

Study on Public Perceptions on Seaweed Aquaculture in Maine

by

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EXECUTIVE SUMMARY

As interest in sustainable food systems and climate-resilient industries grows, seaweed aquaculture has emerged as a promising sector with both environmental and economic benefits. In Maine, the seaweed farming industry has expanded rapidly over the past decade, offering opportunities for coastal economic diversification and the revitalization of traditional working waterfronts. However, the pace and success of industry development depend not only on technical feasibility and ecological impact, but also on public acceptance and stakeholder alignment. This study examines public perceptions of seaweed aquaculture in Maine using data from a multi-state survey conducted by Qualtrics in the summer of 2023. The survey includes 1,011 respondents from Florida, Maine, and North Carolina, with a specific focus on attitudes, knowledge, and demographic trends related to seaweed farming.

Survey respondents were asked to evaluate 17 statements related to seaweed aquaculture across six thematic categories: aesthetics, management, economy, environment, food security, and cultural identity. Responses were analyzed using statistical methods, including Spearman's rank correlations, ANOVA tests, and independent samples t-tests. These methods allowed us to assess relationships between perceptions and key demographic variables such as age, education, income, political affiliation, distance from the coast, and personal engagement with seafood harvesting.

Findings indicate that overall public sentiment toward seaweed aquaculture in Maine is broadly favorable. Respondents showed the highest levels of agreement with statements supporting public participation in aquaculture decision-making, the role of seaweed farming in preserving maritime traditions, and its potential to generate good, locally held jobs. There is also moderate agreement that seaweed farming contributes to local and national food security, although responses in this area suggest some public uncertainty or limited awareness. Conversely, participants were more likely to express concern about water pollution and climate change as external threats to the industry than about negative environmental impacts caused by seaweed farming itself. The industry is generally seen as environmentally benign or beneficial, particularly when compared to more controversial forms of marine aquaculture like finfish farming.

Demographic factors were consistently correlated with levels of support. Older respondents, those with higher educational attainment, and individuals with greater household income were significantly more likely to express positive views of seaweed aquaculture. These groups were also less likely to perceive it as a threat to coastal cultural identity or as environmentally damaging. Meanwhile, rural residents and those living farther from the coast tended to be more skeptical, with lower agreement across several thematic areas. Notably, rural respondents were less likely to see seaweed aquaculture as contributing to food security or preserving traditional

livelihoods, suggesting a disconnect between rural coastal communities and the current trajectory of industry messaging and development.

The study also highlights concerns about equity and corporate access. One of the least supported statements was the idea that large companies should have equal leasing rights to local families and small-scale farmers. This finding points to a strong public preference for community-based ownership, local control, and policies that ensure the benefits of aquaculture are equitably distributed. These attitudes align with broader patterns observed in Maine around natural resource governance and the preservation of local identity.

In conclusion, this study provides a data-driven foundation for designing public engagement strategies, educational campaigns, and policy frameworks that reflect community values. While general support for seaweed aquaculture is strong, the industry's continued growth will depend on its ability to address concerns about equity, cultural relevance, regulatory transparency, and localized benefit. The findings underscore the importance of demographic segmentation in outreach and the value of situating seaweed aquaculture within narratives of coastal heritage, environmental stewardship, and community resilience. These insights are critical for ensuring that seaweed aquaculture not only grows sustainably but also earns lasting public trust and legitimacy.

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1. INTRODUCTION

1.1 General Background of Global Seaweed Aquaculture Industry

Large-scale seaweed aquaculture is being pursued globally as a solution to various contemporary challenges, including climate change, food security, and ecosystem degradation (Spillias, 2022). As of 2019, global seaweed aquaculture experienced remarkable growth, with total output—combining both wild harvest and aquaculture—nearly tripling from 118,000 tons in 2000 to 358,200 tons (Zhang, 2022). 97% of global seaweed production comes from aquaculture. Asia plays a leading role, contributing 97.38% of the world's aquaculture seaweed, with 99% of its production derived from artificial cultivation (Zhang, 2022).

China is the world's largest producer, responsible for 56.82% of global output (Zhang, 2022). Its main cultivated species include *Laminaria japonica*, *Gracilaria spp.*, and *Porphyra spp.* (Zhang, 2022). Indonesia follows with 28.6%, focusing primarily on *Eucheuma spp.* and *Gracilaria spp.* (Zhang, 2022). South Korea ranks third with 5.09%, cultivating a variety of seaweeds such as *Laminaria japonica*, *Porphyra tenera*, and *Undaria pinnatifida* (Zhang, 2022). In contrast, North America contributes a smaller portion—around 1.36% of global production. 95% of the seaweed production in North America is obtained from natural sources rather than farming (Zhang, 2022).

Seaweed farming in Maine, USA, has grown exponentially over the last five years. Between 2017 and 2022, three notable improvements were observed in kelp farms across the region: (1) median seaweed yield increased by 28%, from 3.3 to 4.24 lbs./ft.; (2) labor efficiency improved by 1,275%, from a median of 7.55 to 103.8 lbs. harvested per hour of labor and management input; and (3) median net margin, or net farm income, per pound harvested increased from minus \$6.41 to \$0.16/lb. (Braydon, 2024) These gains can likely be attributed to increased farmer knowledge, "learning by doing," extension support, improved seed production, and economies of scale. When farms were categorized by size, net margins per pound increased and breakeven prices decreased with farm size, highlighting the advantages of scaling up (Braydon, 2024).

Seaweed production in Maine has primarily remained a secondary source of income for fishermen. Researchers observed that many fishermen and shellfish farmers used seaweed farming as a means of supplementary income (Braydon, 2024). However, while long-term profitability is possible, the initial investment is significant. Respondents reported a median startup and investment cost of \$3.07 per foot of planted longline, with a median net margin of only \$0.85/ft. The data suggest that seaweed farming is not a quick-profit industry but presents opportunities for diversification within Maine's working waterfront. Some farmers were able to achieve

a worthwhile supplementary income with minimal (~30 days) time input (Braydon, 2024).

Despite its growing significance, the public's perception and awareness of seaweed farming remain limited, influencing its expansion and acceptance.

1.2 Consumer Attitudes Toward Seaweed Products

Consumer knowledge and perceptions of seaweed significantly influence willingness to try new seaweed-based products (Zheng et al., 2024). Studies suggest that familiarity with seaweed, along with perceptions of its quality, price, and availability, positively affect consumer intentions to try new seaweed-flavored products. (Zheng et al., 2024) However, non-consumers often have distinct reasons of their own for avoiding seaweed, some of which directly impact their openness to trying new products (Zheng et al., 2024).

The study by Zheng et al. in 2024 provides a comprehensive examination of U.S. consumer attitudes toward seaweed products, distinguishing between current seaweed consumers and non-consumers to uncover the sociodemographic, perceptual, and behavioral factors that influence purchase intentions. Seaweed, while novel in Western cuisine, is increasingly recognized for its nutritional and environmental benefits, yet only 36% of U.S. respondents reported consuming it, highlighting the market's early development stage. The study finds that seaweed consumers are generally younger, more racially and ethnically diverse, better educated, and have higher household incomes than non-consumers; they also tend to reside in coastal regions and be the primary food shoppers in larger households with children. These consumers most often use seaweed in sushi, soups, salads, and snacks, and they rate its quality, price, and availability relatively favorably. Their purchase intentions are positively influenced by both subjective and objective knowledge about seaweed, as well as by perceptions of its quality and price, with female consumers and those with graduate degrees showing stronger interest in trying new seaweed-flavored products. In contrast, non-consumers tend to be older, more likely to be White and female, less educated, and located in the Midwest and South; many cite unfamiliarity, uncertainty about preparation, and dislike of the taste as key barriers. However, the study reveals that non-consumers who are unaware of seaweed, unsure how to prepare it, or find it inaccessible are actually more likely to be open to trying it, suggesting that informational and product access interventions could be effective. On the other hand, those who dislike the taste, have allergies, or worry about environmental contamination show significantly lower purchase intentions, with taste being the most difficult barrier to overcome. To expand the seaweed consumer base, the study recommends targeted education, recipe development, increased availability, and sensory improvements through reformulation or culinary innovation. The authors also suggest that rebranding seaweed to avoid negative associations with the word "weed," and highlighting its sustainability benefits, could enhance public perception and market penetration. Ultimately, the findings underscore the importance of tailored

marketing and educational strategies that address the unique concerns and motivations of both seaweed consumers and nonconsumers in order to grow the U.S. seaweed market and leverage its potential for healthier diets and sustainable food systems.

