2019 Maine Marine Aquaculture Survey Results

TECHNICAL REPORT

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1. Acknowledgements

This report was commissioned by the Sustainable Ecological Aquaculture Network (SEANET) Human Dimensions team. SEANET's research was made possible by the Established Program to Stimulate Competitive Research (EPSCoR) at the University of Maine and funding from the National Science Foundation (NSF). We thank these organizations for their generosity and support.

Special thanks to the survey participants who offered their time and effort to complete our survey. The information you provided is invaluable to social scientists, policymakers, and other stakeholders in the aquaculture industry. Because of you, decision-makers will be better able to serve the citizens of Maine.

2. 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:

Familiarity with Aquaculture:

- A majority (88.5%) of our 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, while the rest felt relatively neutral.
- Most of our respondents (79.7%) would like to learn more about aquaculture.

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%).

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.

3. 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,[1] 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).[2] 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 aquaculture farms 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.

[1] Aquaculture has an extensive history in Maine, beginning as far back as the 19th century (Department of Marine Resources [DMR], 2016b)."

[2] According to Cole et al. (2017), this sum includes both the industry's direct impact as well as the multiplier effect.

4. 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.[3] 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.

[3] For general inquiries about our research, please contact Dr. Caroline L. Noblet. Email: caroline.noblet@maine.edu. Phone: 207.581.3172.

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 outside the state of Maine.

Section 3: Revealing Preferences for Aquaculture Expansion or Restriction by Donation Behavior[4]

- 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.[5]

[4] Results not reported here.
[5] Results not reported here.

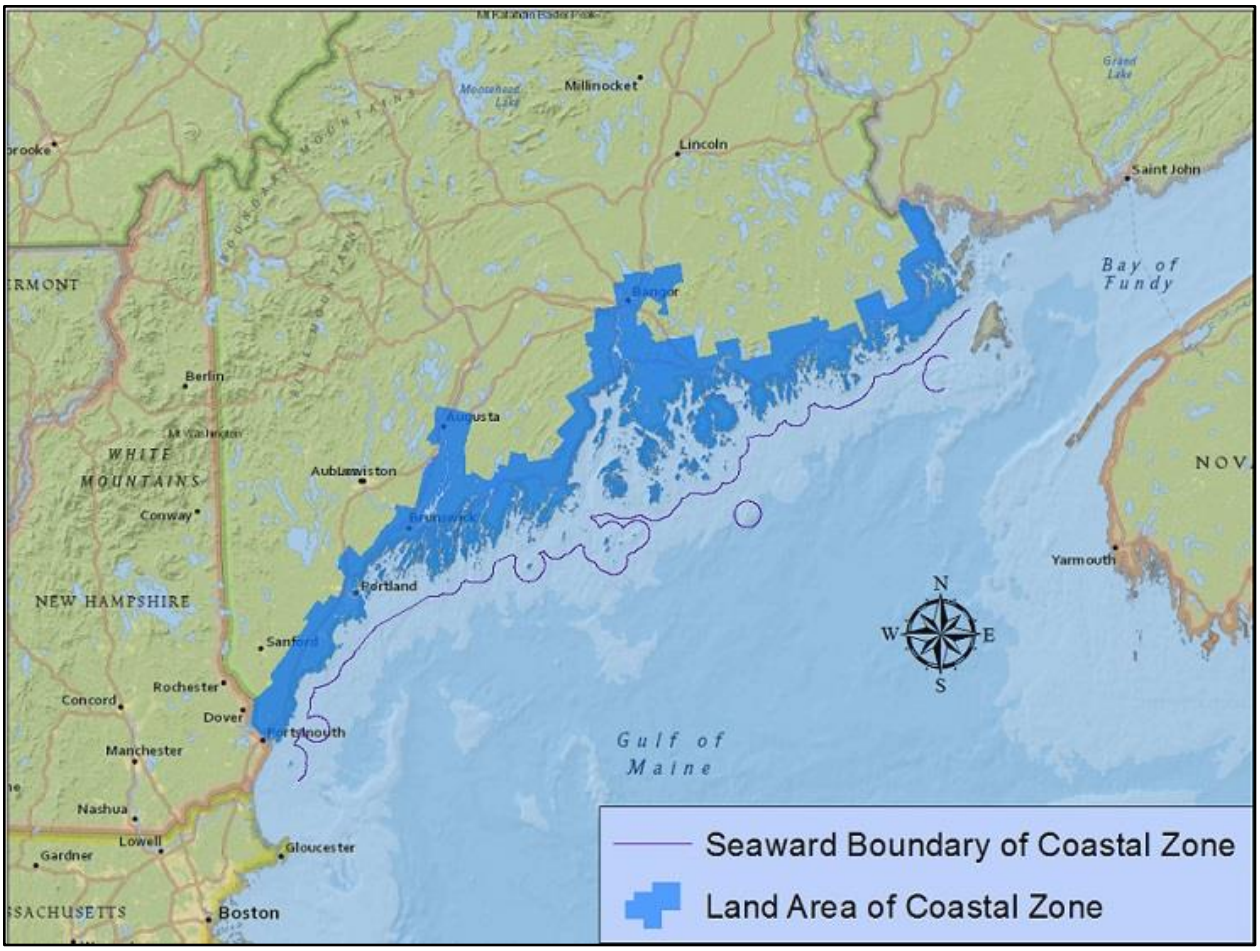

Figure 1: Coastal Zone Map. This map displays Maine's coastal zone as defined by the Department of Marine Resources' Coastal Zone Program. For a full list of towns and cities included in the zone, please see the DMR website (2016a).

