2016

Shellfish and Seaweed Aquaculture as a Mechanism for Economic Diversification in Maine Island and Coastal Communities

Erin Love
University of Southern Maine, Casco Bay Estuary Partnership Island Institute Fellow

Casco Bay Estuary Partnership

ISLAND INSTITUTE

2016

Shellfish and seaweed aquaculture as a mechanism for economic diversification in Maine island and coastal communities

Shellfish and seaweed aquaculture as a mechanism for economic diversification in Maine island and coastal communities

Erin Love
Casco Bay Estuary Partnership Island Institute Fellow

August 2016

Cover image: Aquaculture producer holding a coiled line seeded with *Saccharina latissima* (sugar kelp)

Abstract

Lobster is an iconic species in Maine, and for good reason. In 2015 80% of the landed value of commercially harvested Maine seafood was attributed to lobster. In a changing marine environment, the lobster fishery may not always be as robust as it is now. Shellfish and seaweed aquaculture is one possibility for marine harvesters looking to diversify away from lobster (or other species) in order to supplement their income or to foster an alternative source of income should their current fishery become unviable in the future. We used interview and questionnaire data from Casco Bay to Penobscot Bay to explore the complementarity of aquaculture to other marine harvesting sectors and the factors that influence people to participate in aquaculture. We found that aquaculture may be complementary to commercial fishing (and other livelihoods) and that successful aquaculture producers find a way to represent both business and hands-on practical skills on their teams. We also discovered that of the people who are currently involved in aquaculture, many were influenced to participate by certain personality traits and values rather than their abilities or material assets.

Acknowledgments

Many thanks to everyone who supported this research process. The Casco Bay Estuary Partnership and Island Institute for funding the Island Fellow position that has allowed me to get to know the Casco Bay island communities. Curtis Bohlen for his guidance throughout the research process. His insights and sense of humor were equally appreciated. The staff at Island Institute, especially Stephenie MacLagan, for their feedback on the questionnaire and for allowing me to survey their Aquaculture Business Development Group. Bri Warner, for her help brainstorming ideas early in the project. Caitlin Cleaver for her assistance refining the interview questions. Chris Feurt of University of New England and Wells Reserve for generously sharing her knowledge of qualitative research design. The busy aquaculturists and industry professionals who participated in the survey and interview portions of the research. This project would not have been possible without you.

Introduction

Lobster is by far the most important commercially harvested species in Maine by landed value. Fishermen have become relatively more dependent on it over time, with 80.3% of the landed value of Maine seafood attributed to lobster in 2015, compared to 77.6% in 2014 and 41.1% in 1994[1,2]. The landed value of lobster compared to all commercially harvested marine species in Maine has been steadily increasing since the mid-1990s. The risk that this fishery may not be a reliable source of income in the future does not stop people from participating in it.

The term for this heavy dependence on lobster is the "gilded trap"[3]. The gilded trap is a term that was coined to describe a phenomenon in the lobster industry in which lobster harvesters continue to participate in an activity because it is so lucrative even though its long-term viability is uncertain. And most scientists think that over-dependence on lobster is quite risky in the long run. Lobster can no longer be found in parts of southern New England due to a shell disease combined with other unfavorable conditions. Warmer waters and ocean acidification could lead to a decline in the lobster stocks in Maine as well due to shell disease or temperature intolerance.

Diversification at the household and community levels plays a key role in escaping the gilded trap. One promising way of diversifying is participating in aquaculture (shellfish and seaweed aquaculture for the purposes of this study). We wanted to investigate the complementarity of aquaculture to other livelihoods, with an eye toward commercial lobstering, by asking current aquaculture producers about the level of complementarity they experience between aquaculture and other jobs. We also wanted to investigate the potential for expanding the industry by learning what motivates people to become involved in aquaculture and if there are certain characteristics that unify producers.

This study is driven by two primary research questions: To what degree are shellfish and seaweed aquaculture complementary to other livelihoods? And what motivates people to become involved in aquaculture? A solid understanding of these concepts as they apply to Casco Bay aquaculture will help policy makers and industry professionals serve and shape the sector for the future.

The geographic focus of this study is Casco Bay for several reasons. There are many new shellfish and seaweed farms here, so many people in this area are experiencing or have experienced recently the transition to working in aquaculture[4]. In addition, the researcher lives in Casco Bay, and limitations on her time made studying the area in close proximity the most logical option. In the future it would be interesting to do a comparative study on regional differences in the aquaculture sector across Maine. The researcher's relationship to the Casco Bay Estuary Partnership (CBEP) also contributed to the decision to focus on Casco Bay.

The Casco Bay Estuary Partnership "works as a catalyst for action with the goal of keeping Casco Bay and [its] nearly 1,000 square miles of watershed clean and healthy"[5]. One goal of the CBEP's strategic plan for the years 2016-2021 is to foster resilient communities and their connections to Casco Bay: "[CBEP] seeks to increase public engagement with Casco Bay and to support collaborative initiatives that illuminate the region's ecological and economic interconnections, celebrate the Bay's importance, and help citizens and leaders increase the region's resilience in the face of climate disruptions"[6]. As aquaculture becomes a more prominent part of the marine harvesting economy in Casco Bay, it makes sense for CBEP to learn more about the sector through the work of an Island Institute Fellow. The Island Institute works to sustain Maine's island and remote coastal communities, and as such is exploring the potential for shellfish and seaweed aquaculture to help strengthen community economies, by

supplementing income from lobstering in island and coastal communities. These two organizations' interests drove the research design process for this project.

Maine Seafood, Coastal Livelihood Diversification, and Aquaculture's History and Future Potential in the State: A Literature Review

Maine Seafood and the Gilded Trap

Seafood is an important part of the Maine economy. In 2015, the landed value of commercially harvested seafood in Maine (both wild caught and farmed) was 616.5 million dollars[7]. There are 7,300 registered commercial fishermen in Maine, including over 4,200 active lobstermen[8]. Lobstermen alone routinely land over 100 million pounds of product annually. During 2015, they landed 121 million pounds, worth approximately 495.4 million dollars[1,2]. Many scientists predict that ocean acidification and climate change, in combination with fishing pressures, will alter the productivity and geographic distribution of commercially important marine species[9–15]. Considering what those changing conditions might mean for Maine's seafood sector and economic well-being would benefit anyone who plans to be involved in the lobster industry in the future[9].

Doubt about the future of the lobster fishery is worrisome because Maine fishermen and Maine's coastal communities have become dependent on this extraordinarily valuable species. In 2015 80.3% of the landed value of commercially harvested marine species in Maine came from lobster[1,2]. There are strong economic pressures to maintain the status quo, including the dedication of harvesters to lobstering as a sole source of income, even though doing so may be risky in the long-term given the forecast instability of the industry; and its vulnerability to stochastic events and a changing environment[3]. Maine ecologist Robert Steneck and his colleagues dubbed this co-occurrence of susceptibility to fisheries decline in the future and large rewards in the present that incentivize participation in the industry despite potential risks a "gilded trap"[3].