1.3 Public Communication of Marine Aquaculture

Marine aquaculture (MA) faces significant communication challenges. Despite advancements in efficiency, performance, and sustainability, skepticism from social and political spheres continues to hinder industry expansion, particularly in the United States (Boyd et al., 2020; Costello et al., 2020; Gephart et al., 2020; Naylor et al., 2021; Tlusty et al., 2019). Vocal opposition groups have played a substantial role in shaping public discourse on MA, often leaving public audiences with an impression of its risks rather than its benefits. Paired with a general lack of public awareness, this has led to a skewed perception of MA as a high-risk industry without a commensurate understanding of its potential advantages in mitigating climate change and food insecurity (Billing, 2018; Froehlich et al., 2017; Hall & Amberg, 2013; Rickard et al., 2018; Risius et al., 2017; Weitzman & Bailey, 2019). These challenges, well-documented in the broader aquaculture sector, raise important questions about how seaweed aquaculture is perceived in comparison.

Media coverage further exacerbates this issue. In a 15-year analysis of aquaculture media reports in New England, Rickard et al. (2018) found that media outlets disproportionately emphasized environmental and human health risks, largely overshadowing the potential benefits of aquaculture. Similar trends have been observed in media coverage across the United States and beyond (Froehlich et al., 2017; Weitzman & Bailey, 2019). This imbalance has shaped public perception, making it more difficult for the industry to gain widespread support (Froehlich et al., 2017; Rickard et al., 2018; Weitzman & Bailey, 2019).

However, seaweed aquaculture presents a unique case within the broader marine aquaculture sector. Unlike finfish farming, which has often been the focus of environmental scrutiny, seaweed cultivation is frequently associated with positive ecological impacts, such as nutrient absorption, carbon sequestration, and habitat enhancement (Rickard et al., 2018). Because seaweed does not require feed, antibiotics, or freshwater inputs, it avoids many of the controversies that plague finfish and shellfish aquaculture. In media narratives analyzed by Rickard et al. (2018), while seaweed was mentioned less frequently than other forms of aquaculture, it tended to appear in more favorable contexts, often framed as a “green” or low-impact industry (Rickard et al., 2018). This suggests that seaweed farming may offer a strategic entry point for improving public perception and expanding sustainable aquaculture practices. Still, awareness remains low, and seaweed aquaculture is often lumped into the general category of marine farming, risking the transfer of negative associations from other aquaculture forms. Effective public

communication strategies must therefore distinguish seaweed aquaculture clearly from more controversial operations, highlighting its unique environmental and economic contributions

1.4 Objective

The primary objective of this study is to assess public perceptions, knowledge, and attitudes toward marine seaweed aquaculture in Maine, US. This study aims to analyze public sentiment toward seaweed aquaculture. By identifying which aspects of seaweed farming are viewed positively or negatively, the study aims to highlight areas where greater public engagement or education may be needed.

Another goal is to assess the level of public knowledge about seafood production and how it relates to perceptions of seaweed farming. Understanding whether individuals feel well-informed or uncertain about aquaculture can provide insights into potential gaps in public awareness and where targeted informational efforts may be beneficial.

Ultimately, this research aims to provide valuable insights for policymakers, industry stakeholders, and environmental organizations seeking to promote sustainable aquaculture. By identifying public concerns, areas of support, and potential barriers to acceptance, the study can help guide strategies for better communication, policy development, and industry growth in a way that aligns with community values and expectations.

2. METHODS

2.1 Survey

The data used in this study come from a survey developed by researchers from Duke University, Eckerd College, the Coastal Studies Institute, and the University of Maine. It was administered by the survey company Qualtrics during the summer of 2023, and included respondents from Florida, Maine, and North Carolina. It was designed to assess public perceptions, consumption habits, and knowledge of seafood and marine aquaculture in the United States. The survey includes a wide range of questions that explore demographic details, seafood purchasing behavior, and attitudes toward different types of aquaculture, including shellfish, finfish, and seaweed farming. For the sake of the study, we selected results of questions relative to seaweed farming (Table. 1). Respondents were asked to evaluate their level of agreement with 17 statements regarding of seaweed aquaculture in a Likert scale (Strongly agree = 1, Somewhat agree = 2, Neutral = 3, Somewhat disagree = 4, Strongly disagree = 5). The statements are categorized into 6 groups (Aesthetics, management, economy, environment, food security, cultural/pride) for assisting with further study. They were also asked to characterize perceptions of marine seaweed aquaculture in a Likert-type scale (Strongly positive = 1, Somewhat positive = 2, Neutral = 3, Somewhat negative =4, Strongly negative =5) and how knowledgeable they consider yourself about seafood production (Extremely knowledgeable =0, Very knowledgeable =1, Moderately knowledgeable =2,

Somewhat knowledgeable =3, Not knowledgeable =4).

The respondents were asked to provide their demographic information like their state and county of residence, distance from the coast, type of community they live in (rural, urban, or suburban), age, gender, education level, household income, political affiliation, and racial or ethnic background. Other questions include “Do you or a family member commercially fish or farm seafood,” “Do you or a family member fish or farm seafood for fun,” “How far is the coast from where you live.” The results of the questions were analyzed to identify trends, correlations, and key factors influencing public perceptions of seaweed aquaculture.

Statement No.	Category	Statement
1	Aesthetic	<i>The presence of seaweed aquaculture gear in the water reduces my enjoyment of the coast</i>
2	Management	<i>There should be more seaweed aquaculture in our state</i>
3	Economy	<i>My town does not benefit economically from seaweed aquaculture</i>
4	Economy	<i>Seaweed aquaculture provides good jobs</i>
5	Economy	<i>I think the jobs in seaweed aquaculture are filled by local people</i>
6	Management	<i>I think seaweed aquaculture is well-regulated in my state</i>
7	Food security	<i>Seaweed aquaculture in my state is contributing to local food security</i>
8	Food security	<i>Seaweed aquaculture in my state is contributing to national food security</i>
9	Economy	<i>Seaweed aquaculture is an important way to diversify local economies</i>
10	Cultural/Pride	<i>Seaweed aquaculture is a threat to the cultural identity for coastal communities in my state</i>
11	Management	<i>People in my state should have a say whether and how seaweed aquaculture is developed</i>
12	Management (equity)	<i>Big companies should have the same right as local families and farmers to get seaweed aquaculture leases in state waters</i>
13	Environment	<i>Seaweed aquaculture has negative impacts on the natural environment</i>
14	Management	<i>The state should help to grow the seaweed aquaculture industry here</i>
15	Cultural/Pride	<i>Seaweed aquaculture helps to maintain a tradition of working on the water in my state</i>
16	Environment*	<i>Climate change is a big threat to seaweed aquaculture in my state</i>
17	Environment*	<i>Water pollution is a threat to seaweed aquaculture in my state</i>

Table 1: Statement in the questionnaire regarding seaweed aquaculture in Maine, categorized in groups--Aesthetics, management, economy, environment, food security,

cultural/pride.

