2017

2017 National Aquaculture Survey Results

TECHNICAL REPORT

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Sustainable Ecological Aquaculture Network (SEANET)

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Many of our questions are a response to information needs of important stakeholders, as well developing research questions about aquaculture knowledge, attitudes, and perceptions. The generosity of several stakeholders, researchers, and colleagues has helped to create and analyze this survey.

Executive Summary

This report summarizes findings from the Sustainable Ecological Aquaculture Network (SEANET) 2017 National Aquaculture study, administered by The GfK Group[1] and designed by the University of Maine SEANET Human Dimensions research team. The purpose of the study is to further our understanding of consumer and citizen decision making in regard to sustainable aquaculture. To do this, we examined U.S. resident perceptions of, knowledge of, and attitudes towards sustainable aquaculture through use of an online survey. In this survey we also sought to learn what sources of scientific information our participants utilize in making aquaculture decisions, and factors that influence their use of these materials.

Key findings and implications from this survey include:

- There is relatively low awareness amongst citizens of the U.S. of the risks, benefits, effects, and practices associated with the aquaculture industry. Perceptions of and attitudes towards aquaculture are moderate, which provides an opportunity for public opinion of aquaculture technology to be molded.
- Extensive education efforts should be made to spread awareness of aquaculture to help solidify citizen opinions of the industry.
- Awareness of aquaculture differs across demographics groups. Appropriate methods for aquaculture information dissemination will also vary across these groups. Respondents who are older, less-educated, and live in inland states are likely to need more aquaculture information than others.
- Respondents indicate a largely positive attitude towards scientists and scientific research, indicating that aquaculture information may be best presented through a scientific framework. Television, social media, and product labeling may be the best mediums for further information provision.
- Younger, less-educated participants seem to be critical of aquaculture initiatives, while those living in inland states appear to be less interested in general. Interest and engagement with aquaculture also increases with higher frequencies of seafood consumption.
- Citizens prefer that coastal development be allocated towards food production and recreation rather than energy production. AQ expansion is likely to be more feasible if efforts do not compromise recreation habits of coastal residents and visitors.
- Respondents seem to be more accepting of domestic aquaculture expansion rather than international.

[1] For more information on the GfK group, please visit their website; http://www.gfk.com/en-gb/

Introduction

The importance of aquaculture, which can be defined as the farming of finfish, shellfish, and aquatic plants, is growing in coastal communities, including those in the state of Maine. With economic, cultural, and ecological shifts troubling coastal Maine communities, increasing aquaculture operations can have positive impacts on these towns. Aquaculture, when practiced sustainably, can work to feed the nation's population, while also fostering economic development in coastal towns that rely heavily on the fishing and tourism industries for their survival.

The survey results presented in this technical report are a part of research conducted by the research team affiliated with SEANET Theme 4: *Human Dimensions of Sustainable Aquaculture* at the University of Maine. The Human Dimensions aspect of the SEANET[2] project seeks to identify barriers to and opportunities for aquaculture development with reference to stakeholder and community needs. This survey specifically assesses consumer perceptions of, knowledge of, and attitudes towards sustainable aquaculture, which is particularly helpful in evaluating the decision-making, communication, and engagement of consumers in regard to sustainable aquaculture (henceforth referred to as AQ).

[2] For more information about SEANET related research, please visit https://umaine.edu/seanet/.

Survey Overview

The survey was administered by The GfK Group and designed by the University of Maine SEANET Human Dimensions research team. A sample was obtained using KnowledgePanel, a web-based panel designed to be representative of the United States. The target population was identified to be non-institutionalized adults (18+) living in the United Sates, with English-language survey takers. 1210 responses were collected. Standard survey protocol compensates participants for their time (Dillman, Smyth, and Christian, 2014), thus participants were rewarded with 1,000 points on their KnowledgePanel account for completing the survey. Data collection was performed in January and February of 2017. Average time taken to complete the survey was 24 minutes.

What did we ask?

Seafood Consumption and Information Seeking Behavior

- Frequency and variety of seafood consumption
- Information seeking behavior
- Perceived locations of high quality seafood products

Preferences for Marine Use

- Use preferences for marine development and food production
- Perception of current U.S. coastal use allocations

Awareness of Aquaculture

- Perception of current and desired personal AQ knowledge

Aquaculture Consumption and Product Origin Knowledge

- Knowledge of personal AQ product consumption
- Knowledge of AQ product origin and production methods

Aquaculture in the News

- Knowledge of both positive and/or negative aquaculture presented in the news
- Feelings towards AQ presented in the news

Perceptions of Aquaculture

- Feelings towards AQ practices and products
- Willingness to engage in practices that are supportive of AQ
- Objective knowledge through AQ 'myths'
- Perception of risks vs. benefits

Governance and Aquaculture

- Perceived credibility of government officials, university scientists, and AQ industry representatives as AQ information sources

Socio-Demographic Information

- Standard demographics
- Coastal visitation, recreation, and attitude tendencies
- Perception of climate change and scientific research

Who participated?

The age of respondents varied from 18 to 94, with an average age of 50 years old. There was roughly a 50/50 split of male and female respondents, with most being white (70%). Most respondents (92.3%) had at least a high school education, with 34% having earned at least a Bachelor's degree, indicating a well-educated sample. Political leanings tended to be more conservative with respect to both social and fiscal issues.

Roughly half of the respondents report household income levels between $40,000 and $125,000, indicating an economically varied sample. Most respondents lived in single family detached homes in metropolitan areas, with the most common regions being the South Atlantic (20.6%), Pacific (16.2%), East-North Central (16.0%) and Mid-Atlantic (13.7%) (Appendix A-1). A majority of respondents (89.4%) lived in households where there were 1-3 adult occupants, and were either working as a paid employee (51.2%) or were retired (23.4%).

Employment status and income levels varied by coastal region (Appendix A-2). Most paid employees lived on the East coast, while most self-employed, retired, or disabled respondents lived in inland states. Respondents hailing from the West coast tended to be wealthier, while Gulf coast respondents reported lower incomes. Respondents from East coast and inland states seemed to be more economically diverse (Table 1).

Table 1: Income Levels by Coastal Regions

	West Coast	East Coast	Gulf Coast	Inland
$>25K	20.4%	21.3%	24.0%	18.4%
$25-75K	13.3%	14.8%	26.0%	25.5%
$75-100K	26.5%	22.5%	21.0%	28.2%
$100-150K	18.9%	21.6%	15.0%	17.4%
$150K+	20.9%	19.8%	14.0%	10.6%

How did we analyze our data?

Survey response data was analyzed with SAS 9.4 (**SAS** Institute Inc., 2013). Chi-square tests of distribution differences, t-tests, and analysis of variance (ANOVA) tests were most frequently used for analysis of responses. Reported frequencies that were less than 5% were omitted from applicable figures. Word clouds were also generated using wordclouds.com to reflect qualitative data from open-ended responses. The relative size of the text reflects the relative frequency of the word. Survey respondents who answered either "I don't know" or refused to answer the question were omitted for the purpose of this report.

Findings

Seafood Consumption and Information Seeking Behavior

Frequency of seafood consumption and purchasing plays a role in consumer perceptions of AQ. When asked about seafood consumption, most participants indicated consumption of seafood once a week or once a month (Figure 1). Products consumed by respondents most often were fish (88.4%) and shrimp and/or scallops (72.3%).

About half of our respondents actively seek information about the seafood products they chose to purchase (48.5%), with the most sought-after information being the country of origin (70.2%), followed by how the seafood is produced (47.3%). Females, those with a college education, and those 55 or older tend to seek information most often. Information seeking habits also depend on seafood consumption frequencies; the more often seafood is consumed, the more likely a consumer is to seek information about seafood products. We would expect that frequent seafood consumers will desire information about AQ products, particularly the commonly consumed seafood products, in order to feel more comfortable purchasing and consuming those products.

Respondents were asked to write what areas came to mind when they thought of high quality seafood. Frequently cited answers included the Pacific Northwest (Alaska, Oregon, Washington) (44.2%) and New England (Maine, Massachusetts) (41.5%), as seen by the large text responses in the following word cloud (Figure 2). Respondent perceptions are relatively in line with the current largest AQ production states and comparable to U.S. wild-caught fishery production; Maine, Washington, Virginia, Louisiana, Hawaii, Mississippi, and Idaho ("Basic Questions about Aquaculture," 2012) (United States, Congress, Office of Science and Technology, and David Van Voorhees.). Since 45.8% of respondents report looking to see if their seafood purchases are from a high quality region, it will be useful to establish a high quality seafood reputation for states interested in AQ expansion.