The future of Maine's lobster fishery is uncertain due in part to the unpredictable consequences of climate change and disease. The current state of the industry, with most lobster harvesters relying on only that species up and down the coast, leaves little cushion to absorb any surprises, such as unexpectedly low recruitment of lobsters from year to year[16]. Many lobstermen operate with large amounts of debt because both they and their bankers expect fishing to be lucrative well into the future[3]. This combination of factors means that the Maine lobster industry would be especially vulnerable to a disease. While such an occurrence may appear unlikely in Maine because of the state's robust lobster stocks, shell disease ravaged lobster stocks in Southern New England just a few years ago, contributing to closure of the lobster fishery in that region[3].

Human geographer Neil Adger defines social resilience as "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change"[17]. In an ever-changing world, the ability to respond to unexpected events is essential. Social scientists studying the Maine lobster industry crises of 2008 and 2012, during which the price of lobster plummeted making it difficult for harvesters to continue fishing, have concluded that the industry has low social resilience to external threats[18]. They say this is due to the industry's reliance on coping mechanisms (such as fishing fewer days in an effort to increase prices) instead of effective, systemic reform (such as investing in processing plants that allow access to new markets) during the past decade[18]. The Maine lobster industry has a long history of implementing innovative, systemic changes[18].

But according to social scientists Anna Henry and Teresa Johnson[18], so far it has not been able to make transformative, system-wide improvements that will allow it to respond to low prices or other unexpected downturns in the future.

The lobster industry appears healthy at the moment, despite its low social resilience, but a severe decline of the industry would have far-reaching consequences. According to natural resource economist Daniel Holland, "The fishery supports a large number of lobstermen and many coastal communities that are heavily dependent on the fishery and have few alternative sources of income and employment to offset a decline in productivity and profitability of the fishery"[16]. Without a robust lobster industry or a viable alternative, many island and coastal communities would lose a major source of income and sense of purpose, which would put them at risk of declining populations or a significantly altered sense of place[16]. Clearly lobstermen would not be the only ones to suffer if the lobster industry declined and there were no economic activity to fill that void. The character of the Maine coast and the communities that call it home would change.

Livelihood Diversification, the Distance between Income Sources, and Factors that Contribute to Participation in Aquaculture

The focus of this study is aquaculture as a mechanism for fishermen to escape the gilded trap through livelihood diversification. But before we explore that option, we consider the current body of knowledge about livelihood diversification. Development economist Frank Ellis defines livelihood diversification, also called "pluriactivity," as the "maintenance and continuous adaptation of a highly diverse portfolio of activities"[19]. Resilience is created by diversifying, by having multiple income streams that are not affected by the same shocks equally, and by having a wide support network that can help households react to unexpected events[20].

Acting preemptively to diversify could allow fishermen to mitigate risk and improve their future situations while they have the resources to successfully cultivate a new revenue stream[19]. Rural livelihood expert S. Davies proposes that there are two reasons for pursuing livelihood diversification: necessity and choice[19]. Using aquaculture to diversify Maine fisheries while the lobster industry is still strong would be a choice, whereas diversifying into aquaculture (or another industry) following a crisis in the lobster fishery that left it unviable would be classified as acting out of necessity. Lobster is still highly lucrative right now, so people are not as interested in finding other sources of income as they might be if the lobster market were experiencing a downturn. However, diversifying by choice now would allow fishermen to avoid diversification by necessity in the future when they might not have the resources to outfit a new venture[19].

The role of diversification has been studied more extensively in agricultural settings than in the context of fishing, providing potential lessons for fishing communities. Diversification is a well-established strategy for accomplishing many goals in terrestrial farming: reducing uncertainty and risk, growing and servicing markets, responding to changes in labor and credit markets, enhancing financial condition, fulfilling personal goals, better exploiting underutilized assets, developing seasonally appropriate activities, and strengthening family connections[19,21]. Similar motivations could encourage fishermen to diversify their revenue streams as well. These motivations were incorporated into our analysis of the factors that contribute to participation in aquaculture.

Acknowledging that not all diversification mechanisms are equally strong but rather that they fall along a spectrum is important, according to economist David Mills, who studied economic recovery following

the Asian tsunami of 2004[20]. An increase in the distance between income sources increases resilience[20]. Mills uses the example of aquaculture and fish trade versus aquaculture and taxi driving to explain the concept of distance. Intuitively we understand that the distance between aquaculture and taxi driving is greater than the distance between aquaculture and the fish trade. The more different two sources of income are, the greater the distance between them and the more protection that combination of incomes provides against an unanticipated event.

Protecting against various disturbances, such as human loss, economic shocks, and geo-environmental hazards, will give the most robust risk mitigating income portfolio[20]. Ideally, the risks that one source of incomes faces are completely different from those of another source of income[19]. For example, a teacher and a lobsterman would have an economically resilient household because their sources of income are quite different. The teacher might face job insecurity due to state or local budget cuts, whereas the lobsterman might face job insecurity due to a shell disease that decreases lobster stocks. The distance between these risks is great, so this household's resistance to economic shocks is high.

This framework of distance between incomes brings to light the idea that encouraging everyone in a community to diversify into aquaculture might have the unexpected outcome of simplifying the local economy and making it less able to cope with changes. Diversifying away from lobster would decrease the community's disproportionate dependence on the marine harvesting sector of the economy[3]. But diversifying away from other jobs, such as small business, teaching, or municipal government and into aquaculture, would only destabilize the economy more should a major disturbance to the marine environment occur. For example, the entire sector of the economy that relied on coastal ecosystem services was devastated by the 2004 tsunami in Indonesia[20]. In that case the diversity of activities within the category of coastal ecosystem services mattered little because the entire coastal ecosystem was affected[20]. If an event occurred that affected the ability of marine harvesters and farmers to produce food in the ocean, the saving grace of communities would be activities that do not depend on ocean productivity. Developing the aquaculture sector is an important mechanism for diversifying the marine living resources industry, but it should not come at the expense of livelihoods that do not rely on seafood production and harvest.

History and Current State of Maine Aquaculture

While lobster dominates the Maine seafood industry, aquaculture is a small but growing sector in the state. A 2014 report declared that farmed Maine seafood was worth 79 million dollars, a 39% jump in value from 10 years before[22]. In September 2014 the Maine Department of Marine Resources reported the following quantities of various aquaculture permits: 74 shellfish leases, 26 finfish leases, four seaweed leases, and two urchin leases[22]. These figures do not include the bourgeoning number of smaller, shorter-term limited-purpose aquaculture (LPA) leases[4,22]. LPA leases are often used by aquaculturists to test new sites or techniques and can be an important indication of future industry trends. Aquaculture is becoming a better known technique for growing food globally, nationally, regionally, and statewide. News outlets such as the *New York Times*, *Boston Globe*, and *New Yorker* have published articles about aquaculture, several of which focus on Maine operations[23–27].