*

2.2 Statistics

This study utilized IBM SPSS Statistics software to analyze data and examine factors influencing public perceptions of seaweed aquaculture. The following statistical methods were applied:

Nonparametric Correlations

Spearman's rank correlation coefficient (Spearman's rho) was used to assess the relationships between the following variables and respondents' agreement levels with the 17 statements (Likert scale) as well as their overall perception of seaweed aquaculture:

1. Distance from the coast
2. Age
3. Education level
4. Household income
5. Frequency of seafood consumption
6. Self-reported knowledgeability about seafood production

Analysis of Variance (ANOVA Test)

A one-way ANOVA was conducted to examine differences in agreement with the 17 statements and overall perception of seaweed aquaculture based on political affiliation.

Independent Samples T-Test

Independent samples t-tests were performed to compare differences in agreement with the 17 statements and overall perception between groups based on the following binary variables:

1. Whether the respondent or a family member commercially fishes or farms seafood

2. Whether the respondent or a family member fishes or farms seafood for recreation
3. Whether the respondent lives in a rural area or not

A significance level of $\alpha = 0.05$ was used for all statistical analyses to determine significant relationships and key factors influencing public attitudes toward seaweed aquaculture.

3. RESULTS

3.1 Overview of Statement Agreement

Several findings emerge in public attitudes toward seaweed aquaculture in the United States. Respondents showed the strongest agreement (largest distance from a neutral response of three) with the idea that public involvement in decision-making is important. Statement 11, *“People in my state should have a say whether and how seaweed aquaculture is developed,”* had the lowest average score at 2.19, indicating widespread support for participatory governance in the development of the industry. Environmental concerns were also evident, with Statement 17, *“Water pollution is a threat to seaweed aquaculture in my state,”* receiving a low average of 2.41. This points to public awareness of ecological vulnerabilities that could impact the success of seaweed farming.

Economic and cultural benefits were also broadly supported. Respondents moderately agreed that jobs in seaweed aquaculture are filled by local people (Statement 5, average = 2.46), and that the practice helps to maintain traditional ways of working on the water (Statement 15, average = 2.48). Additionally, Statement 9, *“Seaweed aquaculture is an important way to diversify local economies,”* had an average score of 2.51, suggesting general support for its role in strengthening local economic resilience.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Average Response	3.3	2.6	2.6	2.6	2.5	2.7	2.7	2.8	2.5	3.2	2.2	3.4	3.1	2.6	2.5	2.7	2.4

Table 2. Average Scores of Responses for the 17 Statement

However, several statements received average scores near 3, indicating more mixed or neutral responses. For instance, Statement 1, concerning whether seaweed aquaculture gear reduces enjoyment of the coast, had an average of 3.25, suggesting that for many, it neither strongly detracts from nor enhances coastal enjoyment. Statement 10, which

posed the idea that seaweed aquaculture is a threat to cultural identity, averaged 3.22, reflecting mild disagreement and a lack of widespread concern about cultural conflict.

Notably, Statement 12—“*Big companies should have the same right as local families and farmers to get seaweed aquaculture leases in state waters*”—received one of the highest averages at 3.40, the highest level of disagreement among all the statements by the locals. This suggests a level of discomfort or opposition to corporate equality in access, possibly reflecting a preference for local ownership and community-based development. Similarly, Statement 13, which addressed negative environmental impacts, received an average score of 3.14, a neutral response that suggests that most respondents do not strongly associate seaweed aquaculture with either environmental harm or the opposite.

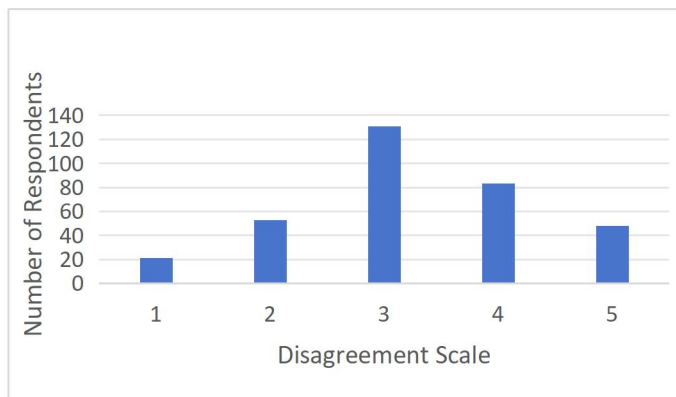
In summary, the data indicate that the public generally views seaweed aquaculture in a favorable light, especially in terms of economic opportunity, cultural preservation, and public governance. While environmental risks and corporate access raise some concern, the responses reflect cautious optimism about the role seaweed farming could play in sustainable coastal development.

3.2 Layout of Responses

Here is a categorized list of the survey statements by their thematic groupings, with statement numbers included:

Aesthetic

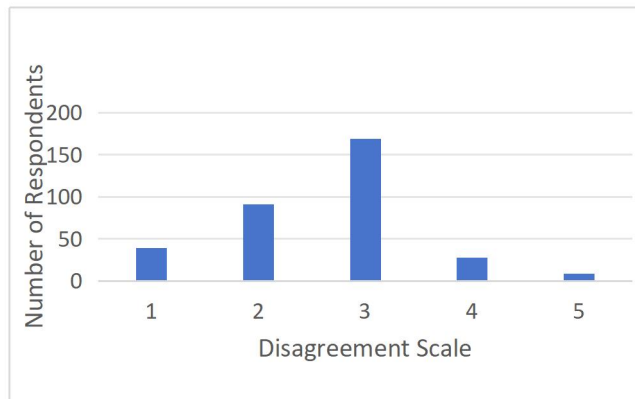
Statement 1: *The presence of seaweed aquaculture gear in the water reduces my enjoyment of the coast*



Responses suggest a generally **neutral to mildly positive** public attitude toward the aesthetic impact of seaweed aquaculture. While opinions vary, most people **do not view the gear as a major disruption** to their enjoyment of the coast.

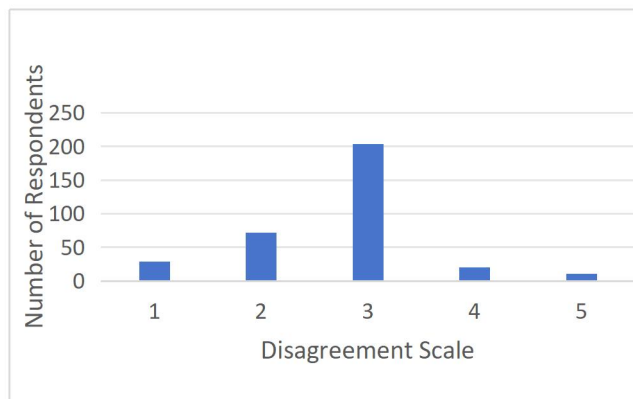
Management

Statement 2: *There should be more seaweed aquaculture in our state*



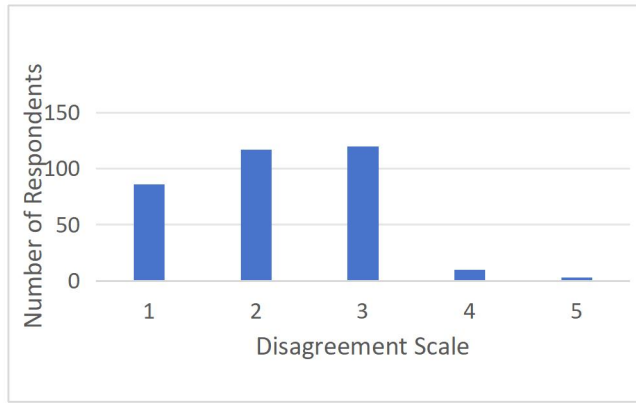
Most respondents are supportive or open to expanding seaweed aquaculture in the state.