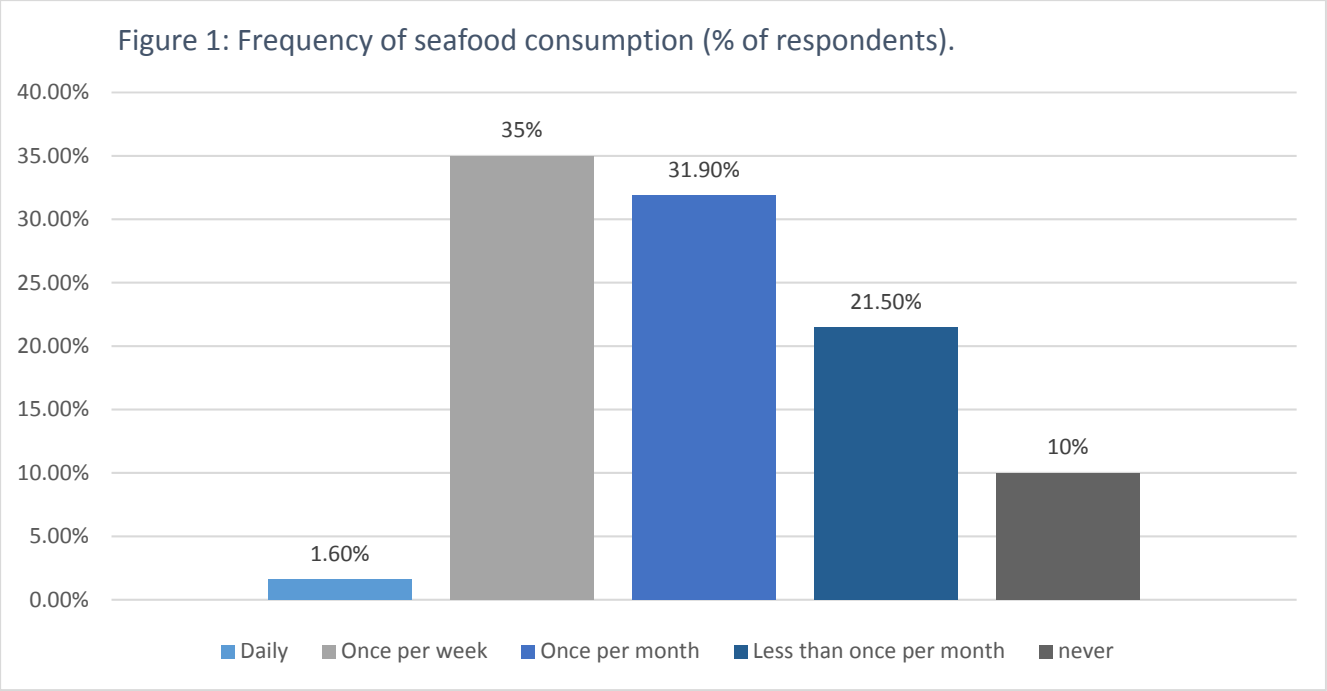


Figure 2: Perceptions of high quality seafood areas (n= 224).

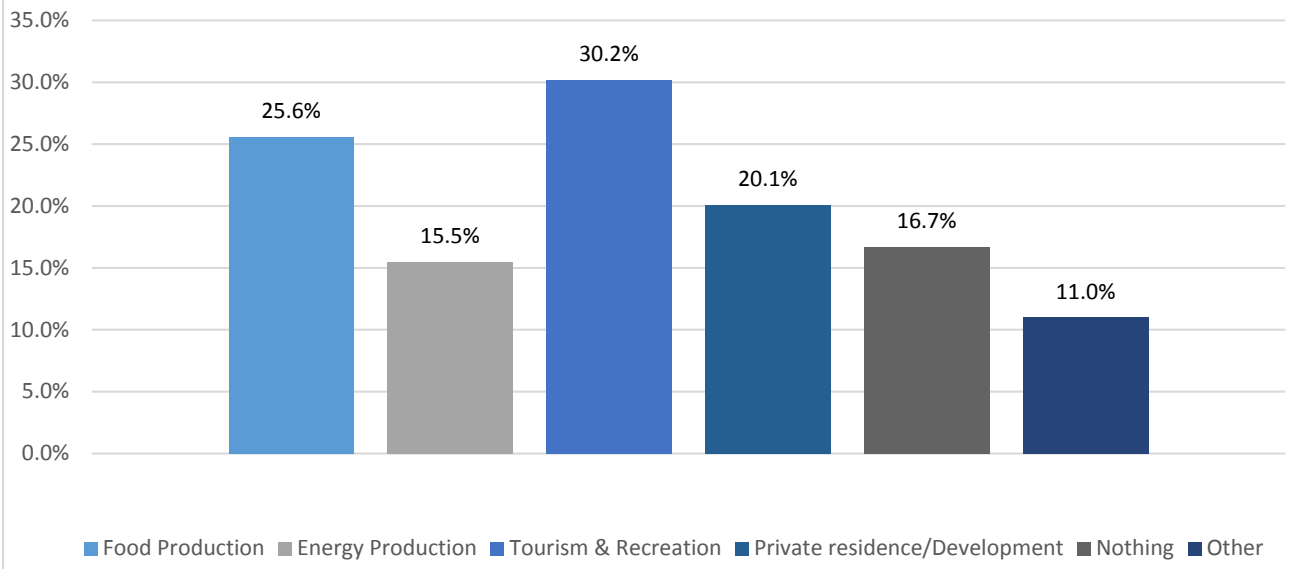
Preferences for Marine Use

Marine AQ is likely to have a variety of impacts on coastlines, both positive and negative. Potential impacts, including habitat destruction, ecosystem exploitation, and pollution, could instigate negative citizen perceptions of the industry (Ducrotoy, 2008). However, other effects, such as food security, job creation, and improved coastal water quality could impart positive citizen perceptions (Pérez-Sánchez & Muir, 2003) (Shumway et al., 2003). In order to gauge citizen perspectives on the importance of coastal food production, survey respondents were randomly assigned to a group consisting of two of the following three coastal use categories; energy production, food production, and recreation. They were then asked how they would chose to allocate their two coastal uses on a percentage scale.

Between food and energy production, respondents chose to allocate more coastal development space to food production. In addition, a significant portion of respondents preferred allocating development space to recreation rather than energy production. Overall, there was no significant difference between allocation of food production and recreation, though inland citizens tended to prioritize more towards food production. Based on survey results, it can be said that there is a significant difference in citizen preferences for marine development when presented with the options of energy production, food production, and recreation. Energy production is least preferred to nearly all respondents, while food production and recreation are nearly equal. While participants do value food production, these results indicate that recreation cannot be overlooked when developing coastal areas for AQ. The perceived potential impacts of AQ listed above could jeopardize recreation habits, so in order to gain citizen support it will be important to ensure that expansion will not compromise recreation.

When asked on a scale of 0-100% how they perceived United States coastline was currently used, respondents indicated tourism and recreation, as well as food production, to be the major uses. Energy production was ranked low (Figure 3). The perception of current coastal use in the United States is similar to citizen preferences for marine development allocation as discussed above. Whether these responses are related because citizens actually believe it to be true, or because it is what they would prefer to think, it could be useful for AQ representatives to know the thoughts and preferences of citizens when expanding coastal operations in the future.

Figure 3: Citizen perceptions of current U.S. coastal use allocations; categories ranked on a percentage scale from 0-100% (averages reported).



Awareness of Aquaculture

Our survey intended to capture citizen knowledge of AQ to better understand the extent to which further information may be needed. When asked the open-ended question "When you think of aquaculture, what comes to mind?" participant responses were varied. 17% percent of answers indicate that participants had no knowledge of AQ, stating that they "don't know," know "nothing," or have "no idea." Over one-third of respondents (35.2%) had some indication of what AQ is, using terms such as "farm-raised," "agriculture," "production of food in water," "breeding of fish," and "hydroponics." One quarter of answers (25.5%) indicate that respondents are unclear about AQ, expressing beliefs that range from "anything to do with water," "water use and development," "marine life," "water recreation," etc. (Figure 4). Given that only a small portion of participants had accurate impressions of AQ, it is clear there needs to be more widespread information about AQ practices available, so that citizens are well informed to make decisions about AQ operations and products.