Although excitement surrounding aquaculture has picked up in recent years, Maine has a history of aquaculture going back to the 1980s. Three major classes of aquaculture are practiced in the state: finfish, shellfish, and seaweed[28]. Finfish aquaculture is more controversial environmentally than shellfish or seaweed aquaculture[29,30]. Some shellfish and seaweed species may actually improve environmental quality, for example, by locally mitigating the effects of ocean acidification[31,32]. Finfish

aquaculture (salmon farming, specifically) in downeast Maine was the first type of aquaculture to take off in the state. In the early 1990s there were meetings about aquaculture monitoring protocols that focused primarily on salmon aquaculture with little mention of any other species[33]. There has been a history of consolidation in salmon aquaculture[34]. Salmon started out as an industry with many small producer-operators, but now most farms are owned by a few multinational corporations[34]. In contrast, most shellfish and seaweed operations in Maine are not part of large corporations but are still locally owned and operated by an individual or small team[4].

Maine Aquaculture: Opportunities and Challenges

Motivations for becoming involved in aquaculture can vary widely, ranging from income generation to a desire to be part of a distinct social group[35]. If aquaculture is complementary to other livelihoods, it would be interesting to pinpoint what draws Mainers to it initially and what keeps them interested in participating. Lobster is very lucrative right now, so it seems unlikely that fishermen would use aquaculture to increase their total incomes at this time. But they might use it to accomplish other goals, such as risk mitigation. Fishermen are unlikely to completely transition away from lobster while it is so profitable, but they may be willing to participate in another activity, such as aquaculture, on a part-time trial basis. This makes understanding the viability of participating in aquaculture on a part-time basis important. Learning about the process of transitioning to running two businesses might help lobstermen understand what doing aquaculture alongside lobstering entails. The reasons for participating can affect the nature of a business, so understanding people's backgrounds and the factors that contribute to their participation in aquaculture will improve any analysis of Maine aquaculture[21,36].

Fishing communities around the globe supplement fishing income with agriculture and aquaculture activities[20,35]. Historical tension between lobstermen and aquaculturists in Maine is subsiding, and people are realizing that the activities complement each other well in many ways[37,38]. The seasons for lobstering and seaweed aquaculture do not overlap much, so theoretically one person could manage their time to do both. Lobstering and running a shellfish operation would be possible but trickier because the busy times of year coincide more. There are overlaps in the knowledge and skills needed for both lobstering and aquaculture, such as boat handling and an understanding of ocean currents.

Last year a University of Maine Cooperative Extension agent led a session at the Northeast Aquaculture Conference & Exposition on transitioning from doing aquaculture part-time to doing it full-time[39]. The provision of such a session suggests that the Cooperative Extension agent knew of at least a few people who were doing aquaculture alongside another job. This may indicate that aquaculture can be complementary to other livelihoods, or it may indicate that aquaculture producers find it necessary maintain another source of income to make ends meet while they start their new operations. The degree of complementarity is the subject of this study.

There are several limitations of aquaculture as a diversification strategy that are important to acknowledge. First, aquaculture could be considered its own gilded trap. While aquaculture is potentially lucrative, aquaculture (as practiced in Maine waters) relies on simplified monocultures that are themselves susceptible to problems like disease[3]. Second, not all aquaculture is created equal. Finfish aquaculture in particular has a checkered environmental history[29,30]. Third, in some cases, when a community adopts aquaculture as a major economic driver, it privatizes resources that used to be public goods, contributing to increased income inequality[20]. Maine has laws designed to preserve the public nature of the waters used in aquaculture, but the industry will likely experience some growing pains in the coming years. It will be important for policymakers and producers to remain vigilant and

communicate well, so the regulations reflect a system that is in the best interest of the most users. And fourth, as discussed above, if people not currently involved in marine-related activities start to participate in aquaculture, they will do so at the expense of their communities' economic diversity. The impact of this shift would be especially high in small, more isolated communities, such as islands or remote coastal towns, and may be lower or insignificant in larger, more economically complex communities like Portland. While aquaculture is not a silver bullet, it could mitigate some of the uncertainty that Maine lobstermen face by diversifying their sources of income in a changing environment.

Aquaculture's appeal is that it can help to strengthen economies on the household and community levels to protect against shocks to either the lobster industry or problems with other marine species. We must keep in mind that the full ramifications of aquaculture are still unknown, as is the case with any new or growing economic or ecological force. But livelihood diversification would contribute to increased resilience, which is key to sustaining Maine's iconic coast[19]. The culture of fishing and working on the water is vital to these natural resource-dependent communities, and a changing environment requires them to be adaptable[40].

Methods

This study aims to answer two questions: (1) To what degree is aquaculture complementary to other livelihoods? And (2) what factors contribute to participation in aquaculture. We used in-person interviews with aquaculturists and industry professionals and a questionnaire administered to a group of new aquaculturists to answer these questions.

Interviews

The interviews were targeted at aquaculture producers in Casco Bay and a few prominent industry professionals in Maine. The principal goal of the interviews was to gain an understanding of complementarity that now exists between aquaculture and other livelihoods and the factors that contribute to participation in aquaculture. We were also interested in exploring whether there exists a specific group of people who would make a great addition to this growing sector in the future.

The semi-structured interviews lasted half an hour to an hour and were conducted from March through June of 2016 at locations of the participants' choosing. We used a snowball sampling technique to find additional participants after generating an initial list of interviewees through a conversation with a Maine Department of Marine Resources staff member. The final list of interviewees included ten producers and three industry professionals.

During the interview, we asked about:

- The participant's employment history and knowledge/skills from previous work that would enable her to participate in aquaculture more successfully
- Aquaculture as a source of income (sole, primary, secondary) and what other jobs the participants holds or has held while doing aquaculture
- Why the participant chose to become involved in aquaculture
- The future of the Maine aquaculture sector
- The role aquaculture plays in Maine's coastal culture

For a complete list of interview questions, please see Appendix A. We took notes during the interview on a laptop computer or, in a few cases, with pen and paper. We captured participants' responses and some choice quotes that represented their ideas particularly clearly. Due to a lack of time for transcription, we chose not to make audio recordings of the interviews.

We generated interview questions based on general knowledge of Maine's commercial fishing and aquaculture sectors, the literature review, and conversations with experts. In order to quantify the qualitative data we collected during interviews, we coded the data using variables and categories (Table 1). Variables were related to the questions we asked participants. The interview question "What did you do before aquaculture?" was the source of the "Previous jobs" variable. Categories were related to the answers participants gave. If someone said "lobstering" in response to the question about what they did before aquaculture, then that answer was put in the "Marine harvesting industry" category. If someone said "doctor," that answer was put in the "Other" category. If a participant was characterized as an industry professional, they were assigned an "N/A" coding option for all questions related to aquaculture production. Once all interview data were broken down into answers and those answers assigned to variables and categories, we tallied the answers in each category for each variable. We used this information to learn about the complementarity of aquaculture in the experience of the interviewees and about the factors that contributed to their participation in aquaculture.

Questionnaire

We administered an online questionnaire to members of the Island Institute's Aquaculture Business Development Group in July 2016. Participants in the Aquaculture Business Development Group are all new aquaculturists in various stages of launching their operations. While the majority of them are not based in Casco Bay, their recent entry into the Maine aquaculture sector made them prime candidates to explain what factors caused them to become involved in aquaculture. We sent the questionnaire to 18 possible respondents, and five returned a completed questionnaire, giving us a response rate of 28%. The questionnaire (Appendix B) asked participants if they were strongly influenced, somewhat influenced, or not influenced by 23 factors that may have influenced their decision to participate in aquaculture. We used information from the interviews to craft the survey, which is why some of the motivational factors are different between the interviews and the questionnaire. The questionnaire also collected demographic information.

