theorized that years in Maine would not have the same impact on a younger person than an older person. Consider a respondent who was older and had moved to Maine only living in Maine for twenty years rather than a respondent who has always lived in Maine and was twenty years of age.

Respondents were asked whether they had seen aquaculture, this is controlled for by a dichotomous variable representing exposure. Beyond controlling for direct exposure those who could either see the coast or had access to it were controlled for with a binary variable. It is thought that while those who have exposure might have more information with their decision on whether to expand aquaculture farms and this could have an ambiguous effect on their decision. This is different from those who access the coast because those with access do not have more information but may still have a preference for keeping the coast undeveloped.

While we discussed the key variables of interest there are several variables that were controlled for that this study is not focused on. These include socio-demographic information such as age, income, education, and gender identity. It was also important to control for the region and while it would be interesting to interpret the results due to data limitations, we do not have sufficient information to do so. For example, there are only 19 respondents from the Downeast region total and only 2 respondents who have a NIMBY preference that are from the Mid-Coast region. Still, it remains important to control for as each region has a different culture and a different mix of aquaculture type that cannot be easily captured elsewhere in the model. Other key differences between respondents that could bias our other estimates include the political leanings of the respondents which may explain a preference that respondents hold for expanding business beyond their preference for aquaculture. Lastly, whether
respondents reside in an urban area could be important to control for as there are key cultural differences between urban and rural Maine that may lead to a different preference mix.

### 3.6 Empirical Strategy

The research objective is to investigate how perceptions of aquaculture influence the decisions of coastal respondents as to whether they will support aquaculture expansion. The citizens’ responses to the key variable cannot be ranked, as such the multinomial logit model was chosen.

Multinomial logit models have been commonly used in analyzing decision making or choice selection in economics. The basic concept is derived from a random utility maximization (RUM) model (Greene 2002). Individuals will choose the option which provides the most utility to them, whether they perceive direct or indirect utility or more likely a mix of the two. In our empirical model, respondents choose to support aquaculture expansion if they expect greater utility, by either direct or indirect benefit. We might assume these direct and indirect benefits are different if the region where aquaculture expansion occurs is the same region as the respondent resides or at the very least the benefits and costs may be weighted differently. The utility derived by respondent $i$ from selecting aquaculture expansion mix $j$ can be expressed as:

$$U_{ij} = \beta_{ij}X + \epsilon_{ij}$$

Where $U_{ij}$ is the utility achieved by respondent $i$ from choosing aquaculture expansion mix $j$, where $X$ denotes the variables affecting the decision and $\beta$ are the coefficients of the parameters with being the random error term associated with each respondent’s choice, with the assumption that the error terms in an individuals’ utility model are independently and identically distributed. Respondent $i$ makes decision $j$ if and only if

$$U_{ij} > U_{ik} \quad \forall \ j \neq k$$
As discussed earlier we expect that the utility is a function of various prior knowledge, exposure, and characteristics that controlled for with socio-demographics as such the utility that individual \( i \) derives from choosing decision \( j \) is,

\[
U_{ij} = u(P, K, D) + \varepsilon_{ij}
\]

The probability that decision \( j \) is selected by respondent \( i \) is denoted as \( (P_{ij}) \).

\[
P_{ij} = P\{ u(P, K, D) + ij \} > \{ u(P, K, D) + ik \}
\]

\[
P_r(j) = \frac{\exp(\beta P_i + \beta K_i + \beta D_i)}{\sum_j \exp(\beta P_i + \beta K_i + \beta D_i)}
\]

It is implicitly assumed that with the multinomial logit model that the unobservable error is identically and independently distributed as a Weibull distribution which leads to the Independence of Irrelevant Alternatives (IIA) property. This property holds that the odds ratio between any two choices is unaffected by the utilities of any other alternative choice. Thus, if this were to not hold, the multinomial logit model would over-predict the choice probabilities of related alternatives while under-predicting the probabilities of the other alternatives.