5 WHO RESPONDED TO OUR SURVEY?

5.1 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 the majority of 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 Figure 2). 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.

Demographics	Gender (% female)	Median age	Median household income
2017 Maine coastal population†	51.2%	44.1 yrs.	$57,123
Marine Aquaculture Survey respondents	36.3%	63.0 yrs.	$87,500

	Ed. (bachelor's +)	Unemployment rate
2017 Maine coastal population	31.3%	5.0%
Marine Aquaculture Survey respondents	66.1%	2.6%

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.

5.2 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.[6] 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.[7] The median household income of our respondents is approximately $87,500.

5.3 Residence Information, Ocean Access and State Regions

On average, respondents lived in Maine for 38.5 years (standard deviation = 21.5 years). Almost all of our 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 or not respondents could see or access the ocean from their residence;[8] 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.[9]

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 4). 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[9]. Despite this the response rates by region were not statistically different.

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[6] The sum of these percentages will exceed 100% since some of our respondents fell into multiple categories.

[7] Related work surveyed commercial lobstermen, including their aquaculture preferences. Contact Dr. Teresa Johnson for more information. Email: teresa.johnson@maine.edu. Telephone: 207.581.4362.

[8] This question may impact responses to survey questions about aquaculture and working waterfronts. Residents who cannot see or access the ocean from their home may not be as familiar with these industries.

[9] Later in this report we share that only 45.1% of respondents said they have seen aquaculture farms in the state. The high percentage of respondents that can neither see nor access the ocean from their home is a potential explanation for this.

[9] 8,000 surveys were sent out to coastal Maine residents with 3,150 sent to the Southern region, 1,595 sent to the Mid-Coast region, 1,003 to the Acadia region, and 252 to the Downeast region.

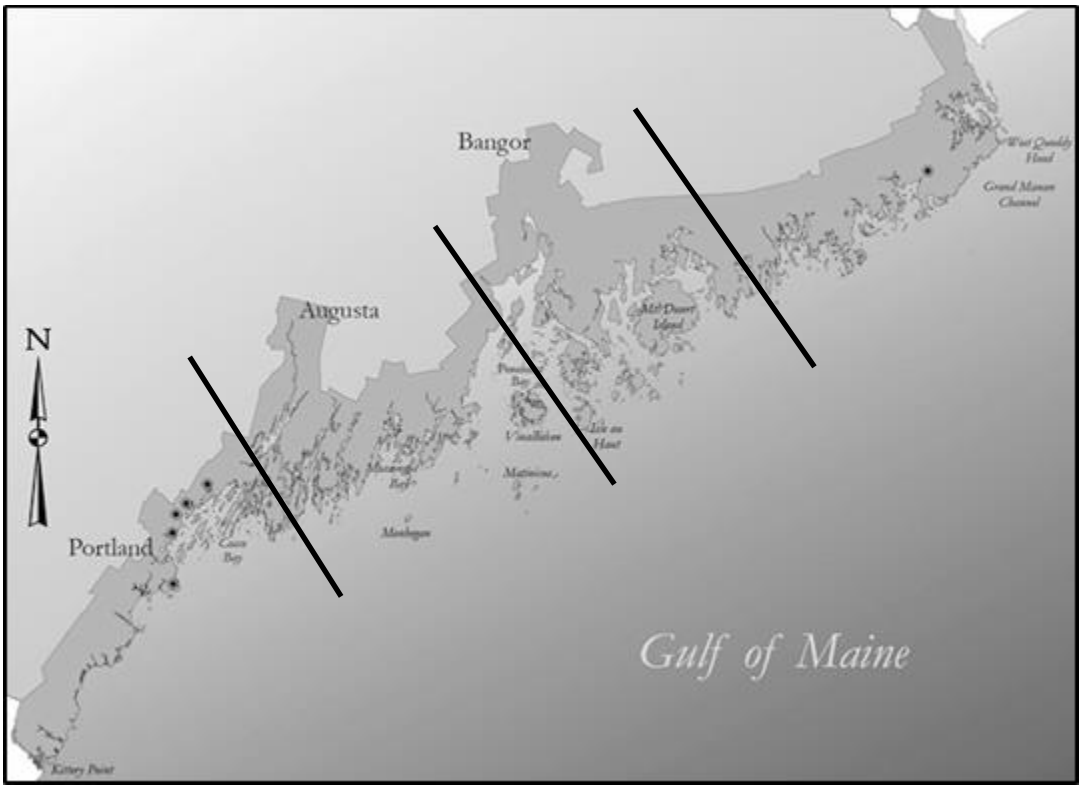

Figure 4: A map of Maine showing the coastal region.. The four regions going from the bottom left to the top right of the map are the Southern region, the Mid-Coast region, the Acadia region, and the Downeast region.