Once we received the questionnaire results, we tallied the number of respondents who said they were strongly influenced, somewhat influenced, and not influenced by each factor. For the most influential factors, we also reviewed trends in the Personality, Values, and Capacity categories, which will be discussed below.

Table 1. Coding variables and categories.

Coding Variables	Coding Categories
General	
Participant's role?	Producer; industry professional
Age range	18-25; 25-30; 30-40; 40-50; 50-60; 60-70; 70+
Career stage	Pre-career; early career; mid-career; late career; post-career; career break; other
Species grown in aquaculture operation	Oysters; blue mussels; scallops; sugar kelp; winged kelp; horsetail kelp; other
Complementarity: Aquaculture and Other Income	
Aquaculture sole source of income?	Yes; no
Aquaculture as a type of income	Primary; secondary; other
Do producers ever expect aquaculture to constitute 100% of their income?	Yes; no
Complementarity: Prior Experience and Capital	
Other current livelihoods besides aquaculture	Qualitative only (not coded)
Previous jobs	Marine harvesting industry, other
Education	Qualitative only (not coded)
Previous knowledge and skills useful to aquaculture	Business skills, practical on the water skills, other
Previously owned equipment useful to aquaculture	Boat, other equipment, none
What producers had to learn when they started doing aquaculture	Business skills, practical on the water skills, specific knowledge of aquaculture species or aquaculture practices, other
Whether producers had participated in marine harvesting before doing aquaculture	Yes; no
Factors Contributing to Participation in Aquaculture	
Factors contributing to participation in aquaculture	Educational resources; availability of equipment; mentorship; technical ability; previous marketing knowledge, skills, and connections; seasonality; learning curve; risk tolerance; time; access to capital; local economy; environmental benefits; entrepreneurial attitude; relative income; enjoyment; reputation of aquaculture industry; money-making capacity of aquaculture; future fisheries outlook; ties to the ocean; legacy; interest in topic

Results

Interviews

Complementarity: Aquaculture and Other Income

One key measure of the complementarity of aquaculture to other livelihoods is how many aquaculture producers have other forms of employment in addition to aquaculture. We used income as a proxy for employment, even though some producers may have income that does not equate to current employment outside the aquaculture sector (savings from a past occupation, for example).

Of the ten producers interviewed, five said that aquaculture or aquaculture-derived activities were their sole source of income. The other five producers work part or full-time jobs ranging from retail to food service to snow plowing to lobstering and clamming.
We did not specifically ask producers if they were using any personal savings to cover living expenses. Therefore, when someone said aquaculture was their sole source of income, we did not know if they were supporting themselves only on the revenue from that aquaculture operation or if they were supplementing that revenue with personal savings. Because it often takes at least two years for an oyster operation to start generating revenue, we must assume that oyster aquaculturists in their first two years of business who say that aquaculture is their sole source of income are using personal savings to make ends meet. Two respondents fell into this category. We note that personal savings are sometimes required to meet day-to-day living expenses when starting an aquaculture operation without maintaining another form of employment. Potential aquaculturists should be intentional about considering the financial repercussions of their decision to maintain or forgo an additional job during their transition to aquaculture.

Four producers classified their operation as their primary source of income, five classified it as a secondary source of income, and one classified it as a hobby. Only three producers did not expect their aquaculture operations to eventually constitute 100% of their income: the hobby producer and two producers who classified aquaculture as a secondary source of income.

Complementarity: Prior Job Experience

Another measure of complementarity is how the knowledge and skills from a current or previous job would transfer to aquaculture. Of the ten producers interviewed, five had at least some experience harvesting marine species in a previous job. That experience was varied and included helping family members with their lobstering operations, working as an assistant on an oyster farm, and commercially harvesting clams, urchins, lobsters, and finfish in Maine and around the world. All five of the producers with harvesting experience cited their knowledge of boat handling, working on the water, and working with fishing gear as helpful in their transition to aquaculture.

One of the remaining five producers worked with collaborators who had these practical skills. The others said they had to put significant energy into learning those skills when they started doing aquaculture. The four producers who lacked prior experience that provided them with on-the-water practical skills cited business experience as key to their successful transition to aquaculture, while none of the five producers with on-the-water skills claimed to have high-level business skills before starting their aquaculture ventures. However, a career as a self-employed marine harvester does require some degree of business skill, so producers with this background may have been better prepared to handle the business side of the operation than they realized.

Only three producers claimed to have prior knowledge of science or biology (their own or a team member's), but every producer except one cited this scientific knowledge or the ability to gain it as a key component of a successful aquaculture venture.

Complementarity: Boats and other Capital Equipment

A final measure of complementarity is the overlap in equipment that aquaculture producers already owned from other work and that which they needed for their aquaculture endeavors. Three of the ten producers interviewed owned boats before starting aquaculture and mentioned that having a boat was useful in the transition to aquaculture. All of the three had previously participated in harvesting marine species. No one had all the gear they needed to participate in aquaculture. Everyone had to buy, make, or invent gear they needed to participate in this growing sector of the marine economy.

Factors that Contribute to Participation in Aquaculture

We organized the 21 factors that may contribute to participation in aquaculture into three categories: Personality, Values, and Capacity (Table 2). The Personality category refers to those factors that are driven by personal attributes or characteristics not tied to either material assets or ethical principles. The Values category refers to those factors that tap into a person's sense of "what is right." The Capacity category refers to those abilities or assets that allow someone to participate more easily in aquaculture. In general, Personality and Values factors contribute to a person's desire to do aquaculture, and capacity factors contribute to a person's ability to do aquaculture. We acknowledge that a few factors could be categorized in multiple ways (e.g. risk tolerance could either be a Capacity factor or a Personality factor). When this was the case, we placed the factor in the category that best captured the essence of that factor as it relates to new aquaculturists in Maine.

Of the 21 discrete factors that contribute to participation in aquaculture cited by the ten producers interviewed, the top five by number of producers who mentioned the factor were future fisheries outlook, environmental benefits, money-making capacity, ties to the ocean, and entrepreneurial attitude (Table 3). We note that all of these factors fall into the Personality category, except one that falls into the Values category. The next four most frequently mentioned factors all fall into the Capacity category: technical ability; previous marketing knowledge, skills, and connections; mentorship; and learning curve.

We kept track of which factors each interviewee mentioned at least once during an interview, but we did not keep track of how many times interviewees mentioned factors. Therefore the maximum number of times each interviewee could mention each factor in our total tally was one. We looked at both the number of separate factors within the Personality, Capacity, and Values categories and the total number of times factors from each category were mentioned at least once in an interview (Table 4). The Personality category led both in mentions by producers (25) and the number of distinct factors within the category that were mentioned (eight) (Table 4). The Capacity category followed, with 13 total mentions in seven separate factors. And the Values category was the least mentioned category with seven total mentions in two separate factors. We should keep in mind that because there were only two factors in the Values category, we would expect it to have a lower total number of mentions that the other two categories.