Estimation of the multinomial logit is completed by maximum likelihood where the vector of is chosen to minimize the log-likelihood given by:

\[
\sum_{n=1}^{N} \sum_{j=1}^{l} \ln(p_{nj})
\]

This is a nonlinear model thus the coefficients cannot be directly interpreted. Instead, marginal effects for each explanatory variable can be derived by differentiation:

\[
\frac{\delta P_{rij}}{\delta x_i} = P_{rij} [\beta_j \sum_k P_{rik} \beta_k] = P_{rij} [\beta_j - \bar{\beta}]
\]
These marginal effects will be then interpreted as a percent change in probability of observing a given choice such that, a one-unit change in $x$ is correlated with a change in probability that an individual $i$ will choose decision $j$ over the other decisions indexed by $k$. When discussing the results, we will focus on the statistically significant marginal effects that are at least significant at the $=0.10$ level.

### 3.7 Results

A multinomial logit model was used to analyze the responses to our key question (Table 5). Marginal effects are utilized for estimating interpretation of the results (Table 6). The model is based on attitudinal factors, exposure, access to the coast and recreation with sociodemographic and political leanings acting as controls.
Table 5: Multinomial Logit Model results, dependent variable is choice to support AQ (per Table 2) n=467. Bold indicates statistically significance at = 0.10. The base outcome is the Expand all preference.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Restrict</th>
<th>NIMBY</th>
<th>Expand Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychometric Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td>-0.583</td>
<td>-0.834</td>
<td>-0.373</td>
</tr>
<tr>
<td></td>
<td>(0.249)</td>
<td>(0.304)</td>
<td>(0.250)</td>
</tr>
<tr>
<td>Wildfish</td>
<td>-0.485</td>
<td>0.078</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.291)</td>
<td>(0.293)</td>
<td>(0.255)</td>
</tr>
<tr>
<td>Big Company</td>
<td>-0.486</td>
<td>-0.294</td>
<td>-0.432</td>
</tr>
<tr>
<td></td>
<td>(0.148)</td>
<td>(0.167)</td>
<td>(0.141)</td>
</tr>
<tr>
<td>Environment</td>
<td>-0.412</td>
<td>-0.005</td>
<td>-0.116</td>
</tr>
<tr>
<td></td>
<td>(0.263)</td>
<td>(0.313)</td>
<td>(0.266)</td>
</tr>
<tr>
<td>Perceptions and Exposure</td>
<td>0.584</td>
<td>0.015</td>
<td>-1.625</td>
</tr>
<tr>
<td>Seen Aquaculture</td>
<td>(0.74)</td>
<td>(0.883)</td>
<td>(0.815)</td>
</tr>
<tr>
<td>Percent Mainly</td>
<td>-0.477</td>
<td>-0.149</td>
<td>-0.466</td>
</tr>
<tr>
<td></td>
<td>(0.457)</td>
<td>(0.528)</td>
<td>(0.464)</td>
</tr>
<tr>
<td>See or access the coast</td>
<td>-0.791</td>
<td>-0.485</td>
<td>-0.612</td>
</tr>
<tr>
<td></td>
<td>(0.373)</td>
<td>(0.397)</td>
<td>(0.371)</td>
</tr>
<tr>
<td>Recreation</td>
<td>0.101</td>
<td>0.174</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.075)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>Recreation$^2$</td>
<td>-0.003</td>
<td>-0.006</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Socio-demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.131</td>
<td>-0.061</td>
<td>-0.156</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.085)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>Age$^2$</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Income</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.573</td>
<td>1.009</td>
<td>0.183</td>
</tr>
<tr>
<td></td>
<td>(0.321)</td>
<td>(0.431)</td>
<td>(0.334)</td>
</tr>
<tr>
<td>Years of Education</td>
<td>0.010</td>
<td>-0.056</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
<td>(0.087)</td>
<td>(0.069)</td>
</tr>