Statement 6: *I think seaweed aquaculture is well-regulated in my state*



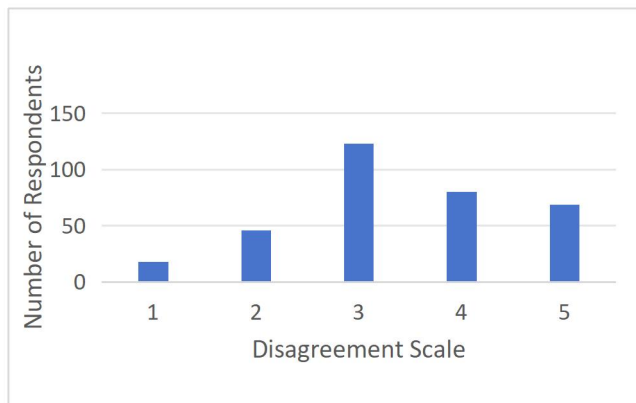
Responses are mostly neutral, indicating uncertainty or limited awareness about current regulations.

Statement 11: *People in my state should have a say whether and how seaweed aquaculture is developed*



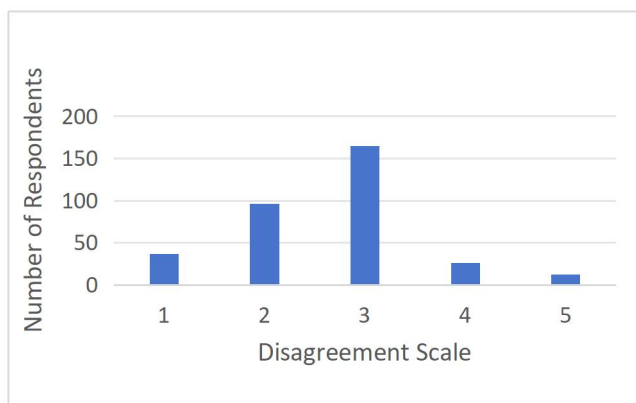
There is strong agreement that residents should have a say in how seaweed aquaculture is developed.

Statement 12 (Equity): *Big companies should have the same right as local families and farmers to get seaweed aquaculture leases in state waters*



Responses lean toward disagreement, showing reluctance to give big companies the same leasing rights as local families.

Statement 14: *The state should help to grow the seaweed aquaculture industry here*

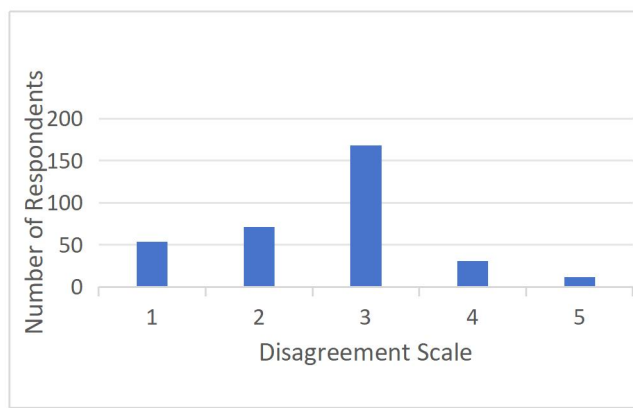


The majority support the idea that the state should play a role in promoting seaweed aquaculture.

Overall: Public opinion on management reflects general support for growth and clear interest in local participation and fairness. While expansion is welcomed, respondents value state involvement, community voice, and equity over broad corporate access. There is also a need to improve awareness or confidence in regulatory oversight.

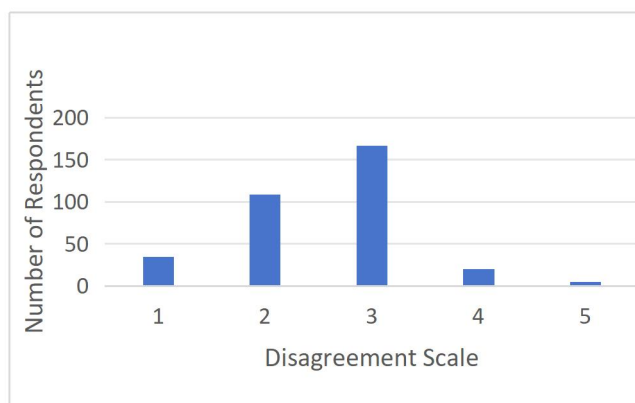
Economy

Statement 3: *My town does not benefit economically from seaweed aquaculture*



Responses are mixed, with many unsure or agreeing that their town does not benefit economically from seaweed aquaculture.

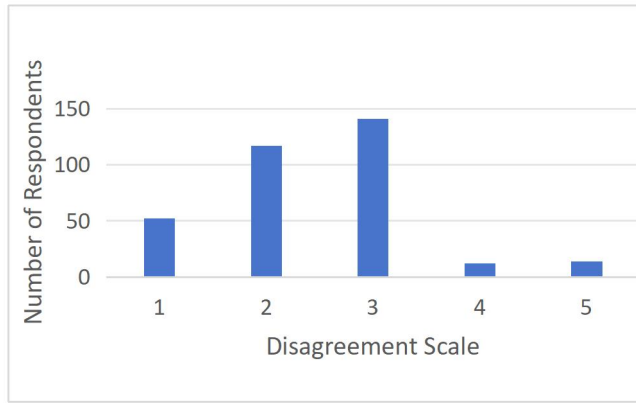
Statement 4: *Seaweed aquaculture provides good jobs*



Most respondents believe seaweed aquaculture provides good jobs, though some remain neutral.

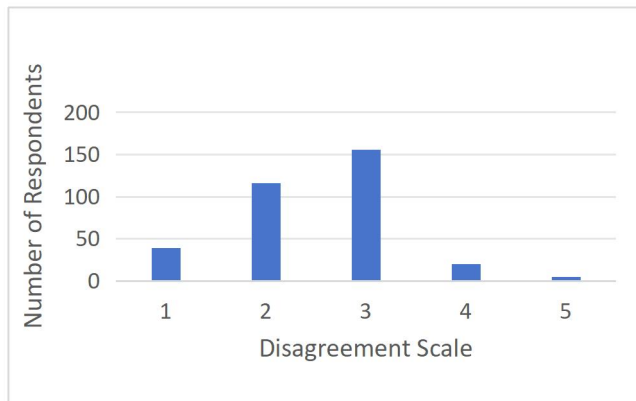
Statement 5: *I think the jobs in seaweed aquaculture are filled by local people*

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A majority tend to agree or remain neutral that local people fill jobs in the seaweed industry.

Statement 9: *Seaweed aquaculture is an important way to diversify local economies*

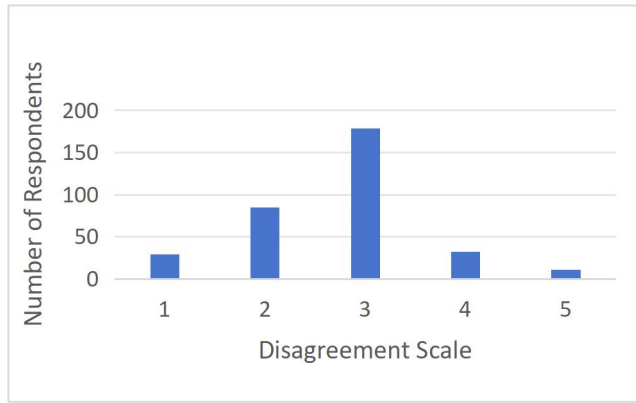


Responses reflect moderate agreement that seaweed aquaculture helps diversify local economies.

Overall: Public perceptions of the economic value of seaweed aquaculture are generally positive but cautious. While many believe in its potential to create good, locally held jobs and diversify the economy, uncertainty remains about how directly their own communities benefit—indicating room for greater visibility and community engagement around economic outcomes.