Questionnaire

Factors that Contribute to Participation in Aquaculture

A few factors that may contribute to participation in aquaculture stood out clearly as the most influential factors for this group of survey respondents (Table 5). They unanimously categorized the following factors as strongly influencing their decision to participate in aquaculture: future fisheries outlook, entrepreneurial attitude, and ties to the ocean. These factors are all in the Personality category. Local economy (Values) and interest in the topic (Personality) also influenced respondents, with four respondents for each question saying they were strongly influenced by these factors and one respondent for each question saying they were somewhat influenced by these factors. Four of these five factors fall into the Personality category, with the remaining factor falling into the Values category. All five factors played a prominent role in this group of respondents' decisions to participate in aquaculture.

Four of the next five factors fall into the Capacity category, with the remaining factor falling into the Personality category. Respondents did not agree unanimously that these factors strongly influenced them, which indicates that they came to aquaculture with different skills and assets.

The remaining factors played roles of varying levels of influence in people's decisions to participate in aquaculture. The small sample size makes it difficult to tell if any of the remaining factors stand out as being more or less influential than the rest.

Survey respondents have various types of leases, grow various species, live from Casco Bay to Penobscot Bay, have been participating in aquaculture from a few months to three years, hold various jobs from lobstering to interior design, range in age from 30 to 60, and are male and female. This diversity makes the clear trends at the top of Table 5 all the more remarkable. The sample size is small, but the mixture of respondents makes the results more robust than they would be if just one type of aquaculturist responded.

Table 2. Factors, broken into categories, that researchers thought might contribute to participation in aquaculture and hypothetical statements that exemplify the factors.

	Personality
	Entrepreneurial attitude: I enjoy starting new projects and talking to people about new ideas.
	Relative income: I think I can make more money doing aquaculture than I do at my current job (if I have one).
	Enjoyment: I think I would enjoy doing aquaculture or it would improve my quality of life.
	Reputation of the aquaculture industry: The culture of the aquaculture industry appeals to me, and I would like to be associated with it.
	Money-making capacity of aquaculture: I think aquaculture will make me money.
	Future fisheries outlook: I think the future of other existing fisheries like lobster will be affected by climate change or other factors.
	Ties to the ocean: I have strong ties to the ocean or a strong desire to work on the water.
	Legacy: It is important to me to leave a legacy, and I think aquaculture could be part of that legacy.
	Interest in topic: I think aquaculture is an interesting topic, and I am driven to learn more about it.
	Values
	Local economy: I want to contribute to the local economy.
	Environmental benefits: I want to participate in an activity that benefits the environment.
	Capacity
	Educational Resources: I have access to training or other educational resources that make learning about aquaculture easier.
	Availability of Equipment: I already have some of the equipment I need or I can easily get it.
	Mentorship: A family member, friend, or acquaintance who already participates in aquaculture introduced me to the concept or offered support as I start doing aquaculture.
	Technical Ability: I already know how aquaculture equipment works or I think I can figure it out without too much difficulty.
	Previous marketing knowledge, skills, and connections: I already know how to sell or market my product.
	Seasonality: The busy season for aquaculture does not overlap with the busy season for my other job (if I have one).
	Learning curve: I think it will be relatively easy for me to learn how to do aquaculture.
	Risk tolerance: I feel like I can handle the uncertainty of whether or not my aquaculture operation is a success.
	Time: I have enough time to try a new activity, or I do not think doing aquaculture will demand a lot of my time.
	Access to capital: I have access to the capital (money, equipment) needed to start an aquaculture operation—either from savings, investors, loans, or another source.

Table 3. Factors that contribute to participation in aquaculture ranked by the number of producers that mentioned them.

Ranking	Motivation	Category	Number of Producer Mentions
1	Future fisheries outlook	P	6
2	Environmental benefits	V	5
2	Money-making capacity	P	5
3	Ties to the ocean	P	4
3	Entrepreneurial attitude	P	4
4	Technical ability	C	3
4	Previous marketing knowledge, skills, connections	C	3
5	Mentorship	C	2
5	Learning curve	C	2
5	Enjoyment	P	2
5	Relative income	P	2
5	Local economy	V	2
6	Educational resources	C	1
6	Risk tolerance	C	1
6	Access to capital	C	1
6	Legacy	P	1
6	Interest in topic	P	1
7	Access to equipment	C	0
7	Reputation of the aquaculture industry	P	0
7	Seasonality	C	0
7	Time	C	0

Table 4. Factor categories by the number of distinct factors in that category that were mentioned and the total number of any factors that were mentioned.

Type of Factor	Number of Separate Factors	Total Number of Mentions
Personality	8	25
Capacity	7	13
Values	2	7

Table 5. Number of survey respondents who say they were strongly influenced, somewhat influenced, or not influenced by factors that may contribute to participation in aquaculture. Categories codes are Personality (P), Values (V), and Capacity (C).

Factor	Category	Strongly Influenced	Somewhat Influenced	Not Influenced
Future fisheries outlook	P	5	0	0
Ties to the ocean	P	5	0	0
Local economy	V	4	1	0
Interest in the topic	P	4	1	0
Entrepreneurial attitude*	P	4	0	0
Access to training programs	C	3	2	0
Technical ability	C	3	2	0
Enjoyment	P	3	2	0
Access to capital	C	3	2	0
Mentorship	C	3	0	2
Reputation of the aquaculture industry	P	2	2	1
Seasonality	C	2	2	1
Environmental benefits	V	2	2	1
Previous marketing, knowledge, skills, and connections	C	2	1	2
Time: demand	C	2	1	2
Time: supply	C	2	0	3
Relative income	P	1	4	0
Risk tolerance	C	1	3	1
Money-making capacity of aquaculture	P	1	3	1
Availability of equipment	C	1	2	2
Legacy	P	1	2	2
Steadiness of income	P	0	4	1
Learning curve	C	0	3	2

**One respondent skipped this question.*

Discussion

Interviews

Complementarity: Aquaculture and Other Income

Five of the ten producers interviewed claimed that aquaculture is their sole source of income currently, and all but three expected that aquaculture will become 100% of their income eventually. This expected transition could indicate that many shellfish and seaweed operations are in the pre-revenue stage of their businesses.

There seem to be two major strategies for coping with the financial realities of starting a new business. Some people live off their savings while attempting to start an aquaculture operation, some maintain employment elsewhere during this time, and some combine the two strategies. Respondents did not indicate whether one strategy was more successful than the other; that may be an area of interest for future research. The fact that many producers are working other jobs while starting an aquaculture operation would indicate that aquaculture is indeed complementary to other livelihoods.

Complementarity: Prior Job Experience

Backgrounds in business, science, and practical on-the-water skills are all useful in starting an aquaculture operation. The science and on-the-water skills were sometimes lumped together into a "hands on" or "practical" skills category, since both relate to the day-to-day growing and management of the product itself. Several producers explicitly said that only operations with both business and practical skillsets represented on their staffs will be successful. Business, science, and on-the-water skills are all trainable, so there may be a significant opportunity to improve nascent aquaculture operations' chances of success by helping new producers get a solid handle on these aspects of the operation. Several people cited their ability to learn new information and skills as crucial to their ability to do aquaculture. This indicates that while having knowledge of oyster biology or the ability to handle a boat before establishing an operation is useful, the knowledge and skills needed for aquaculture can be learned through study and practice.