Figure 4: Responses to "When you think of aquaculture, what comes to mind?" (n=1022).

Survey results reveal a gap in perceived knowledge vs. desired knowledge across genders, age groups, education levels, and regions of the U.S.. AQ industry representatives have an opportunity to inform specific target populations of citizens of the benefits, risks, and functioning of AQ based on these findings. When asked to rate their current knowledge levels of AQ on a scale from 0 to 100 (from knowing nothing to knowing everything), respondents indicated, on average, a knowledge level at 16.2 (Figure 5). When asked to specify how much they think they *need to know* about AQ on the same scale, the average was much higher at 42.8 (Figure 6). Those who frequently consume seafood, as well as east-coast state residents (most notably in New England) tended to rank their current knowledge levels higher. This may be attributed to New England's blossoming AQ economy (Lapointe, 2013). While males and young adults who rank their *current* knowledge levels high, females and older generations (55+) rank their *desired* knowledge higher.This indicates that there may be more potential for information acceptance within those demographic groups. Despite reporting lower levels of current knowledge, respondents from inland states also report lower levels of desired knowledge than those from all other coastal states, likely because the AQ industry is not prominent in these states and thus has less of a direct impact on those citizens. Respondents with at least some college education ranked their current and desired knowledge significantly higher, indicating that those with higher educations may be more interested in AQ expansion overall.

Survey respondents were asked what attributes they associate with Maine seafood. The most common responses were 'freshness' and 'harvested from the ocean'. Nearly all participants did *not* associate 'farm-raised seafood' with Maine products. Further research should seek to determine how AQ can maintain the characteristics of fresh, high quality seafood to preserve consumer interest and establish a positive association with farm-raised products. It might be worth focusing specifically on marine AQ development, which implies in-ocean farming methods, to uphold the ocean-harvested quality that respondents indicated.

Figure 5: Distribution of AQ – Know.

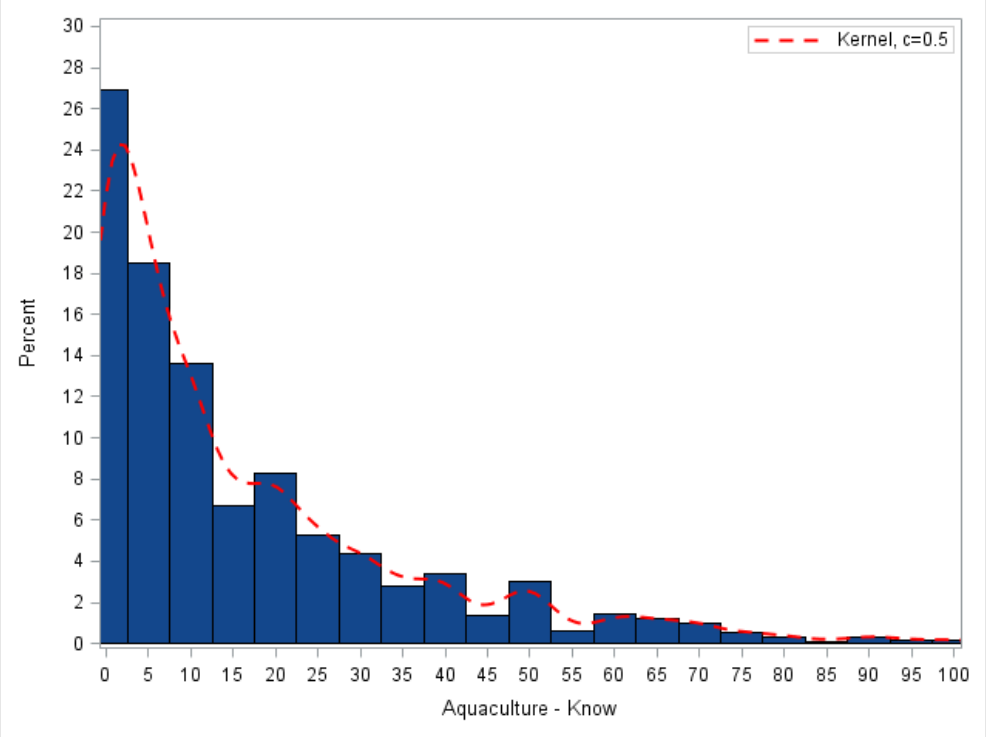
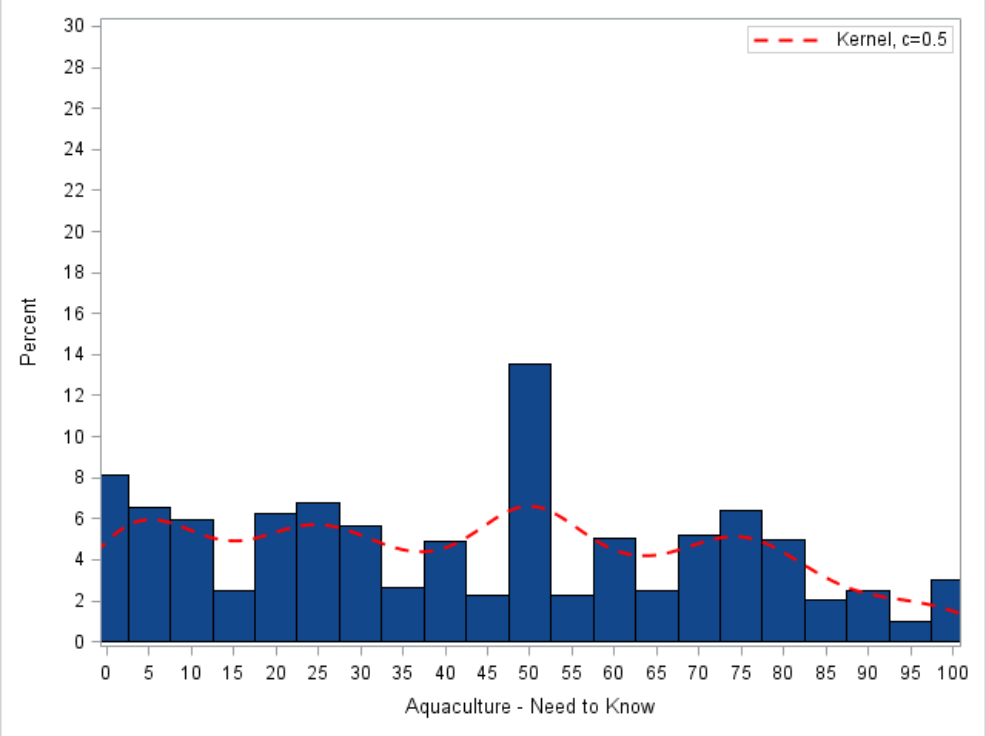


Figure 6: Distribution of AQ - Need to Know.



Aquaculture Consumption and Product Origin Knowledge

We explored whether or not participants knew if they have consumed AQ products to date; a majority of respondents (82.05%) said that they probably have (40.91%) or definitely have (41.14%). Those who report probably or definitely consuming AQ products tended to be residents of either New England, the South Atlantic, East-South Central, or West-South Central regions of the United States. This information is important moving forward in order to gauge where interest in AQ products already lies, and where it does not. Participants who reported frequently consuming seafood were more likely to be aware of AQ product consumption. Older generations and highly educated respondents (some college or more) also reported knowing that they have consumed AQ products more than other participant groups did, indicating more awareness of AQ across these demographic groups, likely because their seafood consumption levels are generally higher. Almost half of our sample (47.26%) were unsure if they had consumed AQ products, indicating that there may need to be improved labeling on packaging to increase awareness of AQ products.

When prompted to rate their agreement levels with statements regarding their personal seafood purchases, respondents, particularly those in coastal states, felt that they did know where their seafood purchases came from, and that both labels/packaging and seafood sellers could provide information about whether the product is farm-raised or wild harvested. Participants in coastal states also tended to feel as though wild-caught seafood is more readily available in their area than farm-raised products. Overall, there is more of a tendency towards respondents indicating that they do choose to be aware of their seafood purchases' origin, so it will be important for AQ producers to provide information about product origin to sellers and on packaging labels. In addition, previous research reveals that consumers also look to see if their seafood products are certified organic or produced in their local state. Consumers indicate a higher willingness to pay for products with these labels (Brayden, 2017). AQ operations that can produce products with these certifications may be more likely to be well received by seafood consumers.