6. Findings

6.1 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 the site selection process for these farms, and (3) familiarity with seafood and aquaculture products.

6.1.1 Familiarity with Aquaculture Farms

To measure familiarity with aquaculture farms, we asked a series of questions beginning with whether or not 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.[10] 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 (circled a 3 or 4 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).

6.1.2 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. In order 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."[11] 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

[10] This higher level of exposure to shellfish aquaculture may be a function of the larger proportion of respondents located in Mid-coast and Southern regions of Maine where many shellfish farms are located. Conversely, a low proportion of respondents from the Washington and Acadia regions is a potential cause for a lower level of exposure to finfish aquaculture.

[11] Options 1, 2, and 3 are all correct depending on the type of aquaculture farm (e.g. shellfish or finfish).

Bay regions of Australia also had moderate to low levels of familiarity with the "government's role in aquaculture," (p. 606).

6.1.3 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 4 through 6 below.

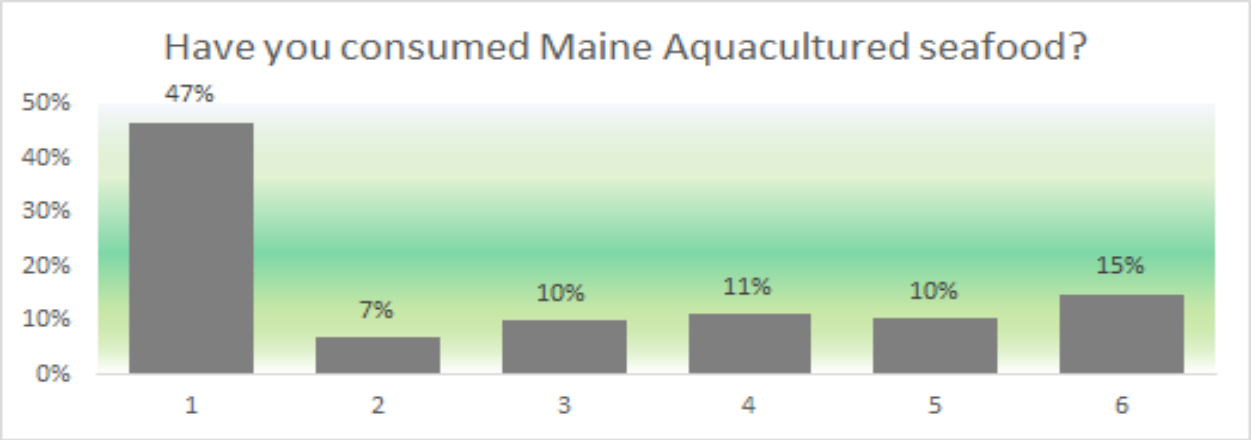

Figure 4: Knowledge of having consumed Maine aquaculture. A majority of all respondents (53.3%) circled a 1 or a 2, implying high confidence in having consumed Maine aquacultured seafood. In contrast, only 25.4% circled a 5 or a 6, implying high confidence in having never consumed Maine aquacultured seafood.

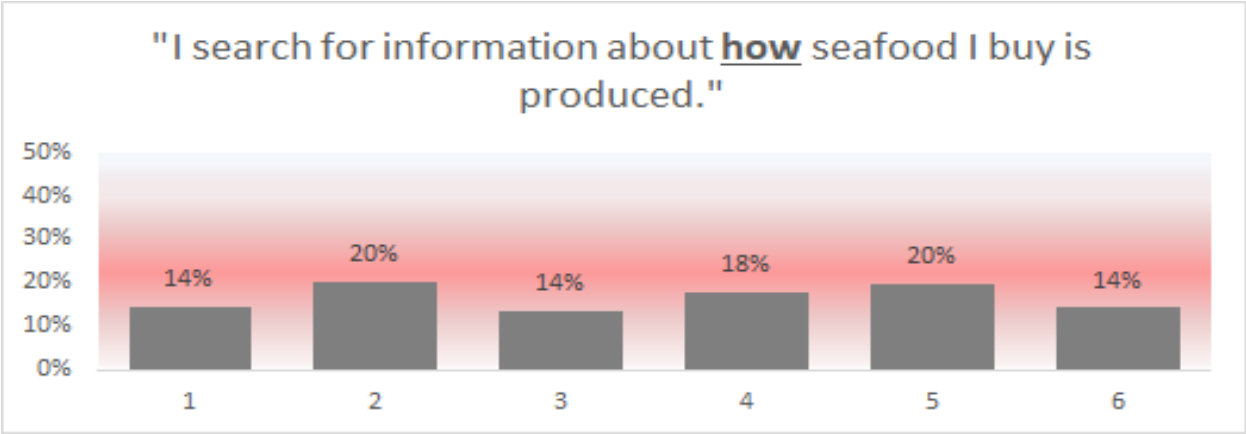

Figure 5: Information-seeking behaviour concerning seafood production method. 51.8% of respondents expressed a tendency to seek such information.[12]

[12] Results from Figure 5 are supported by those of Vanhonacker et al. (2011). This paper asserted that the various consumers taking part in their study had "rather limited awareness … of fish having either farmed or wild origin," (p. 540). Since only about half of our respondents expressed a tendency to seek such information, this might be an area of limited familiarity when it comes to seafood.