Complementarity: Boats and Other Capital Equipment

Aquaculture was less complementary than expected to other marine livelihoods in terms of the equipment needed. All producers interviewed had to buy new equipment for aquaculture and often had to make many pieces themselves. They did not report using the equipment for any activities other than aquaculture. Boats were useful to have before starting an aquaculture venture, but most people bought a boat specifically for aquaculture. No one said that having a boat made them more likely to participate in aquaculture than they otherwise would have been.

Factors that Contribute to Participation in Aquaculture

Four of the top five most mentioned factors that contribute to participation in aquaculture fell into the Personality category. That category had the most separate factors mentioned at least once and received the largest total number of mentions. These responses suggest producers were more influenced by personality traits than by knowledge and skills in their decision to pursue aquaculture. Both hindsight and the use of the word "motivation" in interview questions may have contributed to participants thinking about personality traits and beliefs rather than tools and assets that they drew upon to start their new ventures (Appendix A Question 1d).

It was surprising that the environmental benefits associated with aquaculture were the second most mentioned factor. This fact would indicate that many aquaculturists hope to contribute to the well-being of society and the planet through environmentally sustainable activities.

Questionnaire

Factors that Contribute to Participation in Aquaculture

Survey respondents cited three factors as most influential in their decisions to participate in aquaculture. They agreed unanimously that future fisheries outlook, an entrepreneurial attitude, and ties to the ocean strongly influenced them to participate in aquaculture. Future fisheries outlook could refer to a belief that a certain fishery, such as lobster, will experience changes in coming years or that all fisheries will shift with climate change. It makes sense that someone who currently participates in commercial fishing but who expects fisheries to change in the future might want to explore aquaculture's potential to diversify her income. An entrepreneurial attitude could influence someone to participate in one of many business ventures. He may narrow the focus of a business idea based on interests and life experiences, among other factors. Ties to the ocean clearly would draw someone to a professional life on the water, whether it be lobstering, clamming, sailing freight ships, doing marine biology research, or starting an aquaculture operation. Respondents chose two more factors as very influential but not quite as influential as the first three. A desire to support the local economy and interest in the topic of aquaculture strongly influenced all producers except one. All five of these most and very influential factors fell into either the Personality or Values categories. These results suggest that people with certain personality traits and values are drawn to participate in aquaculture. The agreement among such a diverse pool of respondents indicates that the same factors might be chosen as influential by an even larger group of people.

Many people said that factors in the Capacity category strongly influenced them or somewhat influenced them, but there were no factors everyone agreed were a strong influence. This result indicates that while Capacity factors can play a role in starting an aquaculture operation (after all, you do need capital, equipment, and certain skills), they were not the primary factors that pushed people to make the final decision to participate in aquaculture. It also indicates that people come to aquaculture with different skill sets and material assets and therefore have different strengths and gaps in their capacities to participate in aquaculture.

We did not include people who do not participate in aquaculture in this study. Doing so might reveal if there are people who want to participate in aquaculture but cannot due to capacity constraints or other factors. It may be that people who already participate in aquaculture see capacity constraints as secondary, while those who do not participate see them as of primary importance.

Policy Recommendations

The results of this study indicate that aquaculture can provide some commercial fishermen with a supplemental or alternative source of income that is complementary to their current line of work. Other people may be interested in participating in this sector of the marine economy as well. Our findings have some potential policy implications for those interested in growing Maine's aquaculture workforce and improving the ability of current aquaculturists (especially less experienced aquaculturists) to operate effectively.

Several aquaculturists interviewed for this study indicated that opportunities exist for many more people to start doing aquaculture in the state. Both interview and survey data indicate that Personality and Values factors played a larger role in people's decisions to pursue aquaculture than Capacity factors. Capacity factors can be thought of as components of the question: Can I do aquaculture? And Personality and Values factors can be thought of as components of the question: Do I want to do aquaculture? You cannot participate if you do not have access to certain skills or material assets that give you the capacity to do aquaculture (e.g. capital to cover start-up costs, a boat to check on the rig). But you are more likely to participate if you have certain personality traits and values that are well-suited to a professional life in aquaculture (e.g. a desire to participate in an environmentally sustainable activity, an entrepreneurial approach to the endeavor). Targeting people with these qualities to participate in aquaculture training or other capacity-building programs might be an effective way of increasing the number of successful aquaculturists in Maine. This information may help government, non-profit, and private organizations interesting in building the aquaculture workforce.

Another policy recommendation is to address gaps in capacity for new aquaculturists. While interviewees were strongly influenced to participate in aquaculture by a clear set of Personality and Values factors, they were influenced to varying degrees by Capacity factors. Each producer faces different challenges in his capacity to do aquaculture. Some people need to access more capital so they can invest in more equipment, while others need to learn more about boat handling or oyster biology. Helping new aquaculturists be successful likely means addressing a wide variety of needs and tailoring training and other support to individual circumstances. Ensuring that aquaculturists are well-versed in both the business side of aquaculture and the hands-on side is crucial. Our results indicate that aquaculture training programs that address both skillsets (or tailor the program to suit participants' needs) will be most helpful to potential aquaculturists.

A final policy recommendation is to learn more about the barriers to entry for people who do not participate in aquaculture. Do they not participate because their personal characteristics and interests are not well-suited to aquaculture or because they do not have the materials or skills to participate? In other words, is it a lack of capacity or a personal incompatibility with aquaculture that prevents them from participating? Knowing more about this would help organizations interested in increasing Maine's aquaculture workforce focus their recruiting initiatives.

As Maine's aquaculture industry matures, the people participating may change, along with the factors that influence them to participate. Many current aquaculturists may see themselves as entrepreneurs and pioneers. As best practices become established and knowledge about how to successfully do aquaculture in Maine waters becomes more readily available, people who were not willing to take large risks early in the industry's development may wish to become involved. Scaling up of current businesses could attract a different type of person to aquaculture as business founders seek employees. Conversations about lobstering and climate change will also shape the aquaculture industry. Climate change is a popular topic right now, so it makes sense that many of the aquaculturists in the study cited

future fisheries outlook and the environmental benefits of aquaculture as two of the major reasons they decided to participate. But as other major issues bubble up in society's collective consciousness, shifts may occur in who participates in aquaculture and why. The analysis we have presented here is a snapshot in time of an industry in the making.

While shellfish and seaweed aquaculture is a relatively young sector of the Maine economy, the energy around it is building, and its potential is great. It can contribute to economic diversification at the household and community levels, buffering island and coastal communities against potential changes to the environment that could profoundly impact their livelihoods. Aquaculture is an opportunity in the state of Maine that has not yet been fully realized, especially for communities whose lifeblood is the ocean.