A majority of participants (70.2%) had heard of neither New England nor Maine grown oysters. Residents of the East-North Central, East-South Central, and Mountain regions of the United States were especially unaware of these products. Areas of the United States that are far from the coast and/or do not have large fishing industries may be less aware of AQ practices and products.

Survey participants indicated that bottom-planting is the most preferred method of oyster farming, with cleanliness, taste, and animal welfare being the most important

deciding attributes[3]. Based on this information, it can be said that respondents may care more about the quality of the product rather than the impact of farming. If AQ products meet the quality standards that consumer's desire, the physical effects on local ecology and recreation may not be as critical in their purchasing decisions.

[3] A concern that emerged via the open ended response to this question indicated that survey participants were either confused or felt as though they did not have adequate information to answer this question.

Aquaculture in the News

Our survey informed respondents that several AQ debates have been presented in the news within the last 10 years. We collected data regarding their knowledge of these debates and where they may be obtaining their news in general. Awareness of these debates was relatively low, and information channels varied across age groups. Those aged 45+ report accessing television news more, while younger generations access social networking sites more for their news. When asked to identify any methods used to actively seek information about AQ, a large portion of respondents (69.17%) reported that they have not looked for information at all. Seeing how citizens generally do not actively seek information about AQ, knowing preferred information channels for each age group can help policy makers target their information accordingly moving forward.

Survey participants were randomly assigned to one of five groups, where four groups were asked to read one of four news articles regarding AQ, and a fifth (control) group received no article. (The articles were created by the researchers based on actual U.S. print news coverage of AQ in the last ten years). The articles framed aquaculture development in relation to either the United States or China, and as framed in either a positive (gain frame) or negative (loss frame) manner. Respondents that read articles related to U.S. AQ reported finding the article to be more persuasive, clear, and informative, regardless of the positive or negative framework. They also indicated feeling happier, more hopeful, and more excited than participants who read the article related to China. This may imply that there is more desire for domestic AQ than international. Participants who read articles framed positively reported feeling happier, more hopeful and excited, as well as less angry, guilty, and sad than participants who read negatively framed articles. This indicates that media portrayal of AQ may impact consumer and citizen perceptions.

Perceptions of Aquaculture

Thoughts and feelings towards AQ practices are varied. Most respondents (88.9%) tend to agree more than disagree that the AQ industry supports U.S. communities by providing a source of local jobs, however, some participants lean toward agreeing that AQ can alter views, create noises, and introduce new smells (64%), as well as interfere with recreation (68.6%). Respondents tended to agree that AQ is a good way to relieve pressure on wild fish populations and marine species (86.4%); however, they also lean toward agreeing that it has the same problems as land-based agriculture, including the use of processed feed and antibiotics, and being a source of pollution (80.9%). Some respondents indicated agreeing that farm-raised species are raised in cleaner and healthier environments (55.9%), and lean more towards disagreeing with the idea that AQ is unnatural (57%) and unethical (79.1%).

Age and education level of participants had a significant impact on perception of AQ practices. Older populations tend to agree with the ideas that AQ relieves pressure on wild fish populations and that AQ supports local communities by providing a source of jobs. Younger generations agreed more with the idea of AQ being unethical, indicating that younger populations may be more critical of AQ. Higher educated participants were more inclined to think that AQ has the same problems as land-based farming and that it can interfere with recreational activities. However, this group also acknowledged that AQ can relieve pressure on wild populations in comparison to those with less education. This indicates that highly educated participants are more likely to identify that there are ecological pros and cons to AQ operations.

Participants were also asked to rank how much they agree with given statements about AQ products. Most respondents lean toward agreeing that AQ produces a consistent, affordable product (85.3%) that grows more quickly than wild-harvest seafood (79.1%) and is healthy (85.3%), flavorful (71.4%), and efficiently produced (76.2%). There is some discrepancy on whether AQ raised seafood is safer for consumption, seeing that about half of participants tend to agree that farm-raised seafood is exposed to more pests and diseases (48.6%), but half of respondents also tend to agree AQ products are safer to eat than wild-caught seafood (49%). Furthermore, there is a negative correlation between these two responses, implying that participants who believe AQ products are safer for consumption also believe that the products are not exposed to more pests and diseases than wild-caught seafood.

Analyzing the likeliness of respondents to engage in supportive AQ behaviors can help to gauge citizen perspectives on AQ. Average responses reveal that most participants do

not feel strongly about acting in support of or in opposition to AQ (Figure 7). These moderate responses indicate that there may be potential to increase support for AQ operations. Age and education level are significantly important in the engagement of all supportive behaviors; participants aged 45+ and those with college educations are more likely to be supportive. This echoes previous findings that younger generations appear to be more critical of AQ. It will be important moving forward to determine why participants, particularly younger generations with less education, do not partake in supportive behaviors.

To further understand citizen perceptions of AQ, we asked respondents whether they think the benefits of AQ outweigh the associated risks. On a scale from 1 to 5, with 1 being "risks strongly outweigh benefits" and 5 being "benefits strongly outweigh risks," 48% respondents answered 3, indicating that, on average, feelings are "middle of the road" about the supposed benefits and risks. However, as seen in Figure 8, there is more of a leaning towards the benefits outweighing the risks. Males, those with college educations, and residents in both the New England and Mountain regions of the United States are more likely to think that the benefits of AQ outweigh the risks. Those who are frequent consumers of seafood products also tended to agree more with benefits outweighing the risks, indicating that seafood consumers may be in favor of purchasing and consuming more AQ products.

We also asked participants to indicate their agreement levels with common AQ myths. Responses indicate that there may be some false knowledge of certain AQ practices. A large portion of participants agreed that farmed salmon are supplemented with pink dyes identical to the pigment found in wild salmon, and that U.S. marine AQ operations rely heavily on the use of antibiotics for disease. There also appears to be some misconception with how much imported seafood the U.S. consumes, as 85% of respondents think that 41% of seafood consumed is produced outside the United States (Figure 9a). In reality, a much larger portion of seafood, closer to 80%, both wild-harvested and farmed, is imported ("Sustainable Seafood: The Global Picture"). Despite these perceptions, a large portion of our sample responded to each myth with "I don't know" as seen in Figure 9b, indicating a lack of awareness of aquaculture myths.

Figure 7: Willingness to engage in supportive aquaculture behaviors; categories are rated on a Likert scale from 1 (SD) to 6 (SA) (% of respondents).