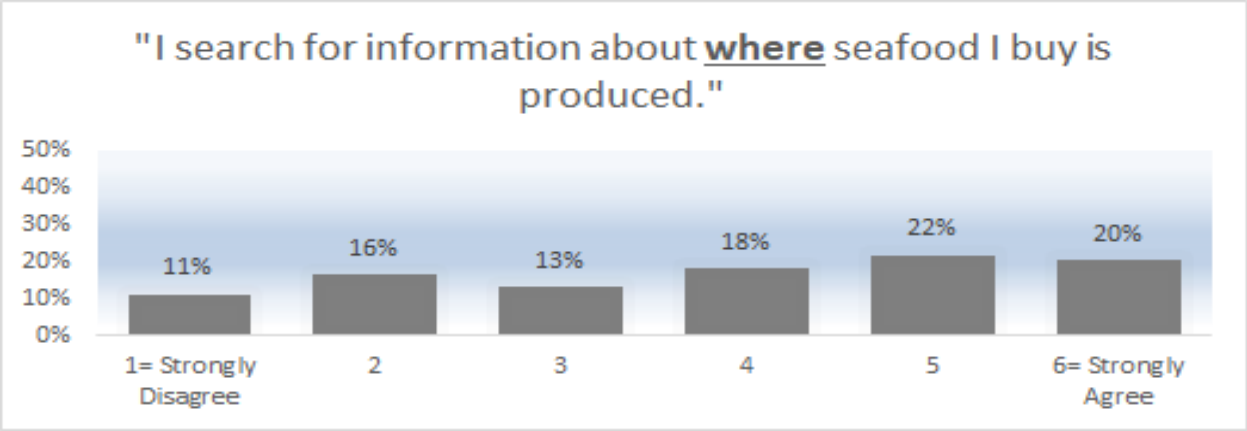

Figure 6: Information-seeking behavior for production location of seafood purchases. 59.8% of respondents tend to seek such information.

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.

6.1.4 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.[13] We explore differences across respondents in section 6.1.5.

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 of our 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 our 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).

[13] Murray et al. (2017) reported on SEANET's national Aquaculture Survey, whose respondents also expressed a desire to increase their level of familiarity with aquaculture. For example, respondents felt a *need* to know more about the topic, which explains why 66.2% of them expressed at least some agreement with being likely to "seek more information on aquaculture," (p. 21). Our respondents (Maine coastal residents) have a higher level of desired familiarity with aquaculture than respondents to the national survey.

6.1.5 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.

6.2 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.

6.2.1 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 7). Our results differ by region within Maine (Figure 8) 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).

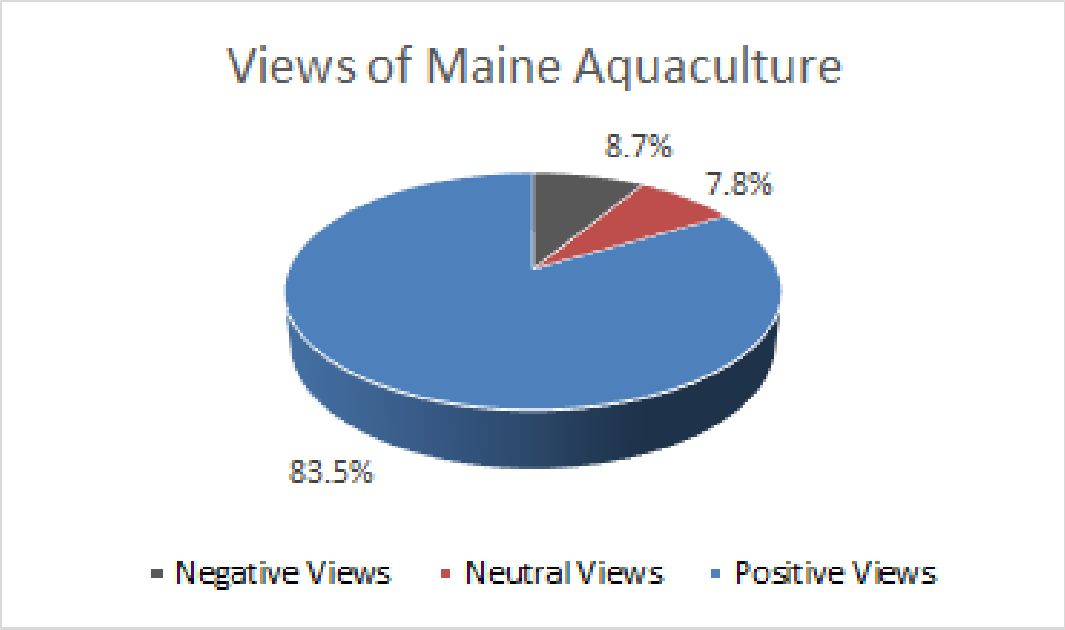

Figure 7: Responses to "Overall, your view of Maine's marine aquaculture are…?" (1 = very negative, 6 = very positive), 83.5% had somewhat positive to very positive views, while 8.7% had somewhat negative to very negative views. 7.8% of respondents remained neutral.