Sources

1. Maine Department of Marine Resources. Historical Maine Lobster Landings. (2016).
2. Maine Department of Marine Resources. Maine Commercial Landings. (2016). at <http://www.maine.gov/dmr/commercial-fishing/landings/documents/AnnualAllSpecies.table.pdf>
3. Steneck, R. S. *et al.* Creation of a Gilded Trap by the High Economic Value of the Maine Lobster Fishery. *Conserv. Biol.* **25,** 904–912 (2011).
4. Maine Department of Marine Resources. Aquaculture Lease Inventory. (2016). at <http://www.maine.gov/dmr/aquaculture/leases/inventory/index.html>
5. Casco Bay Estuary Partnership. What We Do. *Casco Bay Estuary Partnersh. Website* (2016). at <http://www.cascobayestuary.org/about-us/what-we-do/>
6. Casco Bay Estuary Partnership. Casco Bay Plan 2016-2021. (2016). at <http://www.cascobayestuary.org/wp-content/uploads/2014/04/Casco-Bay-Plan-2016-2021-Casco-Bay-Estuary-Partnership.pdf>
7. Maine Department of Marine Resources. Preliminary 2015 Commercial Maine Landings By Ex-vessel Value. *State Maine Dep. Mar. Resour. Website* (2016). at <http://www.maine.gov/dmr/commercial-fishing/landings/documents/2015ValueBySpecies.Pie.Graph.pdf>
8. Maine Department of Marine Resources. Lobster Zone License and Trap Tag Annual Summary. *State Maine Dep. Mar. Resour. Website* (2016). at <63. http://www.maine.gov/dmr/science-research/species/lobster/documents/lictagsummary7-20-15.pdf >
9. Johnson, C. *et al. Final Report of the Commission to Study the Effects of Coastal and Ocean Acidification and its Existing and Potential Effects on Species that are Commercially Harvested and Grown along the Maine Coast*. (2015).
10. Dupont, S. & Portner, H. Marine Science: Get Ready for Ocean Acidification. *Nature* **498,** 429 (2013).
11. Cheung, W. *et al.* Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change. *Local Chang. Biol.* **16,** 24–35 (2010).
12. Branch, T. A., DeJoseph, B. M., Ray, L. J. & Wagner, C. A. Impacts of Ocean Acidification on Marine Seafood. *Trends Ecol. Evol.* **28,** 178–186 (2013).
13. Le Quesne, W. & Pinnegar, J. The potential impacts of ocean acidification: scaling from physiology to fisheries. *Fish Fish.* **13,** (2011).
14. Griffith, G. P., Fulton, E. A. & Gorton, Rebecca, Richardson, A. J. Predicting interactions among fishing, ocean warming, and ocean acidification in a marine system with whole-ecosystem models. *Conserv. Biol.* **26,** 1145–1152 (2012).
15. Sumaila, U. R., Cheung, W. W. L., Lam, V. W. Y., Pauly, D. & Herrick, S. Climate change impacts on the biophysics and economics of world fisheries. *Nat. Clim. Chang.* **1,** 449–456 (2011).
16. Holland, D. S. Planning for changing productivity and catchability in the Maine lobster fishery. *Fish. Res.* **110,** 47–58 (2011).
17. Adger, N. Social and ecological resilience: are they related? *Prog. Hum. Geogr.* **24,** 347–364 (2000).
18. Henry, A. M. & Johnson, T. R. Understanding Social Resilience in the Maine Lobster Industry. *Mar. Coast. Fish.* **7,** 33–43 (2015).
19. Ellis, F. The Determinants of Rural Livelihood Diversification i n Developing Countries. *J. Agric. Econ.* **51,** 289–302 (2000).
20. Mills, D. J., Adhuri, D. S., Phillips, M. J., Ravikumar, B. & Padiyar, A. P. Shocks, recovery trajectories and resilience among aquaculture-dependent households in post-tsunami Aceh,

Indonesia. *Local Environ.* **16,** 425–444 (2011).
21. Barbieri, C. & Mahoney, E. Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers. *J. Rural Stud.* **25,** 58–66 (2009).
22. Cowperthwaite, H. & Clime, R. *Maine Seafood Study*. (2015).
23. Goodyear, D. A New Leaf. *New Yorker* (2015). at <http://www.newyorker.com/magazine/2015/11/02/a-new-leaf>
24. Jolly, D. Fish Farming Overtaking Traditional Fisheries. *New York Times* (2011). at <http://www.nytimes.com/2011/02/01/business/global/01fish.html>
25. Greenberg, P. *American Catch: The Fight for Our Local Seafood*. (Penguin Books, 2014).
26. Shekhtman, L. US waters create potential for shellfish farming. *Boston Globe* (2014). at <https://www.bostonglobe.com/business/2014/11/23/musseling/85M5oCVF8XorWFuAFVVo8M/story.html>
27. Christian, J. New England seaweed the next big thing in local food? *Boston Globe* (2015). at <https://www.bostonglobe.com/lifestyle/2015/10/04/seaveg/aABLT2CSS56eWyqlY2ueBN/story.html>
28. Belle, S. *Personal Communication*. (2016).
29. The Limits of Aquaculture. *New York Times* (2005). at <http://www.nytimes.com/2005/06/10/opinion/the-limits-of-aquaculture.html?_r=0>
30. Greenberg, P. Don't Discount (Smart) Fish Farming. *New York Times* (2015). at <http://www.nytimes.com/roomfordebate/2013/03/03/too-few-fish-in-the-sea/dont-discount-smart-fish-farming>
31. Arnold, S. Can growing sugar kelp locally reduce ocean acidification in Maine's waters? *Work. Waterfr.* (2016). at <http://www.islandinstitute.org/blog-post/can-growing-sugar-kelp-locally-reduce-ocean-acidification-maine%E2%80%99s-waters>
32. Flannery, T. Seaweed could save the world's oceans from becoming too acidic. *Quartz* (2015). at <http://qz.com/534553/seaweed-could-save-the-worlds-oceans-from-becoming-too-acidic/>
33. Normandeau Associates Inc. *Maine Aquacultue Review*. (2003).
34. *Governor's Task Force on the Planning and Development of Marine Aquaculture in Maine: Report and Recommendations*. (2004). at <http://www.maine.gov/dmr/aquaculture/aqtaskforce/AQTF_FullReport2-13.pdf>
35. Cooke, F. M. Symbolic and social dimensions in the economic production of seaweed. *Asia Pac. Viewp.* **45,** 387–400 (2004).
36. Schrobback, P., Pascoe, S. & Coglan, L. Shape up or ship out: Can we enhance productivity in coastal aquaculture to compete with other uses? *PLoS One* **9,** 1–25 (2014).
37. Maine Department of Marine Resources. *Findings of Fact, Conclusions of Law, and Decision: Ocean Approved, LLC Lease CAS-CHEB*. (2012).
38. Anonymous Aquaculturist. *Personal Communication*. (2016).
39. Northeast Aquaculture Conference & Exposition: Program and Abstract. in (2015).
40. Groening, T. Stonington: A Town on the Edge. *Isl. J.* **31,** (2015).