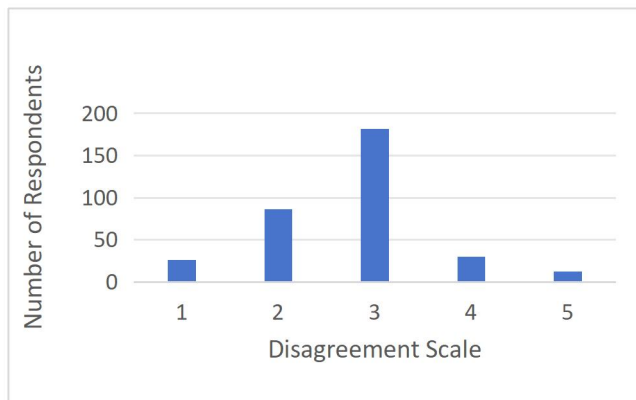
Food Security

Statement 7: *Seaweed aquaculture in my state is contributing to local food security*



Most respondents are neutral or somewhat agree that seaweed aquaculture contributes to **local food security**.

Statement 8: *Seaweed aquaculture in my state is contributing to national food security*

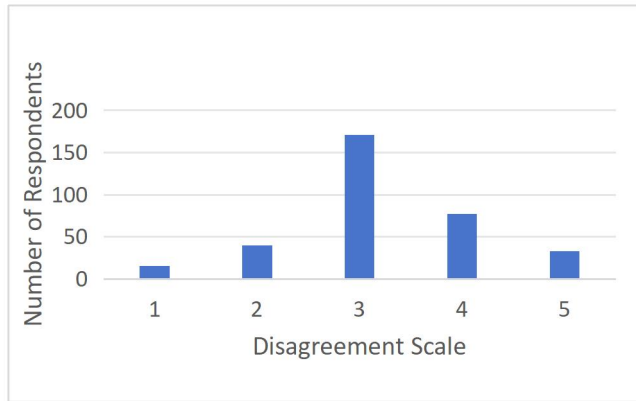


A similar pattern is seen regarding **national food security**, with many showing cautious agreement but limited strong support.

Overall: Public perception of seaweed aquaculture’s role in food security is moderately positive but not strongly affirmed. While respondents generally see potential, there appears to be uncertainty or a lack of clear connection between seaweed farming and direct food supply impact—suggesting an opportunity for greater public education on this issue.

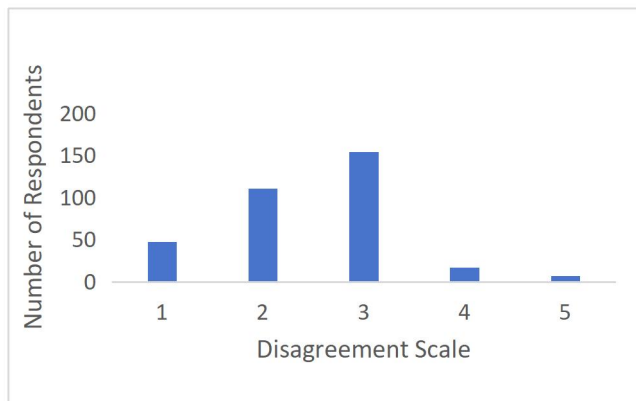
Cultural Identity / Pride

Statement 10: *Seaweed aquaculture is a threat to the cultural identity for coastal communities in my state*



Responses lean toward disagreement, suggesting that most people **do not see seaweed aquaculture as a cultural threat** to coastal communities.

Statement 15: *Seaweed aquaculture helps to maintain a tradition of working on the water in my state*

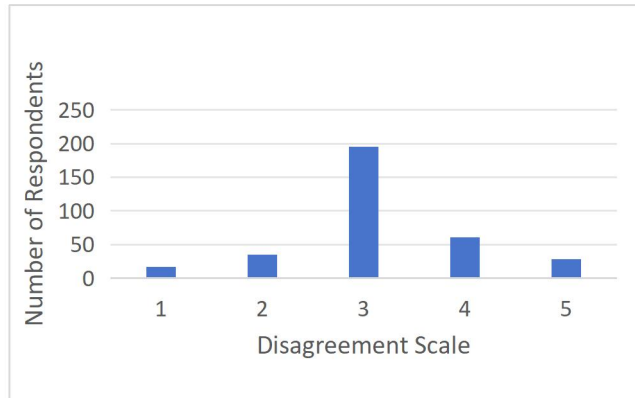


Many respondents agree or lean toward agreement that seaweed aquaculture **supports traditional maritime practices**.

Overall: Public perception of seaweed aquaculture’s cultural role is generally positive or neutral, with little concern about cultural harm and some recognition of its potential to preserve working waterfront traditions.

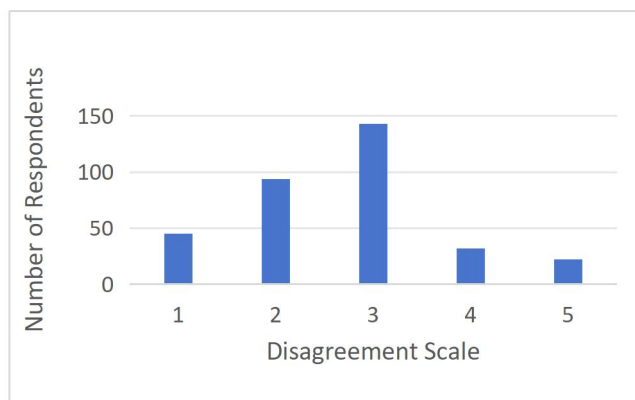
Environment

Statement 13: *Seaweed aquaculture has negative impacts on the natural environment*



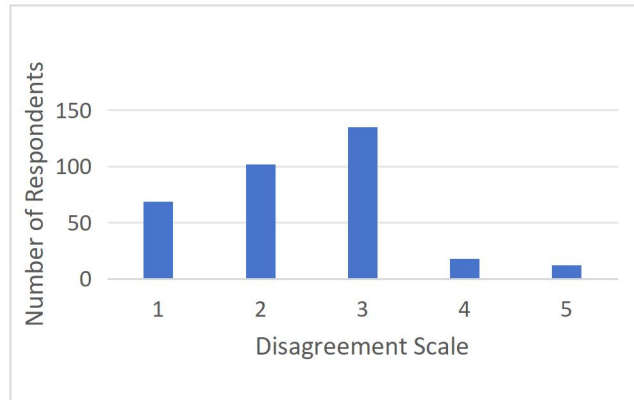
Most responses are neutral or disagree, suggesting that people **do not strongly associate seaweed aquaculture with environmental harm.**

Statement 16: *Climate change is a big threat to seaweed aquaculture in my state*



Responses reflect moderate agreement that **climate change is a threat** to seaweed aquaculture.

Statement 17: *Water pollution is a threat to seaweed aquaculture in my state*



A majority of respondents agree that **water pollution poses a threat** to seaweed aquaculture.

Overall: While the public generally sees **seaweed aquaculture as environmentally low-impact**, there is significant concern about **external environmental threats**, especially **climate change and water pollution**, which are perceived as risks to the industry's success.

3.3 Relationships between Attitudes and other key variables

Fish for Fun or not?

Related Question: Q23) Do you or a family member fish or farm seafood for fun?

The statement "*Climate change is a big threat to seaweed aquaculture in my state*" reveals a significant difference in perception between those who fish for fun and those who do not. Individuals who do **not** fish for fun are more likely to agree with this statement than those who do. This difference is statistically significant ($t(334) = 2.244$, $p = 0.025$, mean difference = 0.354, 95% CI [0.044, 0.665]), indicating that non-anglers perceive climate change as a greater threat to seaweed aquaculture compared to recreational fishers.

Fish for Money or Not?

Related Question: Q22) Do you or a family member commercially fish or farm seafood?