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, a large portion of that 72.3% circled a 4 (about 65.8%). 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 <u>not</u> 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".

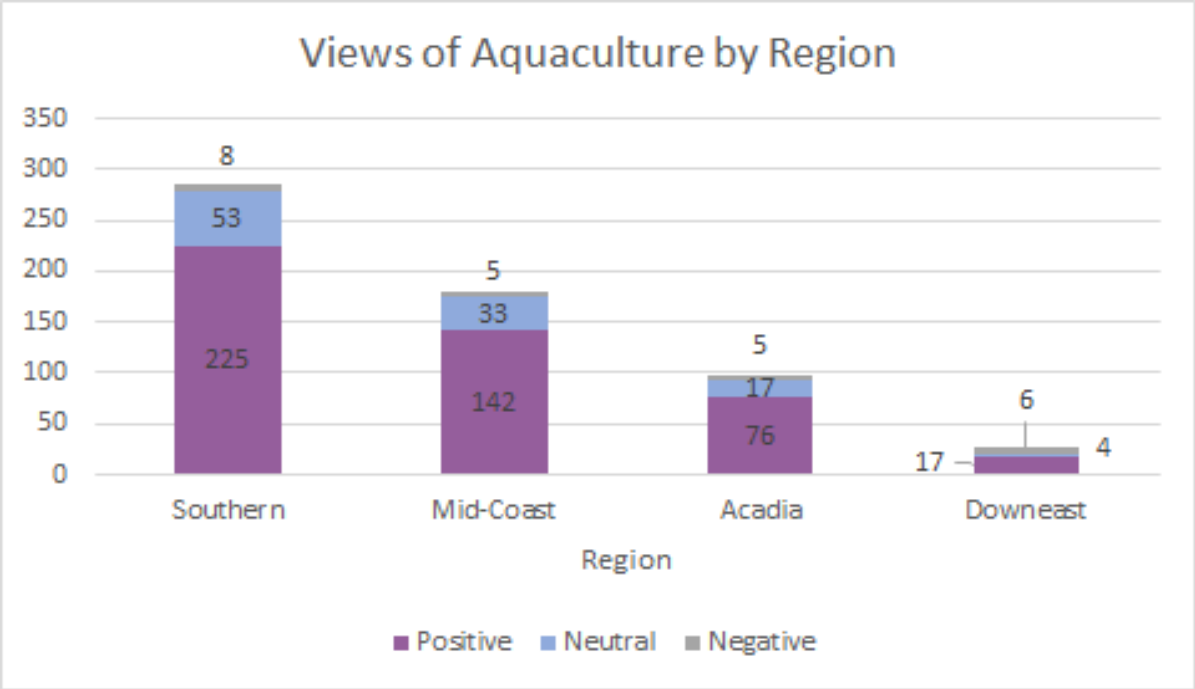

Figure 8. Responses to "Overall, your view of Maine's marine aquaculture are…?" (1 = very negative, 6 = very positive) split up by region. You can see a fairly consistent positive view of aquaculture witha slightly higher percentage of Acadia and Downeat citizens responding with either a Neutral or Negative 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).[14] 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?" most respondents (68.3%) tended to disagree, circling a 3 or lower on a six-point scale. However, 59.6% of our 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

[14] Respondents to SEANET's national survey responded somewhat differently, with 64% tending to agree that "[Aquaculture] operations can alter views, create noise, or introduce new smells," (Murray et al., 2017, p. 19).

aquaculture in relation to commercial fishing from these questions. Interestingly a majority of our respondents (68.8%) felt aquaculture "has the same problems as some types of land-based agriculture."[15]

6.2.2 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 positive, than those who responded with a 3 (119), closer to negative. Responses varied when viewed by level of exposure to aquaculture, respondents who had seen aquaculture averaged slightly higher (i.e more psotive) 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

6.2.3 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.[16] 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

[15] Similar to these findings, 80.9% of SEANET's national survey respondents "lean[ed] toward agreeing that [aquaculture] has the same problems as land-based agriculture," (Murray et al., 2017, p. 19). Indeed, aquaculture has historically factored into nutrient loading, as have other types of land-based agriculture (Goldburg, Elliott, & Naylor, 2001).

[16] Our survey also included an information experiment seen by roughly half our respondents. This experiment contained data on the number and type of jobs aquaculture provides to the state as well as the annual value of its products (among other things). The potential effects of this information treatment are not analyzed here.

asked to select their level of agreement on a scale of 1 to 6. The first statement was: "aquaculture lowers the price of seafood." A majority of 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[17] 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).[18]

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 10). 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[19] 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

[17] Statistical significance, in this case, was found using a one-sided T-test with a P-value less than 0.001.

[18] Research from Evans et al. (2017) examined the effect of aquaculture on residential property values along three dimensions: density, acreage, and proximity of farms. Dimensions were quantified for the Casco Bay, Damariscotta River, and Penobscot Bay regions. The authors found that aquaculture's effects were statistically and economically significant in only one region—Penobscot Bay. Here, aquaculture was found to have a negative effect on property prices across all three dimensions. The authors hypothesized this was due to the region's "reliance on the natural quality of its environment" for sustaining its ecotourism industry (p. 263).