<tr>
<td>Fiscally Conservative</td>
<td>0.197</td>
<td>0.035</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
<td>(0.124)</td>
<td>(0.102)</td>
</tr>
<tr>
<td>Urban</td>
<td>0.640</td>
<td>0.425</td>
<td>0.249</td>
</tr>
<tr>
<td></td>
<td>(0.364)</td>
<td>(0.394)</td>
<td>(0.392)</td>
</tr>
<tr>
<td>Region (Base = Southern)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Coast</td>
<td>0.59</td>
<td>-2.48</td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td>(0.432)</td>
<td>(0.803)</td>
<td>(0.429)</td>
</tr>
<tr>
<td>Acadia</td>
<td>0.52</td>
<td>-0.52</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>(0.389)</td>
<td>(0.507)</td>
<td>(0.465)</td>
</tr>
<tr>
<td>Downeast</td>
<td>0.76</td>
<td>-14.11</td>
<td>3.21</td>
</tr>
<tr>
<td></td>
<td>(0.967)</td>
<td>(826.8)</td>
<td>(0.821)</td>
</tr>
<tr>
<td>Constant</td>
<td>2.83</td>
<td>2.75</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>(2759)</td>
<td>(3.482)</td>
<td>(2.591)</td>
</tr>
</tbody>
</table>
Table 6: Marginal Effects Table: The dependent variable is choosing expansion mix for AQ n=467. * Indicates statistically significance at =0.10, ** indicates = 0.05, and *** indicates = 0.01. This table consistently shows that the psychometric factors, perceptions, and exposure are important in respondents' decision making.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Restrict</th>
<th>NIMBY</th>
<th>Expand Local</th>
<th>Expand All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychometric Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>-7.55%***</td>
<td>-4.09%*</td>
<td>3.95%</td>
<td>7.69%**</td>
</tr>
<tr>
<td>Economy</td>
<td>-3.97%</td>
<td>-5.76%**</td>
<td>-1.39%</td>
<td>11.1%***</td>
</tr>
<tr>
<td>Wildfish</td>
<td>-5.54%**</td>
<td>1.99%</td>
<td>0.96%</td>
<td>2.60%</td>
</tr>
<tr>
<td>Big Company</td>
<td>-3.99%*</td>
<td>-0.81%</td>
<td>-3.28%**</td>
<td>8.07%***</td>
</tr>
<tr>
<td><strong>Perceptions and Exposure</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seen Aquaculture</td>
<td>-6.39%*</td>
<td>1.74%</td>
<td>-8.22%**</td>
<td>12.9%***</td>
</tr>
<tr>
<td>Percent Mainer</td>
<td>-4.15%</td>
<td>0.59%</td>
<td>-3.96%</td>
<td>7.51%</td>
</tr>
<tr>
<td>See or access the coast</td>
<td>-6.65%*</td>
<td>-1.64%</td>
<td>-4.15%</td>
<td>12.4%**</td>
</tr>
<tr>
<td>Recreation</td>
<td>0.60%</td>
<td>0.69%**</td>
<td>-0.30%</td>
<td>-0.99%*</td>
</tr>
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<td><strong>Socio-demographics</strong></td>
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<td>Age</td>
<td>0.05%</td>
<td>0.21%</td>
<td>0.13%</td>
<td>-0.39%*</td>
</tr>
<tr>
<td>Income</td>
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<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Male</td>
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<td>10.2%***</td>
<td>3.69%</td>
<td>-1.90%</td>
</tr>
<tr>
<td>Urban</td>
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<td>1.85%</td>
<td>-0.04%</td>
<td>-8.33%</td>
</tr>
<tr>
<td>Fically Conservative</td>
<td>2.54%</td>
<td>-0.40%</td>
<td>0.04%</td>
<td>-2.18%</td>
</tr>
<tr>
<td>Education</td>
<td>0.17%</td>
<td>-0.61%</td>
<td>0.43%</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Region ( Base= Southern)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Coast</td>
<td>4.5%</td>
<td>-19.8%***</td>
<td>27.1%***</td>
<td>-11.8%</td>
</tr>
<tr>
<td>Acadia</td>
<td>5.92%</td>
<td>-10.1%**</td>
<td>10.8%**</td>
<td>-6.60%</td>
</tr>
<tr>
<td>Downeast</td>
<td>-4.79%</td>
<td>-21.3%***</td>
<td>55.9%***</td>
<td>-29.9%***</td>
</tr>
</tbody>
</table>