Appendix A: Interview questions

1. Please describe your aquaculture operation.

    a. What is your role in the aquaculture operation? (owner, investor, technical support, laborer) How many employees do you have?

    b. Where (generally) is your farming operation? What species do you grow? How long have you/your company been in existence? What kinds of lease(s) do you have and how do you use them? How many years into your lease(s) are you? How much space do you use to farm? How big is your operation? Do you have a processing or shore-side facility of some sort (on the waterfront or elsewhere)?

    c. Can you describe your market?
    Prompts: What kinds of people/groups do you sell to? Wholesale or retail (middle man vs. final consumer)? What is the geographic distribution of you market?

    d. What motivated you to become involved in aquaculture?

2. What did you do before aquaculture? Have you ever been involved in another marine industry, or are you still currently involved? If so, what? What is your educational background?

3. What was the transition process to aquaculture like?

    a. What knowledge, skills, equipment, or attitudes did you have to acquire? Did you already have some of what you needed?

    b. How has the regulatory process impacted your participation in aquaculture?

    c. How long did it take you or will it take you to cover your start-up costs and start making a profit?

4. Please characterize the stage you are at in your career. Options: pre-career, early career, mid-career, late career, post career (retirement), career break, other.

5. Please characterize aquaculture as a source of income for you. Options: primary, secondary, hobby, other. Do you currently have another source of income?

6. Estimate the percentage of your income comes from aquaculture. Do you anticipate it ever being 100% of your income?

7. Characterize the intensity of your participation in aquaculture. Where along the spectrum (below) do you fall?

Small hobby operation Large operation that is sole source of income

8. Do you think aquaculture is one viable way of maintaining a culture of fishing and living off the water? In what ways would aquaculture change the current fishing culture?

9. What's the typical working waterfront of your community? Past/present? Does aquaculture fit with your working waterfront/the culture of your community?

10. Is there anyone else I should interview? How willing are they?

11. If other questions come up, can I contact you again?

Appendix B: Questionnaire for the Island Institute Aquaculture Business Development Group

Page 1
Welcome

Welcome to the survey for the Island Institute's Aquaculture Business Development Group. The survey is part of a research study on Maine's growing aquaculture sector. On the next page you will find a consent form that provides you with information about this research study and documents your decision to participate, should you choose too.

Page 2
Consent Page

For full text of Consent Page, contact author.

Page 3
Part I: Motivations

Choices for each question in this section were "strongly influenced," "somewhat influenced," or "not influenced." Each question also had a comment box.

1. Access to training programs

   I am _____ by my ability to access structured training programs that make learning about aquaculture easier.

2. Availability of equipment

   I am _____ by the availability of equipment that I need for aquaculture.

3. Technical ability

   I am _____ by my knowledge of how aquaculture equipment works or my ability to figure it out without too much difficulty.

4. Mentorship

   I am _____ by the support and guidance of a family member, friend, or acquaintance who already participates in aquaculture.

5. Previous marketing knowledge, skills, and connections

   I am _____ by my knowledge of how to sell or market my product.

6. Reputation of the aquaculture industry

   I am _____ by a desire to be associated with the aquaculture industry and its culture.

7. Future fisheries outlook

   I am _____ by a belief that other existing fisheries, like lobster, will be affected by climate change or other unpredictable forces.

8. Seasonality

   I am _____ by the fact that the busy season for aquaculture does not overlap with the busy season for my other job (if I have one).

9. Learning curve

   I am _____ by an expectation of how easy or difficult it will be for me to learn how to do aquaculture.

10. Enjoyment

    I am _____ by the enjoyment I expect to experience while doing aquaculture.

11. Risk tolerance

    I am _____ by my ability to handle the uncertainty of whether or not my aquaculture operation will be a success.

12. Money-making capacity of aquaculture

    I am _____ by an expectation that aquaculture will make me money.

13. Relative income

    I am _____ by an expectation that my total income will increase if I do aquaculture.

14. Steadiness of income

    I am _____ by an expectation that my income will become steadier if I do aquaculture.

15. Time: Supply

    I am _____ by the amount of free time I have to try a new activity.

16. Time: Demand

    I am _____ by the amount of my time I think aquaculture will take.

17. Access to capital

    I am _____ by my access to the capital (money, equipment) needed to start an aquaculture operation—from savings, investors, loans, or another source.

18. Entrepreneurial attitude

    I am _____ by a desire to start new projects and talk to people about new ideas.

19. Local economy

    I am _____ by a desire to contribute to the local economy.

20. Environmental benefits

    I am _____ by a desire to participate in an activity that benefits the environment.

21. Ties to the ocean

    I am _____ by ties to the ocean or a desire to work on the water.

22. Legacy

    I am _____ by the desire to leave a legacy, of which I think aquaculture can be a part.

23. Interest in the topic

    I am _____ by a belief that aquaculture is an interesting topic and a desire to learn more about it.

24. Other #1 (Optional): Is there anything that influences you to be involved in aquaculture that was not listed as a motivation above? If so, please list it in the comment box and select its level of influence.

25. Other #2 (Optional): Is there anything that influences you to be involved in aquaculture that was not listed as a motivation above? If so, please list it in the comment box and select its level of influence.

26. Other #3 (Optional): Is there anything that influences you to be involved in aquaculture that was not listed as a motivation above? If so, please list it in the comment box and select its level of influence.

Part II: Demographic Information

27. What kind of aquaculture lease do you have or do you plan to apply for in the near future? (Check all that apply.)

- ☐ LPA
- ☐ Experimental
- ☐ Standard

28. In which part of Maine do you plan to locate your aquaculture operation? (Check all that apply.)

- ☐ Downeast (east of Blue Hill Peninsula)
- ☐ Penobscot Bay (Rockland northward/eastward)
- ☐ Mid-coast Maine (south/west of Rockland)
- ☐ Casco Bay (south/west of Bath)
- ☐ Other (please specify)

Comments

29. What do you plan to grow? (Check all that apply.)

- ☐ Kelp
- ☐ Oysters
- ☐ Mussels
- ☐ Other (please specify)

30. How long have you been involved in aquaculture?

31. What industry do you currently work in? (Check all that apply.)

- ☐ Ground Fishing
- ☐ Lobstering
- ☐ Boatbuilding
- ☐ Wild Mussel Harvesting
- ☐ Fish Processing
- ☐ Aquaculture (my own business)
- ☐ Aquaculture (as an employee)
- ☐ Other (please specify)

32. If you are currently fishing, indicate which licenses you hold. (Check all that apply.)

- [ ] Not currently fishing
- [ ] Ground Fishing
- [ ] Lobster
- [ ] Shellfish
- [ ] Aquaculture
- [ ] Other (please specify)

33. Where do you currently live? (Choose one.)

- ○ Downeast (east of Blue Hill Peninsula)
- ○ Penobscot Bay (Rockland northward/eastward)
- ○ Mid-coast Maine (south/west of Rockland)
- ○ Casco Bay (south/west of Bath)
- ○ Other (please specify)

34. What is your age?

- ○ 18-25
- ○ 25-30
- ○ 30-40
- ○ 40-50
- ○ 50-60
- ○ 60-70
- ○ 70+

35. What is your gender?