[19] Statistical significance was found by using a Chi-squared test with a P-value of 0.26

waterfronts," nearly 84% of respondents 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 .

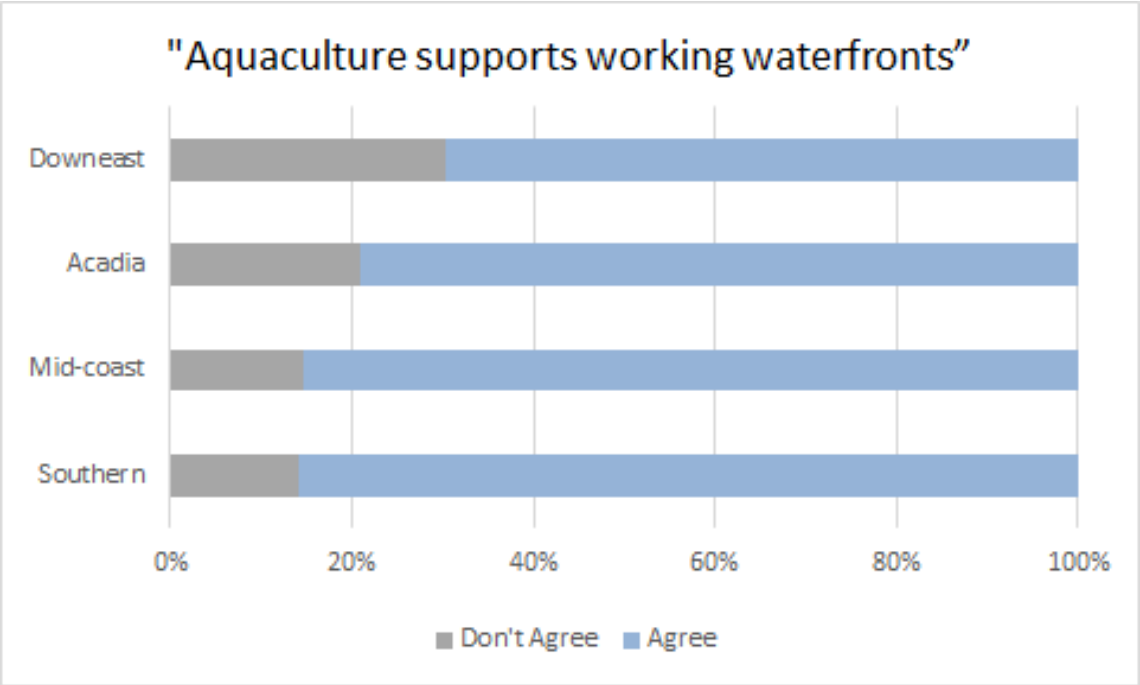

Figure 10: "Aquaculture provides good jobs to coastal residents." Respondents tended to agree with this statement, as 84.5% selected a 4 or higher on a six-point scale.

6.2.4 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) .[20] Our next statement was "aquacultured seafood is less

[20] Environmental impacts associated with aquaculture may include "(1) biological pollution [e.g. fish escapes], (2) fish for fish feeds, (3) organic pollution and eutrophication, (4) chemical pollution [e.g. drug effluents from

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 (see Figure 11). Research by Flaherty et al. (2019) supports this finding, as 60% of their respondents also believed "aquaculture relieves pressure on wild stocks," (p. 27).[21]