The goal of our model is to understand the choice preference of respondents, but not necessarily be able to predict choice outcome. One opportunity to evaluate model fit is the percent of respondents whose choice the model would have correctly predicted given the data used from the survey. This percent was equal to 58%, while a blind guess would have yielded around 25% or simply choosing the most common response would have yielded a 44%. This percentage shows that variables of interest are useful in understanding what decisions people make when evaluating whether to expand aquaculture even if they do not explain all the variation in respondents' decision making.
The model includes four aquaculture attitude variables. First, is the environmental factor which captures how respondents believe aquaculture impacts the ecology and fits with Maine’s coast. Second, is the economic factor which captures how respondents believe aquaculture helps provide jobs and other economic benefits. Third, is the big company factor which reveals respondents’ preferences for non-local and large aquaculture companies. Finally, given Maine’s rich maritime history it seemed important to explore if respondent’s view of how aquaculture affected the wild fisheries impacted their decisions to expand or restrict aquaculture.

It is clear from Table 5 that there is evidence that attitude variables, exposure, and recreation are all important factors in understanding respondents' decisions to expand or restrict in their own or other regions however there is no evidence to support that place identity has an impact on respondent’s decision making when looking at percent Mainer. From the literature this was a bit surprising seeing as those who have been in Maine for the largest percent of their life could have been more resistant to change. It appears aquaculture's perceived impact in the community (whether through the economy, environment, or the wild fishing industry) impacted respondents' decision making the most.

One limitation to this model is that there is some evidence that the IIA assumption does not hold. After running the model, the Hausman test failed at the 0.05 level of significance when removing the Expand all group (the choice with the most responses). The consequence of this are bias estimates and may suggest that a different model could be better suited for this data. There are many limitations with surveys such as response bias with a generally low response rate and even response bias with low response rates for each question. Generally, we would expect that we are getting less respondents who don’t feel passionately about the subject responding to the survey and then for each question those who don’t respond might not feel strongly about the question or don’t feel comfortable answering (such as with age, income, etc.). One argument against this limitation is that with the subject material we
might care more about the vocal advocate/critic as they are the most likely to speak out or actively support.

This paper uses a multinomial logit model to analyze primary survey data about how citizens evaluate the costs and benefits of aquaculture providing useful insights on how Mainers prefer to allocate one of Maine’s most important resources, the coastline. While the coast has a very important role in Maine’s economy in a variety of ways results from this survey show an overall positive view of aquaculture. Our findings indicate that a majority of respondents support aquaculture in Maine. (In fact, only 2.2% expressed desire to ban aquaculture from Maine waters). Some of this support also extends to aquaculture expansion: when asked to state their likelihood of supporting “policies that expand aquaculture operations in Maine” on a scale of 1 to 6 (1 = highly unlikely and 6 = highly likely), around 83.5% of respondents circled a 4 or higher. This was statistically more than support for aquaculture expansion in the U.S. (mean = 4.33, SD = 1.32) compared to in Maine (mean = 4.54, SD = 1.32). This indicates that Mainers may prefer in-state expansion, as opposed to out-of-state expansion. The majority of respondents are concerned about Maine’s economy and have positive economic associations with aquaculture; thus it makes sense that they would want to keep the aquaculture-generated economic benefits within the state.