For Statement 7, “Seaweed aquaculture in my state is contributing to local food security,” individuals not involved in commercial fishing or seafood farming were more likely to agree with this statement compared to those who are. This difference is statistically significant ($t(334) = 2.531, p = 0.012$, mean difference = 0.335, 95% CI [0.075, 0.595]), suggesting that non-commercial respondents see greater food security value in seaweed aquaculture.

For Statement 16, “Climate change is a big threat to seaweed aquaculture in my state,” a similar trend is observed. Those not commercially fishing rated the climate threat higher than those who do, with statistical significance ($t(334) = 2.244, p = 0.025$, mean difference = 0.354, 95% CI [0.044, 0.665]). This indicates that commercial fishers are less likely to view climate change as a pressing risk to seaweed aquaculture.

Together, these findings point to a pattern: commercial fishing families are generally less concerned about both the benefits and vulnerabilities of seaweed aquaculture compared to non-commercial participants.

Lives in Rural?

Related Question: Q25) In what type of community do you live?

The analysis reveals that rural residents tend to view seaweed aquaculture less favorably than non-rural residents across multiple dimensions. For **Statement 11**, “*Seaweed aquaculture in my state is contributing to national food security*,” rural residents showed significantly lower agreement than non-rural respondents ($t(334) = 2.203, p = 0.028$, mean difference = 0.208, 95% CI [0.022, 0.394]). A similar pattern appears in **Statement 18**, “*Seaweed aquaculture helps to maintain a tradition of working on the water in my state*,” where rural respondents again expressed less agreement ($t(334) = 2.238, p = 0.026$, mean difference = 0.214, 95% CI [0.026, 0.403]). This trend continues with the **overall perception of seaweed aquaculture**, where rural participants rated it less positively overall ($t(334) = 2.760, p = 0.006$, mean difference = 0.265, 95% CI [0.076, 0.454]). These results suggest that rural residents are consistently more skeptical or less enthusiastic about the benefits and cultural value of seaweed aquaculture compared to their non-rural counterparts.

3.4 Statement Agreement in relation to Multiple Variables

In the result of the ANOVA-Test across agreement of different statements and multiple variables (see Table xxx), a number of combinations show statistically significant results (2-tailed significance at the 0.05 level). Below are the statements and variables combination that shows significant correlations.

			living distance from shore	Age	Education	Income
Spearman's rho	Statement 1	Correlation Coefficient	-.120*	.137*	.126*	0.086
		Sig. (2-tailed)	0.029	0.012	0.022	0.127
		N	327	336	334	317
	Statement 2	Correlation Coefficient	0.010	-0.078	-0.086	-0.091
		Sig. (2-tailed)	0.864	0.155	0.118	0.105
		N	327	336	334	317
	Statement 3	Correlation Coefficient	-.152**	-0.097	-0.035	0.090
		Sig. (2-tailed)	0.006	0.074	0.521	0.112
		N	327	336	334	317
	Statement 4	Correlation Coefficient	0.041	-0.073	-0.075	-0.071
		Sig. (2-tailed)	0.457	0.184	0.172	0.206
		N	327	336	334	317
	Statement 5	Correlation Coefficient	0.020	-.177**	-0.031	-.146**
		Sig. (2-tailed)	0.723	0.001	0.570	0.009
		N	327	336	334	317
	Statement 6	Correlation Coefficient	-0.076	0.039	0.083	-0.067
		Sig. (2-tailed)	0.173	0.482	0.131	0.236
		N	327	336	334	317
	Statement 7	Correlation Coefficient	-0.042	-0.018	0.026	0.023
		Sig. (2-tailed)	0.451	0.736	0.634	0.678
		N	327	336	334	317
	Statement 8	Correlation Coefficient	-0.027	0.033	0.033	-0.012
		Sig. (2-tailed)	0.627	0.549	0.542	0.835
		N	327	336	334	317
	Statement 9	Correlation Coefficient	0.090	-.114*	-.108*	-0.089
		Sig. (2-tailed)	0.105	0.036	0.048	0.115
		N	327	336	334	317
	Statement 10	Correlation Coefficient	-0.065	.135*	.154**	0.070
		Sig. (2-tailed)	0.244	0.013	0.005	0.211
		N	327	336	334	317

Statement 11	Correlation Coefficient	0.082	-0.101	-0.104	-0.065
	Sig. (2-tailed)	0.137	0.065	0.057	0.246
	N	327	336	334	317
Statement 12	Correlation Coefficient	-0.104	.184**	.142**	0.073
	Sig. (2-tailed)	0.061	0.001	0.010	0.195
	N	327	336	334	317
Statement 13	Correlation Coefficient	-0.074	.152**	.196**	0.105
	Sig. (2-tailed)	0.182	0.005	0.000	0.061
	N	327	336	334	317
Statement 14	Correlation Coefficient	-0.013	-.151**	-0.010	-0.078
	Sig. (2-tailed)	0.815	0.006	0.850	0.164
	N	327	336	334	317
Statement 15	Correlation Coefficient	.112*	-.111*	-0.081	-.110*
	Sig. (2-tailed)	0.042	0.041	0.139	0.050
	N	327	336	334	317
Statement 16	Correlation Coefficient	0.066	0.023	0.006	-0.012
	Sig. (2-tailed)	0.236	0.670	0.920	0.834
	N	327	336	334	317
Statement 17	Correlation Coefficient	0.048	-0.048	-0.036	0.017
	Sig. (2-tailed)	0.390	0.378	0.510	0.765
	N	327	336	334	317
overall attitude	Correlation Coefficient	0.049	-.155**	-.109*	-0.100
	Sig. (2-tailed)	0.379	0.004	0.046	0.076
	N	327	336	334	317

Table 3. Correlations between multiple variables and agreements.

Note: (1) **. Correlation is significant at the 0.01 level (2-tailed).

(2) *. Correlation is significant at the 0.05 level (2-tailed).

Statement 1: The presence of seaweed aquaculture gear in the water reduces my enjoyment of the coast

The statement *"The presence of seaweed aquaculture gear in the water reduces my*

enjoyment of the coast" shows varying levels of agreement among individuals. People who live farther from the coast tend to agree more with this statement, indicated by a positive correlation. Potentially, this would suggest that the presence of the gears does not significantly affect the view of the coast, since people who live closer to the shore are supposed to know the view better. In contrast, there is a negative correlation with age, educational level, and income—meaning that older individuals, those with higher education, and those with higher income are generally less likely to feel that seaweed aquaculture gear diminishes their coastal enjoyment. Overall, perceptions of seaweed farming's impact on coastal enjoyment appear to be influenced by demographic and socio-economic factors.

Statement 3: My town does not benefit economically from Seaweed aquaculture

The statement "*My town does not benefit economically from seaweed aquaculture*" has a positive correlation with living distance from the coast—individuals who live farther away are more likely to agree with this perception. No significant correlations were found with age, educational level, or income, suggesting that views on the economic benefits of seaweed aquaculture for one's town are not strongly influenced by these demographic or socio-economic factors.

Statement 5: I think the jobs in Seaweed aquaculture are filled by local people

The statement "*I think the jobs in seaweed aquaculture are filled by local people*" shows a positive correlation with both age and income, indicating that older individuals and those with higher incomes are more likely to believe that local people are employed in seaweed aquaculture. However, no significant correlation was found with living distance from the coast or educational level, suggesting that these factors do not strongly influence perceptions about local employment in the industry.

Statement 10: Seaweed aquaculture is an important way to diversify local economies

The statement "*Seaweed aquaculture is an important way to diversify local economies*" is viewed differently depending on various demographic factors. In particular, there is a positive correlation with both age and educational level, which means that older individuals and those with higher education tend to agree more strongly with this perspective. While living distance from the coast and income were also assessed for potential influence, no significant correlation was noted with these factors, suggesting that the perception of economic diversification through seaweed aquaculture is more strongly linked with age and education than with geographic proximity or income.