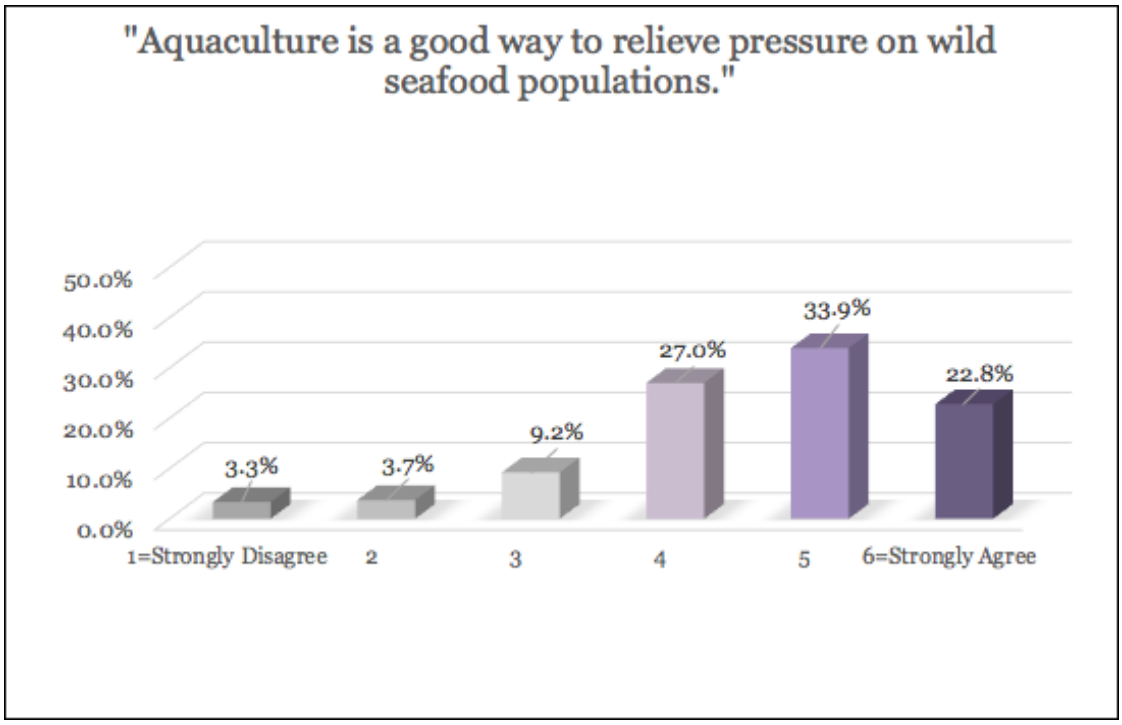

Figure 11: "Aquaculture is a good way to relieve pressure on wild seafood populations." Respondents rated their agreement with this statement on a scale of 1 to 6, where four or higher indicates some level of agreement. Roughly 83.7% circled a four or higher.

6.2.5 Summary & Comments

Most of our 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

aquaculture farms], and (5) habitat modification," (Goldburg et al., 2001, p. 6). Given the high mean age of our respondents, some might also remember an event from December of 2000, when a large storm "resulted in the escape of 100,000 salmon from a single farm in Maine" (Goldburg et al., 2001, p. 7). Farmed fish escapes such as this one can negatively impact the environment by "flooding the wild salmon gene pool," (p. 7).

[21] It is important to note that the value "60%" is an average of responses from residents on either side of Canada's coast—both Atlantic and Pacific—and that responses differed between regions. In fact, only 48% of respondents on the Pacific coast (British Columbia) believed "aquaculture relieves pressure on wild stocks," (Flaherty et al., 2019, p. 27).

these perceptions of aquaculture are positive, our study did reveal potentially negative perceptions. Many of our 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.

6.3 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.

6.3.1 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.[22]

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 or not 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.

[22] A recent study in Rhode Island suggested that intensity of operations (e.g. number of boats or visibility of equipment) is a factor in the level of public support for shellfish aquaculture, not just the size of these aquaculture farms (Dalton et al., 2017).

6.3.2 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). A majority of 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 our respondents were neutral (35.2% circled a 3 or 4). On the whole, *research* would be welcomed by most respondents, as 56.5% circled a 5or higher (see Figure 12). 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).

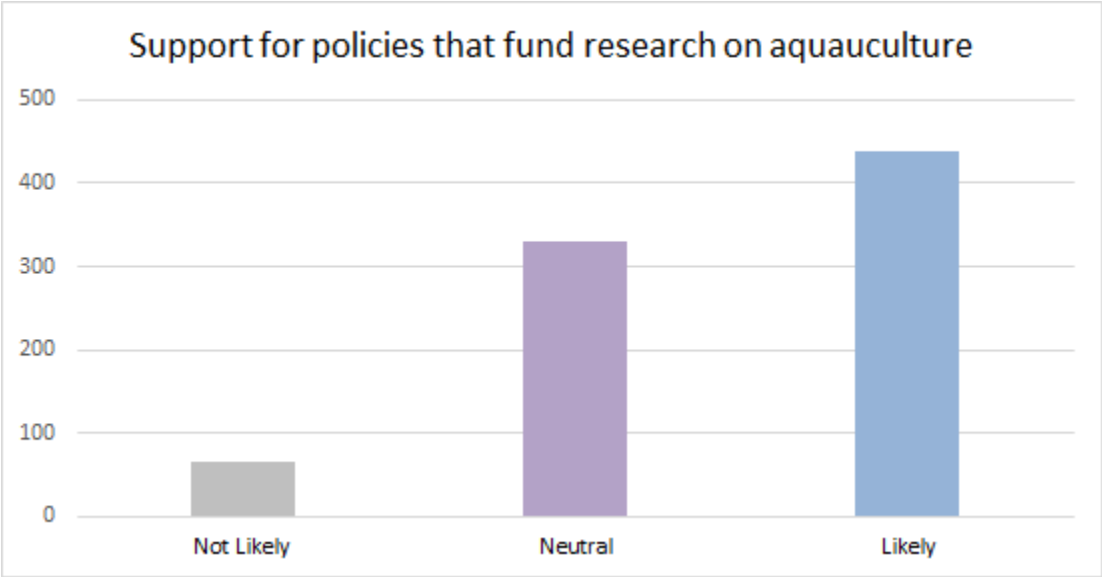

Figure 12: Support for policies that fund *research* on aquaculture. 82.7% of our respondents indicated support for such policies by circling a 4 or higher on a 6-point scale.

Respondents 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 our respondents appreciate this opportunity.[23] As reported previously, very few of our 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

[23] As explained in sections 2.08 and 2.64 of Chapter 2 in the DMR's Procedural Rules, riparian landowners within 1,000 feet of a proposed standard or experimental aquaculture lease are notified upon completion of the application, and public comments are solicited. In addition, public notices are placed in local newspapers, on the DMR website, and through email to those enrolled on the list.

were eligible to answer this question,[24] 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 a question for future studies.