3.7.1 Psychometric Factors

Respondents’ perception of aquacultures’ environmental impact plays a role in their decision to expand or restrict aquaculture. Respondents who believe that aquaculture has a positive impact on the environment were more likely to choose to expand in all regions and were less likely to be in the NIMBY and the Restrict group. It’s interesting that while the environmental variable coefficients for the NIMBY and Restrict All groups are both negative (Table 5), the environment’s marginal likelihood on the NIMBY group is far smaller. If a respondent believed that there was an environmental cost, they were more likely to restrict aquaculture than to have a NIMBY preference.
Next when observing the economic factor, believing that aquaculture benefits the economy is correlated with respondents falling into the Expand all group but less likely to be in the NIMBY group. Of interest, the economic factor is not statistically significant in the Restrict group or the Expand local group. This could indicate that respondents did not choose to restrict aquaculture because they felt that there were no economic benefits to aquaculture. This variable had the largest marginal effect of our key variables in the NIMBY group and was the most statistically significant. The NIMBY group seems to not want aquaculture in their own region either because they do not want their region to bear the perceived costs or because the benefits are not enough. This is in line with other research such as that done by Dalton et. al, (2018) who found that aquaculture's effect on the economy is important to residents' support for or against aquaculture. Additionally, they concluded that “key attitudes toward aquaculture impacts relate to features of the social system” (page 855), this is also in line with our findings both for our economic variable and our environmental factors as our environmental factor does impact the social system by including the question “aquaculture is noisy/smelly/ugly”.

While the economic factor seems to have a large impact on NIMBYism our results replicate evidence found in other research that those who participate in coastal recreation are more sensitive to aquaculture expansion in their own region (Shafer, et. al., 2010) and are more likely to be in the NIMBY group. While a marginal effect of 0.63% may not seem to have much impact, it is important to recall that the variable captures per day recreating on the coast, which on average for our sample was seven days a month. Taking this into consideration an average amount of recreational activity for the respondents is associated with a 4.45% chance to fall in the NIMBY group as opposed to those who do not recreate on the coast. This very well could be due to how place identity is formed over time with recreational usage. Kyle et al. (2004) found that the more strongly people see a recreational place as a part of themselves the more they are likely to see negative impacts of change. These results indicate how it is perceived
marine farms affect coastal environments is important to respondents and should inform the decision making process for farms siting such that impact on communities of coastal recreators is lowered.

The big company factor suggests that the more comfortable respondents were with large non-local companies the more likely they would respond with an expand all preference and less likely to be in the Expand local or Restrict preference. The significant impact on Expand local indicates that respondents who have an aversion to large companies were less likely to want aquaculture in their own region.

3.7.2 Knowledge of and Exposure to Aquaculture

Our model did not suggest that place attachment to the state had a significant role in their decision. Based on prior research we thought that the percent of someone’s life spent in Maine would have some impact on their decision making but this was not the case. Age was weakly correlated with a NIMBY response however the relative impact was extremely small. While place attachment to state was not important how aquaculture complimented the commercial fisheries was statistically significant. This is interesting as wild fisheries have a rich history in Maine. If respondents felt it complimented wild fisheries, they were far more less likely to respond with a Restrict preference.

Overall results indicate that information about how aquaculture can positively impact the economy, environment and wild fisheries are important to respondents' decision making. However, it is interesting to note that exposure does not have a universally pro-aquaculture effect. Respondents who had seen aquaculture were far less likely to show a restrict or a Expand local preference and were more likely to have shown an Expand all preference.

3.8 CONCLUSIONS

These results can also be used as evidence in how perceptions of aquaculture impact individuals' decision to expand aquaculture both in their own region and elsewhere. Perceptions of
aquaculture’s impact on the environment, the economy, wild fisheries, and individual recreation are important to understanding the decision-making process on whether to support expansion. Preferences regarding aquaculture farm ownership structure, including size and location of owners, is also important in expansion decisions. These findings provide useful information for aquaculture policy makers, stakeholders, and advocates regarding what type of information to concentrate on in order to effectively communicate and alleviate potential concerns. While there has been much push back on the use of a NIMBY label on local opposition to development this work helps to understand why respondents may hold this preference. Understanding that many who actively oppose aquaculture will be holding a restrict and NIMBY group, this research gives insight on what common concerns are commonly associated with these preferences to address them.