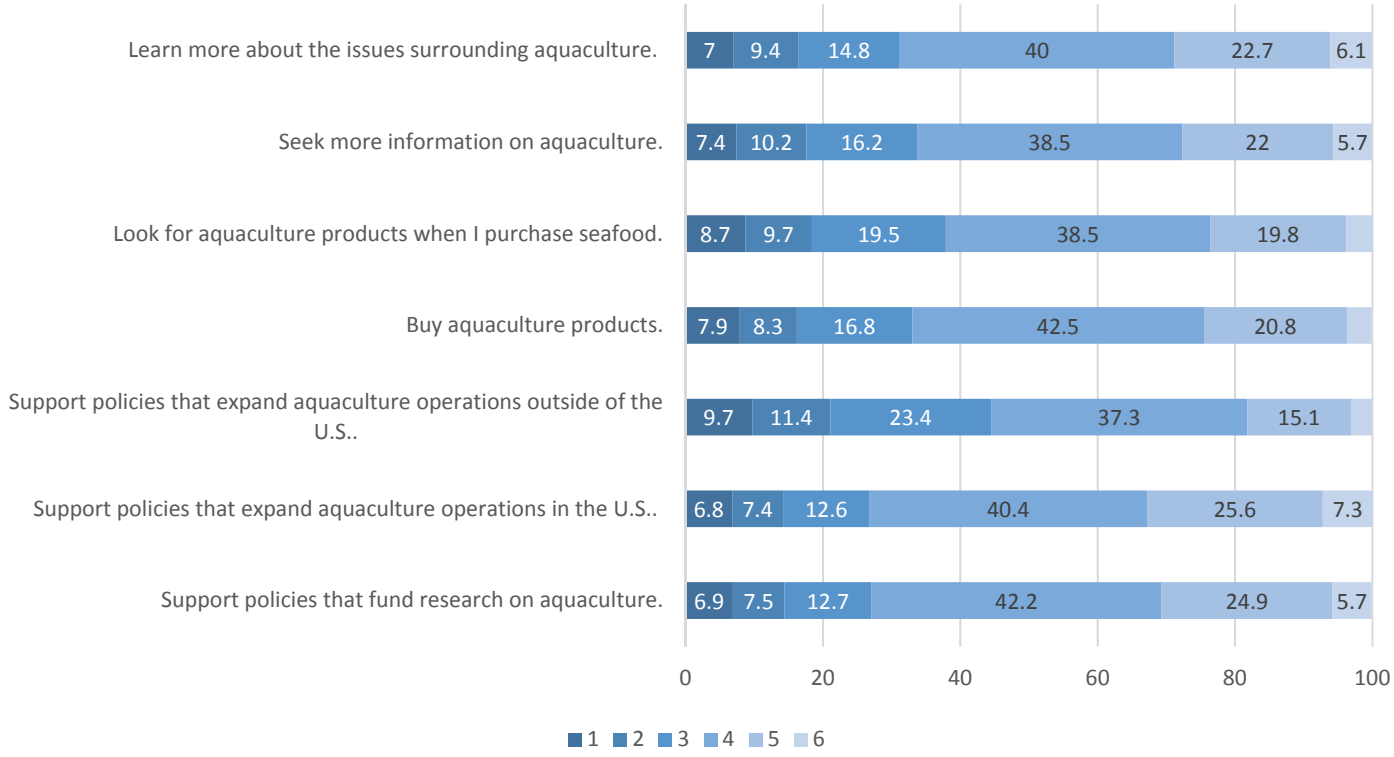


Figure 8: Perspectives on benefits versus risks of aquaculture; categories ranked from 1 (risks strongly outweight benefits) to 5 (benefits strongly outweight risks) (% of respondents).

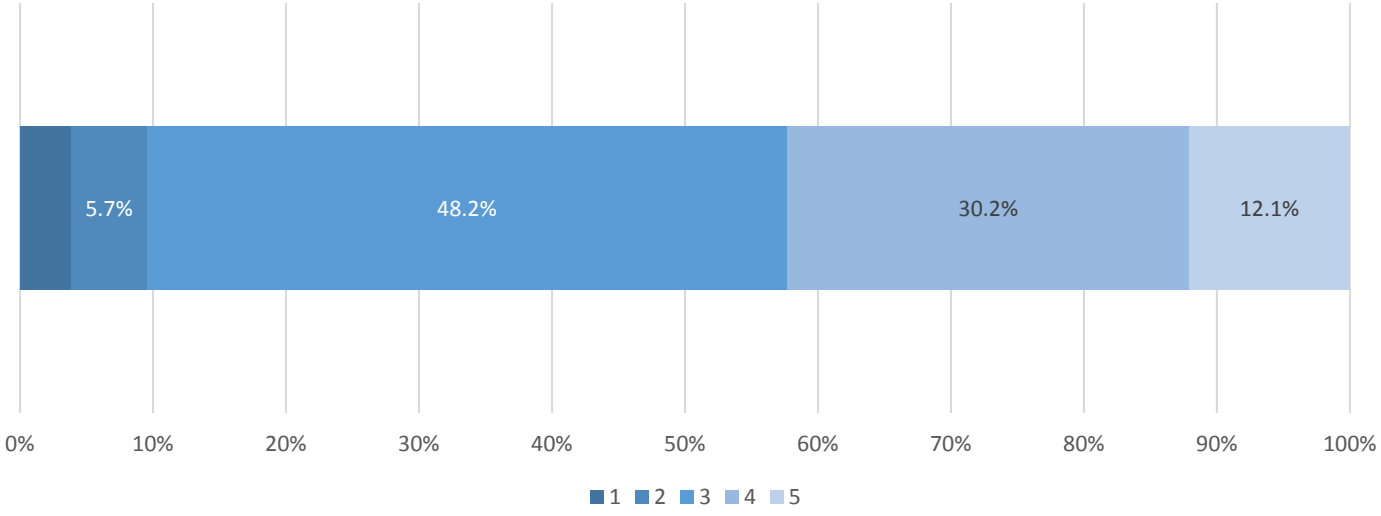


Figure 9a: Perceptions of common aquaculture myths (% of respondents).

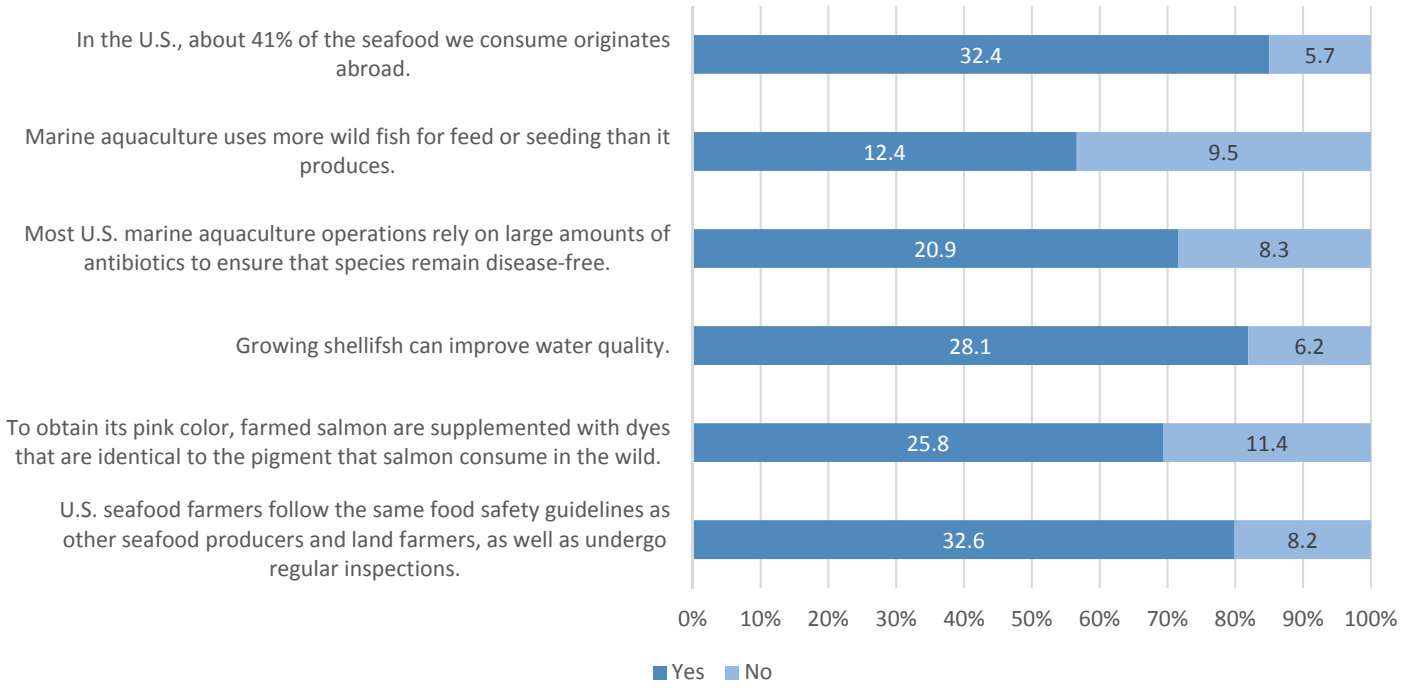
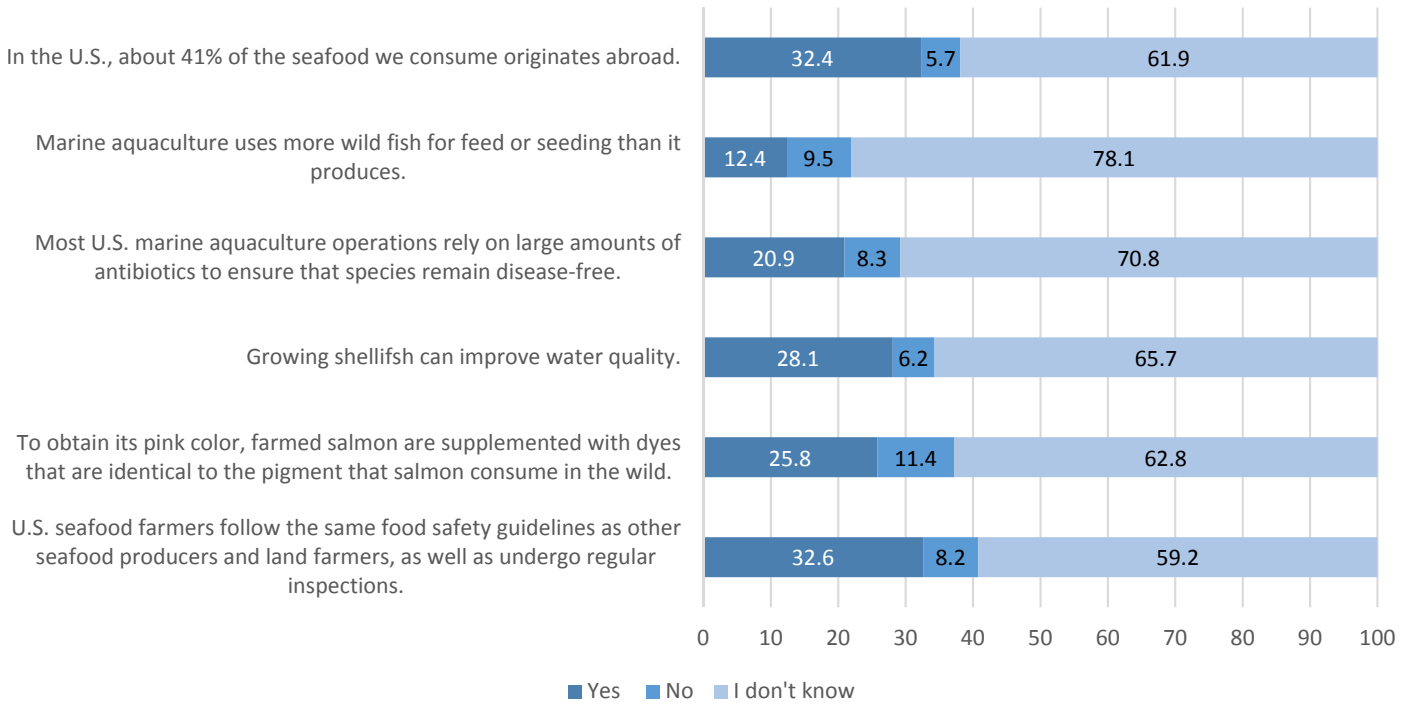