Public comment processes allow respondents to voice potential concerns about aquaculture development. For example, 96.6% of our 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.[25]

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 of our respondents found these options to be mutually exclusive. For example, about 66% of respondents circled a 4 or higher when asked if they support "set[ting] 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.

6.3.3 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 our 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

[24] This question had a response rate of 9.2%.

[25] Research from Scotland examined public and stakeholder attitudes toward various environmental and socio-economic impacts of salmon aquaculture and found that both groups generally assign less importance to its aesthetic impacts than they do to other impacts like employment, pollution, the fish supply, or effects on wild salmon stocks (Whitmarsh & Palmieri, 2009).

disagree. It's 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 our 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 [26]. 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 the majority of respondents (61.1%) who felt the current rate of aquaculture development is satisfactory.

[26] Respondents were given the information that currently less than 1% of Maine's coast is currently used for aquaculture.

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 3 and were asked to "check one box for each row."[27] 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 13. Importantly, we found that regional support differed significantly for two regions—Acadia and Downeast—where more support for aquaculture expansion came from <u>outside</u> these regions than from within them.

MAINE COASTAL REGIONS	RESTRICT	EXPAND
SOUTHERN REGION (York and Cumberland counties)	☐	☐
MID-COAST REGION (Lincoln, Knox, Waldo, and Sagadahoc counties)	☐	☐
ACADIA REGION (Hancock county)	☐	☐
DOWNEAST REGION (Washington county)	☐	☐

Table 3: 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.

[27] Only respondents who previously expressed a desire to allow aquaculture in Maine were eligible to answer this question.

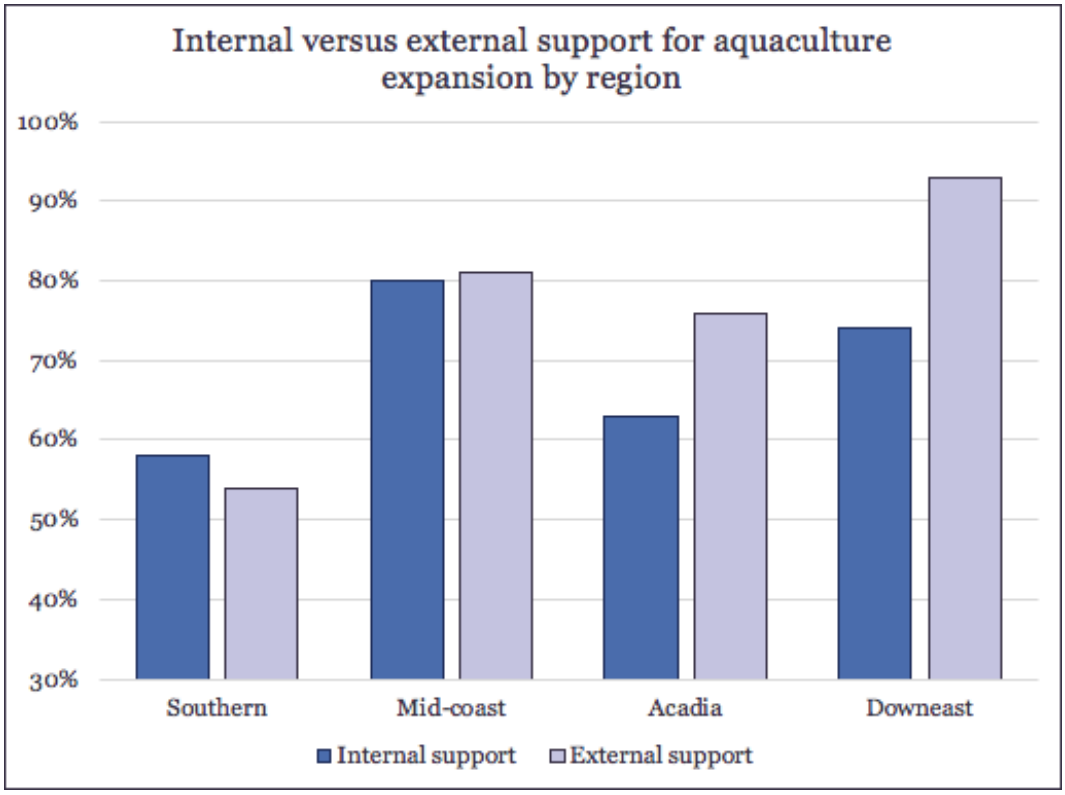

Figure 13: Maine's support for Aquaculture Expansion by region. A majority of respondents support expansion across all regions, however residents from Acadia and Downeast express comparatively less support for expansion inside these regions than do residents from outside these regions.

6.3.4 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 aquaculture. 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).[28] 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

[28] Respondents from the Downeast and Acadia regions reported the lowest average income when compared to respondents from the Mid-coast and Southern regions.

awareness is correlated with increased support for aquaculture). Future research will try to further understand differences in regional support.

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 our respondents (although not a majority) indicated dissatisfaction with the current permitting process, which makes the mandatory public commenting period all the more important since policymakers may use this information to amend the current process and tailor it to respondents' preferences.

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 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 questions 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.

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