Those who viewed aquaculture less positively and held a “Restrict” preference seem to have concerns primarily with aquaculture impact on the environment and its perceived conflict with wild fisheries. In contrast, respondents who held a NIMBY preference were less certain about aquaculture benefit to the economy. This study shows that aquaculture is considered to be a locally undesirable land use to some and that respondents may have a NIMBY preference for aquaculture, however, importantly the NIMBY response category was the smallest of the four response categories at only 11.8%. Respondents who spent more time on the coast were more likely to show a NIMBY preference indicating that they believed that it could reduce their utility. Other research has shown that those who participate in recreation on the coast form a bond with that place and are more sensitive to changes particularly in the environment (White et. al, 2008; Ibitayo & Virden, 1996). Additionally, respondents were more likely to show a NIMBY preference if they expressed concern for aquaculture impact on the surrounding environment.

Finally, although this paper focused specifically on a Maine population the insights gleaned about how perceptions of aquaculture impact their decision making have much broader implications
than that of just Maine. Aquaculture is growing rapidly and not just in Maine and as a large percentage of our population live on or near coastal water the decision of where aquaculture should expand to is of great importance. Being able to communicate effectively with those who would be impacted by expansion will surely alleviate opposition and perhaps help inform top concerns for better sitting of aquaculture.
CHAPTER 4

CONCLUSION

This thesis explores the preferences for expanding aquaculture farms and many of the factors that impact that decision. While exploring this topic this research adds to two bodies of literature: one being the perceptions of aquaculture and the other being the growing Not In My BackYard (NIMBY) literature for both land and marine use.

Chapter 2 looks to cover the data from the 2018 Maine Marine Aquaculture survey and explore some of the many questions that come from it. A series of t-test and ANOVA tests were conducted to analyze the results of the survey while covering a wide breadth of topics such as, “How does exposure to aquaculture impact perception?” and “Factors affecting knowledge of the aquaculture permitting process”. This study found aquaculture, generally, has quite a bit of support in Maine. Believing that aquaculture had a positive impact on the economy by providing good jobs, supporting working waterfronts, and lowering seafood prices. Respondents also tend to think that it does not negatively impact the environment. While Maine’s costal residents had familiarity with aquaculture, they did not know much about the permitting process for aquaculture farms.

Chapter 3 focused on how respondents had various expansion mixes for aquaculture across Maine and how a variety of factors influence their decision. We used a Multinomial logit model to measure the marginal impact of each factor on the probability of choosing one of the four expansion mixes, expand all, restrict, expand local, and NIMBY. Finding that costal recreation was positively correlated with a NIMBY response. Concerns for how aquaculture impacts the environment, and the wild fishing industry were correlated with a restrict preference as well as seeing or having access to the coast. Finally seeing aquaculture was negatively correlated with both a restrict and an expand local preference. Through research like this aquaculture stakeholders, coastal residents, policymakers, and
research can gain valuable knowledge, where we can achieve a quantity of aquaculture production that is optimal.


MCHT (Maine Coast Heritage Trust). (2012). MCHT conservation planning phase I (PowerPoint presentation by James DeNormandie)


https://doi.org/10.1016/j.marpol.2008.10.003

https://doi.org/10.1111/j.1365-2109.2010.02672.x


https://doi.org/10.1080/10498850.2017.1390028
BIOGRAPHY OF THE AUTHOR

Nicholas D. Alvarez was born in Baytown, TX, and graduated from South Portland High School in Maine. He obtained his undergraduate degree at the University of Maine, Orono with a Bachelor’s of Arts in Mathematics with a concentration and a Bachelor’s of Science in Economics. He is currently a graduate research coordinator at the University of Maine. He is a candidate for the Master of Science degree in Economics from the University of Maine in the August of 2021.