Statement 11: Seaweed aquaculture is a threat to the cultural identity for coastal communities in my state

The statement "*Seaweed aquaculture is a threat to the cultural identity for coastal communities in my state*" shows a negative correlation with both age and educational level. This suggests that older individuals and those with higher levels of education are less likely to perceive seaweed aquaculture as a cultural threat. There were no significant correlations with living distance from the coast or income, indicating that views on cultural identity in relation to seaweed farming are more influenced by age and education than by location or economic status.

Statement 13: Big companies should have the same right as local families and farmers to get seaweed aquaculture leases in state waters

The statement "*Big companies should have the same right as local families and farmers to get seaweed aquaculture leases in state waters*" is negatively correlated with both age and educational level. This means that older individuals and those with higher levels of education are less likely to support equal leasing rights for big companies compared to local families and farmers. There is no significant correlation with living distance from the coast or income, suggesting that opposition to corporate access to seaweed aquaculture leases is primarily shaped by age and educational background rather than geographic or economic factors.

Statement 14: Seaweed aquaculture has negative impacts on the natural environment

The statement "*Seaweed aquaculture has negative impacts on the natural environment*" is negatively correlated with both age and educational level. This indicates that older individuals and those with higher levels of education are less likely to believe that seaweed aquaculture harms the environment. No significant correlation was found with living distance from the coast or income, suggesting that environmental concerns related to seaweed farming are more closely tied to demographic factors like age and education rather than where someone lives or their economic status.

Statement 15: The state should help to grow the seaweed aquaculture industry here

The statement "*The state should help to grow the seaweed aquaculture industry here*" shows a positive correlation with age, meaning older individuals are more likely to support state involvement in expanding the industry. There were no significant correlations with living distance from the coast, educational level, or income, suggesting that support for government promotion of seaweed aquaculture is primarily influenced by age rather than socioeconomic status or geographic proximity to the coast.

Statement 16: Seaweed aquaculture helps to maintain a tradition of working on the water in my state

The statement "*Seaweed aquaculture helps to maintain a tradition of working on the water in my state*" is positively correlated with both age and income, indicating that older individuals and those with higher incomes are more likely to view seaweed aquaculture as a continuation of maritime traditions. There is a negative correlation with living distance from the coast, meaning people who live closer to the coast are more likely to agree with this statement. No significant correlation was found with educational level, suggesting that this perception is more influenced by age, income, and proximity to the coast than by formal education.

Overall Perception of Seaweed Aquaculture

Overall perception of seaweed aquaculture is positively correlated with both age and educational level, meaning that older individuals and those with higher levels of education tend to view seaweed aquaculture more favorably. A positive correlation is also observed with income, suggesting that people with higher incomes are more likely to support or have a positive view of the industry. There is no significant correlation with living distance from the coast, indicating that overall attitudes toward seaweed aquaculture are shaped more by demographic and socioeconomic factors than by geographic location.

3.5 Synthesis of Observed Trends

Based on survey responses, public perception of seaweed aquaculture in Maine is generally positive, with varying levels of support across different themes. Aesthetically, most respondents are neutral or mildly positive, indicating that the presence of seaweed farming gear is not widely seen as a disruption to coastal enjoyment. In terms of management, there is strong support for expanding the industry, with clear interest in public involvement in decision-making and broad approval for state-led promotion of seaweed aquaculture. Respondents tend to prefer prioritizing local families and farmers over large corporations when it comes to leasing access. However, many are uncertain about how well the industry is currently regulated, pointing to a need for more transparency and communication around regulatory frameworks.

Economically, seaweed aquaculture is viewed as a source of good jobs that supports local employment and contributes to economic diversification. Still, opinions are mixed on whether individual towns directly benefit, suggesting that the industry could strengthen efforts to demonstrate tangible community-level impacts. Regarding food security, respondents generally see seaweed farming as having potential to support both local and national food systems, though this connection is not strongly

affirmed—highlighting an opportunity for public education. Culturally, most people do not perceive seaweed aquaculture as a threat to Maine’s coastal identity and instead recognize its role in helping preserve traditional maritime livelihoods. Environmentally, seaweed farming is not seen as harmful; rather, respondents express concern about external environmental threats, especially climate change and water pollution, which are widely viewed as risks to the industry’s future. Overall, Mainers appear broadly supportive of seaweed aquaculture—particularly when it reflects local values, delivers community benefits, and is guided by transparent, inclusive management.

Based on the findings, several patterns emerge regarding public perceptions of seaweed aquaculture. Individuals who do not fish for fun are significantly more likely to view climate change as a serious threat to seaweed aquaculture compared to recreational fishers. Additionally, rural residents tend to hold less favorable views of seaweed aquaculture across multiple dimensions. They are less likely to believe it contributes to national food security, helps preserve maritime traditions, or deserves overall positive recognition, compared to non-rural residents.

Perceptions of how seaweed aquaculture affects enjoyment of the coast also vary. People living farther from the coast are more likely to feel that aquaculture gear reduces their coastal enjoyment, while older, more educated, and wealthier individuals tend to be less affected by its presence. Similarly, those who live farther from the coast are more likely to believe their towns do not benefit economically from seaweed aquaculture, although this perception does not appear to be influenced by age, income, or education.

Belief that local people are employed in seaweed aquaculture is stronger among older individuals and those with higher incomes. Support for the idea that seaweed aquaculture helps diversify local economies is also positively associated with age and education. Conversely, concerns that seaweed farming threatens cultural identity are more common among younger and less educated individuals.

When it comes to leasing access, older and more educated individuals are less supportive of giving big companies the same rights as local families and farmers. Similarly, they are less likely to believe that seaweed aquaculture has negative environmental impacts. State support for the growth of the industry is most favored by older individuals, and the belief that seaweed farming maintains a tradition of working on the water is strongest among those who are older, wealthier, and live closer to the coast.

Overall, positive perceptions of seaweed aquaculture are most strongly associated with being older, more educated, and having higher income. Interestingly, geographic distance from the coast does not significantly influence overall attitudes, suggesting that demographic and socioeconomic characteristics play a larger role in shaping public opinion on this emerging industry.

4. DISCUSSION

These findings suggest that personal and professional relationships with the marine environment shape perceptions in distinct ways. For example, individuals who fish for recreation were more likely to perceive climate change as a major threat to seaweed aquaculture, while those who fish for profit were less likely to share this concern. One potential interpretation is that recreational fishers, who often spend leisure time on the water, may develop a stronger emotional or ecological connection to marine environments, making them more attuned to climate-related changes. This group could serve as an important ally in building public support for climate resilience strategies in marine farming. In contrast, those economically dependent on marine resources may exhibit lower risk perception—possibly due to financial optimism, higher risk tolerance, or a desire to maintain industry momentum despite environmental uncertainties.

A similar pattern appears in perceptions of local food security. Commercial fishers were less likely to agree that seaweed aquaculture contributes to local food systems. This may reflect a limited sense of overlap between seaweed and their core economic activities—typically focused on fish or shellfish. For some, seaweed may not be seen as a “real” or substantial food source. Additionally, fishers whose income is tied to seafood markets may prioritize export potential and price stability over local nutritional access, meaning they are less likely to associate seaweed aquaculture with community food justice or dietary resilience.

The observed skepticism among rural residents regarding shellfish aquaculture’s contribution to national food security may stem from several overlapping factors. These communities might not view shellfish farming as directly benefiting them, particularly if the industry is concentrated elsewhere or oriented toward urban markets and export rather than local consumption. Rural residents may also associate tradition more closely with wild harvest practices, perceiving aquaculture—especially in its more industrial forms—as a departure from cultural norms. If shellfish aquaculture is not visibly practiced in their area, it may feel distant or irrelevant. Additionally, rural respondents may feel economically disconnected from the industry, either due to limited job opportunities or perceptions that the sector is dominated by outside investors or corporate actors. In contrast, non-rural residents may have greater exposure to shellfish aquaculture through coastal proximity, media, or consumer markets, which could help explain their more favorable views.