Figure 9b: Perceptions of common aquaculture myths (% of respondents including those who answered "Don't Know").



Governance and Aquaculture

Understanding citizen's feelings towards regulation of AQ may be a factor that is helpful in determining acceptance of AQ farms and their products. We examined whether different players in AQ regulation impact citizen perceptions, and in what ways that may be. Figure 10 showcases citizen impressions of these different AQ industry players. When asked about government officials as information sources about aquaculture, respondents feel them to be untrustworthy, inaccurate, unfair, incomplete in the sense that they do not tell the "whole story", and biased. Respondents generally felt that University scientists could be trusted, are accurate, fair, tell the whole story, and ranked them as the least biased of all three parties. Participants find AQ representatives to be biased and incomplete, but feelings about trust, accuracy, and fairness were more mixed. However, feelings were more critical towards AQ reps than University scientists. This information indicates that citizens may be more likely to engage with and respect AQ information that comes from university scientists. AQ expansion initiatives associated with scientists may foster more citizen support.

Related, our survey also sought to gauge citizen's feelings towards science in general, because scientists and scientific research play an important role in the development and expansion of AQ. Participants tended to agree that scientists can raise our standard of living and improve food safety, while also considering them to be reliable and important. Most respondents feel as though they can trust scientists who study food safety and/or how we use the environment. On the contrary, a significant portion of people believe that science is unreliable, indicating some mixed feelings across respondents in regards to the reliability of scientists and their research. There were also mixed feelings of science going "too far" and people fearing the impacts of scientific research (Figure 11). Overall, many respondents, particularly those with higher educations, exhibit a trust in scientific research, but some citizens may feel that science can be a bit overwhelming. Moving forward, scientists working on AQ operations should continue to educate citizens in a manner that is approachable, transparent, and instills trust in the scientific process.

Statistical analysis revealed a strong correlation between 7 responses relating to citizen feelings towards scientists and their research, as discussed above. These 7 responses included: x, y… z. Collectively, these 7 variables were identified as responses that indicate a trust in science with a correlation of 91% (Cronbach's $\alpha = .91$). From this, we were also able to identify correlations between trusting in science and attitudes towards government officials, industry representatives, and university scientists as sources of information about AQ. Though there was positive correlation between trust in science

and all three sources of information, the strongest correlation was between trust in science and university scientists.

Figure 10: Feelings towards aquaculture information sources; categories ranked on a Likert scale from 1 (less agreement) to 6 (more agreement) (averages reported).

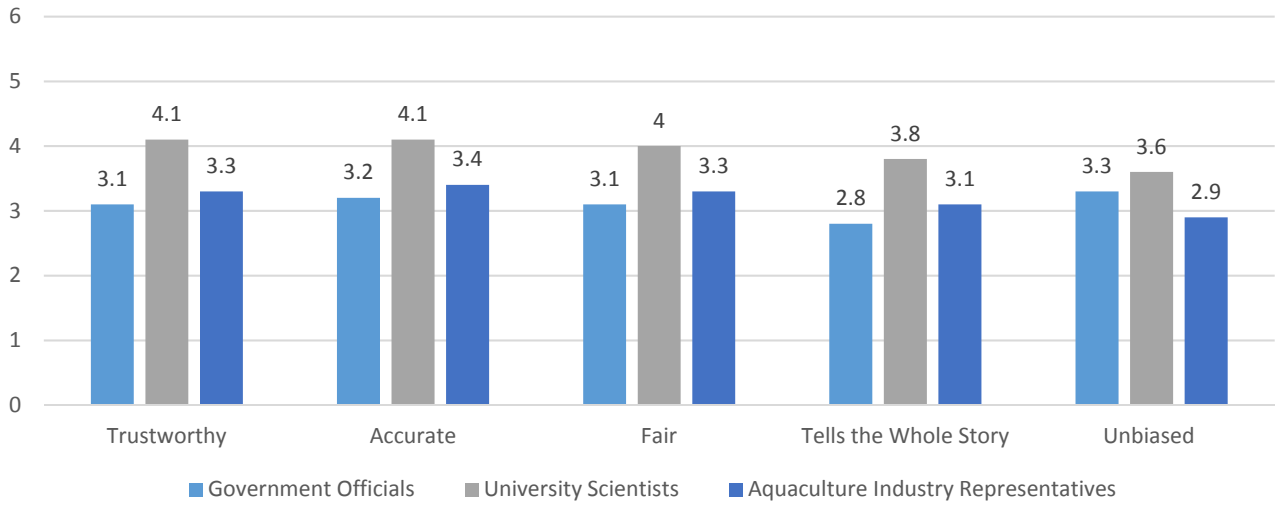
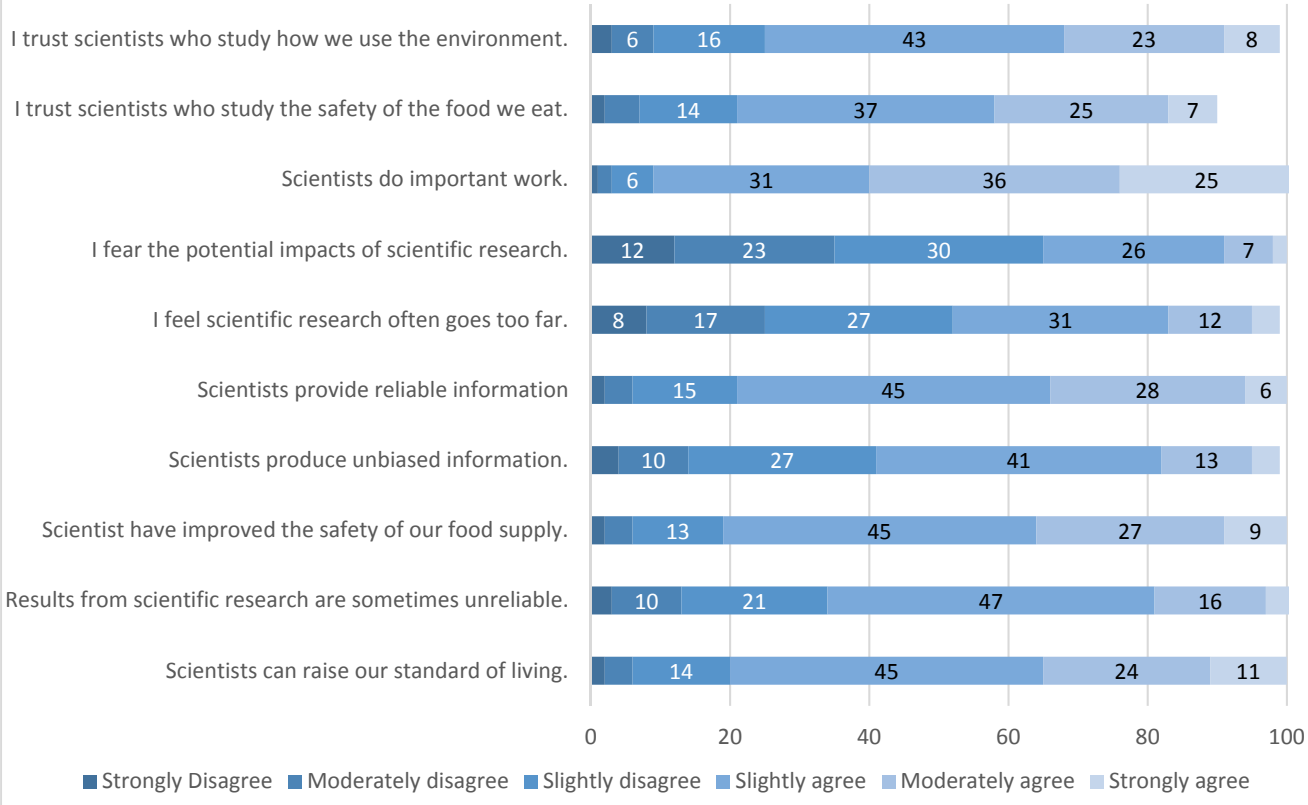


Figure 11: Citizen perspectives of science; categories ranked on a Likert scale from 1 (SD) to 6 (SA) (% of respondents).



Socio-Demographic Information

Respondents were asked to discuss their coastal visitation habits as well as their thoughts on climate change and the state of the environment. Awareness of current coastal uses, and potential conflicts with AQ expansion are important to understand citizen acceptance of different marine uses. Development of marine AQ will play a role in both coastal visitation and recreation.

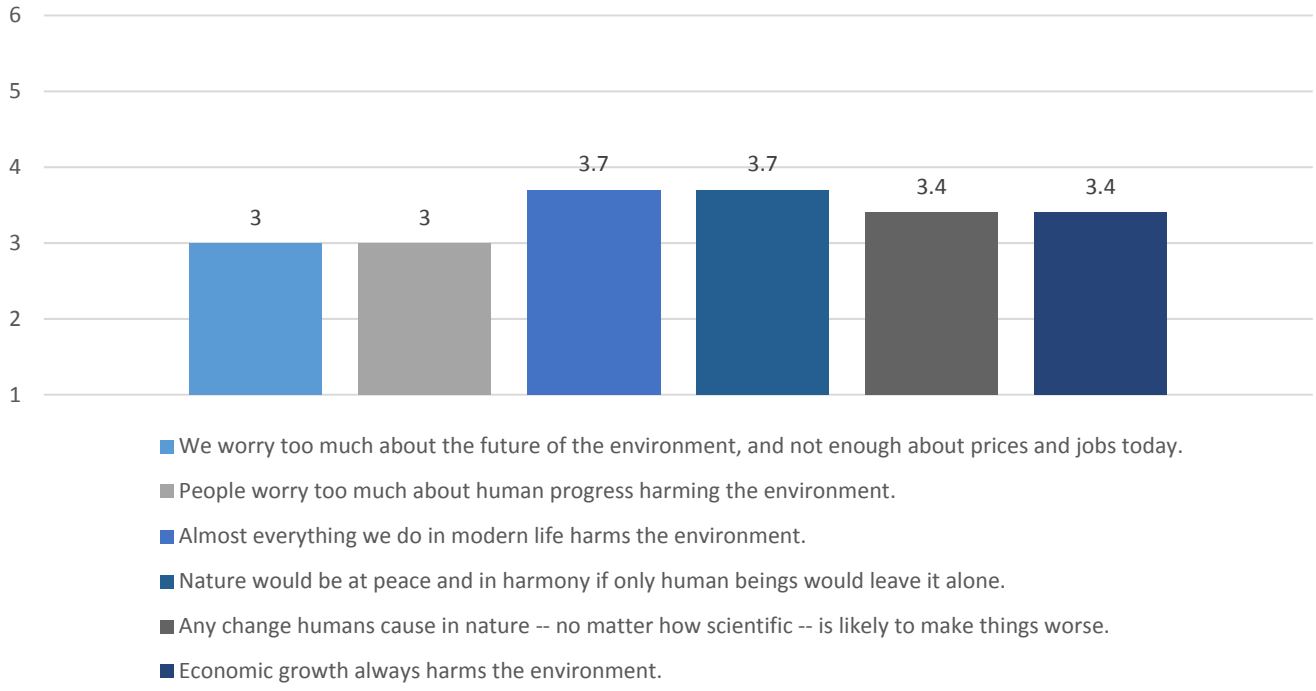
Many respondents indicate visiting the coast at least once per year (30.2%), while another portion (26.9%) report that they never visit the coast. Respondents in inland states reported visiting the coast less than those in coastal states. 71.2% of participants report visiting the same coastal area, and on average, those respondents have been frequenting the same coastal spots for 20.5 years. Some participants report owning or renting a home within 50 miles of the coast (30.4%). Of those who do, the average length of time that the respondent has owned or rented the home is about 17 years. When picking their coastal home, the most important features for respondents were clean coastal water, access to coastal recreation, and access to boating. Respondents were also asked to identify any coastal recreational activities they have participated within the last year. The most popular activity is swimming (30.3%), followed by boating, and fishing.

Understanding citizen perceptions of climate change is important for AQ expansion because people may be fearful of the impacts AQ has on the environment, or vice versa. Some respondents (39.2%) indicate that an equal combination of human activities and natural changes in the environment are the cause, while another large portion (36.4%) believe human activities only are the most profound cause. A small number of participants (16.2%) believe that climate change is almost entirely natural, and an even smaller percent (8.2%) believe it is not happening at all. Moving forward, it will be important to assess AQ'S impact on the environment, as well as what impact climate change may have on AQ operations, and inform citizens accordingly. The magnitude of impact has the potential to play a role in citizen support for AQ; that is, if AQ practices are likely to be detrimental to the environment, it may be harder to foster support. Alternatively, if our changing climate compromises the economic viability of AQ operations, citizens may find it unfeasible to further expand that market.

In continuance with our environmental perception questions, respondents were asked to rate the extent of their agreement with general opinions about the state of the environment. Most participants lean towards agreeing that nature would be at peace and harmony if humans left it alone, and that almost everything humans do in modern life is harmful to the environment. Respondents tended to feel moderately about

whether *all* human changes make the environment worse off, if economic growth always harms the environment, if we worry too much about the future of the environment and not enough about jobs and prices today, and whether we worry too much about human progress harming the environment (Figure 12). Based on this evidence, there does not appear to be any strong opinions amongst citizens about the current state of the environment. Survey results from this question echo common perceptions that older generations are less apt to express environmental concerns, while younger generations are more prone to. Based on these findings, it may be likely that gaining acceptance for AQ practices will be harder to facilitate with younger citizens who are more concerned with human impact on the environment. This parallels previous survey findings that illustrated how younger respondents are generally more critical of AQ (page 19).

Figure 12: Citizen perspectives regarding the state of the environment; categories ranked on a Likert scale from 1 (SD) to 6 (SA) (averages reported).



Discussion

What do consumers know about aquaculture?