Age emerged as one of the most consistent predictors of support for seaweed aquaculture. Older individuals were less likely to perceive the industry as environmentally harmful or culturally disruptive and were more likely to believe that it provides economic value, supports local employment, and deserves state

involvement. This pattern may reflect stronger trust in regulatory institutions, deeper familiarity with Maine's working waterfront traditions, or greater comfort with pragmatic approaches to coastal development. Older respondents may also have more direct experience with marine industries, which could foster a sense of continuity between traditional livelihoods and emerging aquaculture practices.

Educational attainment also plays a significant role in shaping perceptions of seaweed aquaculture. Individuals with higher levels of education expressed less concern about potential environmental harm or cultural disruption and showed greater support for the industry's role in economic diversification. Notably, they were also more likely to oppose equal leasing rights for large companies, favoring local control instead. These patterns suggest that education may enhance exposure to scientific information, sustainability narratives, and policy frameworks—fostering more informed, critical, and values-driven attitudes toward aquaculture development.

The data also reveal significant equity concerns regarding who should have access to seaweed aquaculture leases. Older and more educated respondents were less likely to support granting large companies the same leasing rights as local families and small-scale operators. This suggests a clear value-driven preference for community-based ownership, reflecting concerns about fairness, local benefit, and the protection of Maine's coastal identity. Among these stakeholders, there appears to be stronger support for policies that prioritize equity and resist corporate dominance in the development of marine resources.

This study's findings on public perception of seaweed aquaculture in Maine align with several patterns observed in prior research, particularly regarding the role of demographics in shaping attitudes. As seen in national consumer studies such as Zheng et al. (2024), older, more educated, and higher-income individuals in Maine express stronger support for seaweed farming. This demographic trend underscores a broader association between socioeconomic status and openness to emerging sustainable food systems. Consistent with earlier research emphasizing the role of familiarity, the study also finds that Mainers with more exposure to or awareness of seaweed aquaculture are more supportive of its development—especially when it is linked to local values, economic benefits, and maritime traditions. Additionally, the general perception that seaweed aquaculture is not environmentally harmful aligns with global literature, including Zhang (2022) and Spillias (2022), which point to the ecosystem services and climate resilience benefits of seaweed farming.

At the same time, this study identifies several Maine-specific nuances that diverge from or complicate national and international narratives. Notably, rural residents in Maine tend to be more skeptical of seaweed aquaculture, expressing less belief in its contributions to food security, cultural preservation, and economic development—challenging assumptions that rural coastal populations naturally align

with ocean-based industries. Despite the industry's visibility in the state, the study also reveals persistent public knowledge gaps, particularly regarding regulation and seaweed's role in food systems. This contrasts with findings from other regions, such as in Zheng et al. (2024), where consumer knowledge levels are often higher among those who engage with seaweed products. Another unexpected finding is that geographic proximity to the coast does not significantly influence overall support, suggesting that demographic and attitudinal variables are more predictive of public sentiment than location alone. Finally, while some younger and less educated respondents express concerns that seaweed farming may disrupt cultural identity, the broader public does not view it as a cultural threat. Instead, most see it as compatible with Maine's working waterfront heritage, highlighting the potential for seaweed aquaculture to be embraced as both an economic and cultural asset.

5. CONCLUSION

This study reveals that public attitudes toward seaweed aquaculture in Maine are shaped not only by knowledge or proximity, but by deeper layers of identity, experience, and trust. A central insight is that marine identity is stratified: individuals relate to the ocean differently depending on whether their engagement is recreational or professional. Those who fish for fun are more likely to perceive climate threats, possibly due to a more emotionally grounded connection to the environment. In contrast, commercial fishers—whose livelihoods depend on marine resources—may downplay risk in favor of industry continuity, optimism, or economic stability.

These differences suggest that strategic outreach must be segmented. Recreational users may be natural allies in climate resilience messaging, while commercial users may respond more positively to narratives that emphasize economic adaptability, infrastructure support, and resource stewardship without provoking existential threat. Communication strategies that ignore this distinction risk missing the values and priorities of each group.

Furthermore, rural skepticism toward aquaculture could stem from a sense of disconnection—both real and perceived. When rural communities do not see aquaculture operations, job creation, or cultural relevance in their area, the industry can appear extractive or irrelevant. Tailored engagement that includes rural voices, demonstrates tangible benefits, and reflects local values will be essential to broadening support.

Generational and educational differences also shape the perceived cultural role of seaweed farming. There is a generational divide in cultural interpretation: older Mainers often see seaweed aquaculture as an extension of the state's working waterfront tradition, while younger or less formally educated individuals may view it with suspicion—as a threat to place-based identity or environmental health. These

competing cultural frames underscore the need for context-sensitive messaging that bridges tradition with innovation.

Education, meanwhile, strongly and positively associates with trust towards seaweed aquaculture. It is not simply associated with more favorable views, but with stronger alignment to sustainability goals, civic participation, and equity concerns. More educated individuals are both more supportive of aquaculture and more critical of corporate influence—indicating a nuanced, value-driven endorsement rather than blanket approval.

In this light, equity concerns should not be treated as marginal or symbolic. The opposition to granting large companies equal leasing rights is grounded in identity and history—particularly among older, educated, and locally invested stakeholders. Failing to address these concerns may erode trust and provoke resistance even among otherwise supportive groups.

Finally, this study affirms that support for seaweed aquaculture is conditional—not blind. Public acceptance is strongest when the industry is seen as locally governed, culturally resonant, economically inclusive, and environmentally accountable. If seaweed aquaculture in Maine is to thrive, it must not only deliver material benefits but also earn legitimacy through transparency, fairness, and community-rooted development.

The findings from this survey can be applied in several practical ways to support the development of seaweed aquaculture in Maine. Policymakers can use public support for local control and state involvement to create inclusive policies that emphasize transparency and community engagement. Educational outreach can address areas of uncertainty—such as regulation and food security—to build public understanding and trust. Positive perceptions of job creation and economic diversification suggest opportunities for investing in community-based operations. Preferences for supporting local families and small-scale operators should inform lease allocation and permitting practices to ensure fairness and local benefit. Given the perception gaps between rural and urban residents, tailored engagement strategies are needed to ensure equitable distribution of benefits and representation. Additionally, environmental messaging should highlight the low impact of seaweed farming while addressing concerns about climate change and water pollution. Culturally, framing seaweed aquaculture as a way to preserve Maine’s working waterfront heritage may strengthen public alignment with the industry. Finally, demographic insights can guide outreach and workforce initiatives, helping to grow the sector by engaging supportive groups and addressing hesitations in others.

Building on the findings of this study, several directions for future research emerge. Given the high number of neutral responses, especially around topics like regulation, food security, and local economic benefits, further investigation is needed to understand whether this reflects a lack of awareness, engagement, or information. In

particular, exploring the roots of rural skepticism through qualitative methods could offer deeper insights into how perceptions are shaped by local experience and economic realities. Research should also examine public trust in regulatory frameworks and identify what drives perceptions of effective or ineffective governance. Comparing perceived and actual economic impacts of seaweed aquaculture could highlight information gaps and guide more effective communication strategies. Additionally, future studies might explore how cultural identity and heritage influence attitudes, especially in coastal communities where traditions play a central role. As concerns about climate change and water pollution were prominent, further exploration into how these issues shape public opinion could help the industry develop more resilient and responsive strategies. Longitudinal research tracking changes in perception over time would also be valuable as the industry evolves and public outreach efforts grow. Demographic segmentation in future studies could inform more targeted messaging, while examining the effects of proximity and exposure to aquaculture sites may reveal how firsthand experience influences support and understanding. Sustainable seaweed aquaculture in Maine will thrive not only with scientific and economic innovation, but also with community-informed governance and trust.

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