Results from this survey indicate a relatively low awareness of aquaculture practices and products across the United States. There is both missing knowledge, and false knowledge, across our survey respondents. Participants think they know relatively little about aquaculture, a notion that is strengthened by their beliefs in several aquaculture myths. There is little knowledge of aquaculture related issues in the news media, and respondents indicate seldom seeking out information on aquaculture. However, knowledge participants think they have about aquaculture is highly correlated with both hearing or reading about aquaculture (passive information delivery) and information seeking behavior (active information seeking). While awareness is low, participants did indicate a desire to know more about the topic. Overall, the lack of aquaculture knowledge across survey participants may expose a need to increase accessible aquaculture information to help solidify public opinion.

Scientific information is necessary to bridge the knowledge gaps presented by these survey results. If consumers are unaware of, or unclear about what aquaculture is, data suggests that they will be less apt to purchase any products labeled as such, or support aquaculture development in their region. Aquaculture information is particularly needed across respondents from inland states, specifically the older, less-educated demographic groups, as well as younger generations who seem to be more critical of the industry. Participants report rarely 'actively' seeking information about aquaculture, so further information should be manifested in a way that does not require active searching. Survey results illustrate that television advertisements/programs, social media postings, and information presented on package labeling may be useful to reach citizens and increase their awareness of aquaculture.

What are consumer perceptions of aquaculture?

Just as there is not an overwhelming amount of citizen knowledge regarding aquaculture, consumer perceptions of the industry are also varying. Survey results indicate mixed feelings amongst participants about the effects of aquaculture practices, as well as the quality of aquaculture products. Respondents also express neutral feelings about the risks and benefits of aquaculture operations. Those with higher education levels indicate believing there to be pros and cons to the aquaculture industry, while responses to these questions are widely distributed across lower educated groups. Our data shows that those with less education consume seafood less often, and thus may be unsure of how to answer these questions because they are not familiar with the seafood industry in general.

What are the attitudes of consumers towards aquaculture?

Respondents indicate that they are uncertain about an expanding aquaculture industry. Survey responses reveal that citizens would prefer to see coastal development affiliated with recreation and/or food production rather than energy production. In addition, respondents indicated more consideration and encouragement of domestic aquaculture expansion rather than international.

Respondents were relatively impartial to supporting any funding for research or aquaculture-related policies, and did not appear to be inclined to seek or purchase aquaculture products. While findings illustrates that citizens are not insistent on expanding the aquaculture industry, their neutrality also showcases that they are not opposed either.

Future research suggestions

Survey results indicate that citizens' perceptions of, knowledge of, and attitudes towards aquaculture are diverse and malleable. We can conclude that there may need to be more accessible information about aquaculture to solidify consumers' judgment of the industry. The methods for conveying this information are less clear, and may serve to be a challenge for industry stakeholders to develop. However, there is an established sense of trust and respect between survey respondents and scientists, so it is likely that informative materials will be most attractive to citizens when presented in a scientific frame. In addition, messaging framework experimentation included in this survey indicates more citizen acceptance of information when presented in a positive manner, which could be helpful for further provision.

Targeting populations of citizens that seldom associate with the seafood industry may also serve to be a difficult feat for aquaculture educators. Methods should be created to best educate younger, less-educated, lower-income, and inland citizens who consume seafood products less, and thus likely have fewer pre-established attitudes towards and perceptions of the industry.

The world's changing climate and growing concern for the state of the environment may generate some difficulty in expanding the U.S. aquaculture market. Most respondents indicate feeling that human impact is in large part a cause of climate change, with results also echoing that citizens feel as though human progress makes the environment worse off. Seeing as aquaculture is a process made possible through human interaction with the environment, acknowledging the relationship between aquaculture practices and environmental impacts, and working to maintain and publicize sustainable, environmentally-friendly practices is necessary.

Results from this survey indicate many avenues for further research, including but not limited to; further understanding of inland citizens' perceptions of aquaculture, exploring visitor preferences for coastal recreation, determining framing of and information channels for effective aquaculture messaging, and cost-benefit analyses of citizen perceptions of aquaculture.

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Appendix A

1: U.S. States by Coastal Bin

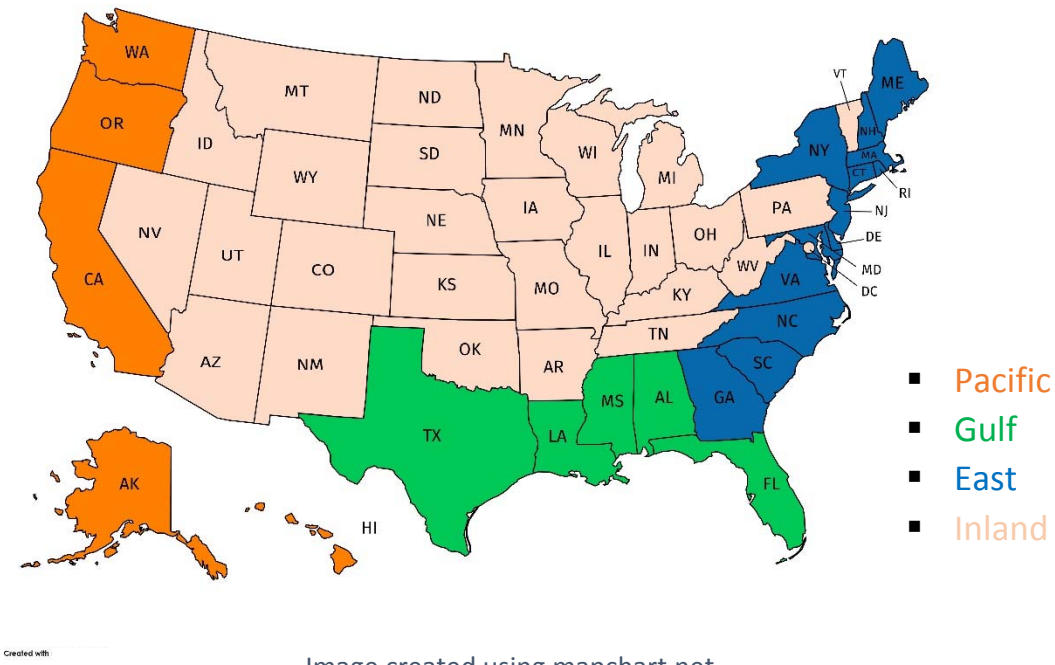
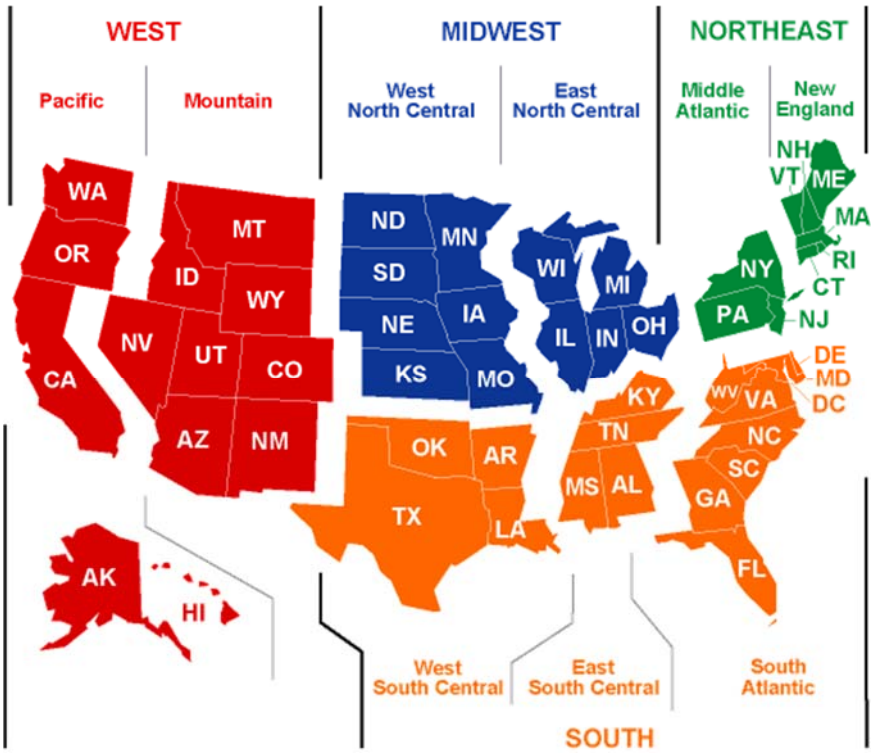


Image created using mapchart.net

2: U.S. States by Region



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