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Are all benefits equal? An exploratory analysis of coastal perspectives of seafood farming expansion in the United States

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Abstract

Seafood farming is heralded for its economic opportunities and its potential to reduce the greenhouse gas emissions associated with food production. Yet the persistent lack of awareness among the US public about these potential benefits of seafood farming is often cited as a barrier to social acceptance and industry growth. We employed two exploratory online surveys of residents of western and northeastern US coastal states and a unique message-testing approach to explore: (1) how existing opinions about seafood farming vary across sociodemographic attributes, geography, and prior familiarity with aquaculture; (2) the malleability of opinions about seafood farming; and (3) what benefits of marine aquaculture broadly and of seaweed farming specifically were viewed as the strongest reasons to support industry expansion, and what messengers are most trusted to share that information. We found that baseline attitudes about seafood farming strongly correlate with prior familiarity and that opinions about both marine aquaculture and seaweed farming were highly malleable, at least in the short term. If confirmed by further studies, our

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results suggest that messages emphasizing benefits in terms of environmental sustainability, as opposed to economic benefits or social benefits, may be an important tool to better engage residents of western and northeastern US coastal states with seafood farming expansion.

KEYWORDS
coastal community development, marine aquaculture expansion, seafood farming, stakeholder perceptions, triple bottom line

1 | INTRODUCTION

Marine aquaculture (MA) is facing a communication challenge. The efficiency, performance, and sustainability potentials of the global MA industry have never been greater (Boyd et al., 2020; Costello et al., 2020; Gephart et al., 2020; Naylor et al., 2021; Tlusty et al., 2019); yet social and political skepticism continue to stall industry expansion in the United States and elsewhere (Chu et al., 2010; Fong et al., 2022; Ford et al., 2022; Knapp & Rubino, 2016; Young & Liston, 2010; Zajicek et al., 2021). The substantial impact of vocal, devoted oppositional groups (Billing, 2018; Ford et al., 2022; Murphy-Gregory, 2018; Risius et al., 2017; Young & Liston, 2010), paired with a general lack of public awareness of MA (Fong et al., 2022; Rickard et al., 2020; Risius et al., 2017), has left public audiences with an impression of great risk, without commensurate understanding of the potential benefits of modern practices (Billing et al., 2021; Froehlich et al., 2017; Hall & Amberg, 2013; Rickard et al., 2018; Risius et al., 2017; Weitzman & Bailey, 2019). For instance, in a 15-year analysis of aquaculture media coverage in New England, Rickard et al. (2018) discovered an emphasis on risks to environmental and human health that significantly outweighed coverage of the potential benefits of aquaculture. Rickard's findings are echoed in other media coverage analyses, both in the United States and elsewhere (Froehlich et al., 2017; Weitzman & Bailey, 2019). This unbalanced and at times limited coverage has effectively skewed public perception of the impacts of expansion of seafood farming sectors (Froehlich et al., 2017; Rickard et al., 2018; Weitzman & Bailey, 2019).

Evaluations of content delivery mechanisms (Rickard et al., 2018; Yang et al., 2021), public opinion surveys (Dalton et al., 2017; Galparsoro et al., 2020; Gegg & Wells, 2019; J. Kim et al., 2019; Murray & D'Anna, 2015; Rickard et al., 2020; Risius et al., 2017), and public comments (Billing, 2018; Froehlich et al., 2017) suggest that improving public understanding of seafood farming can increase consumer acceptance of industry expansion, as well as confidence in aquacultured products (Carrassón et al., 2021; Froehlich et al., 2017; Hall & Amberg, 2013; Rickard et al., 2020; Risius et al., 2017). More specifically, Yang et al. (2021) found that a brief (3-min) informational video about sustainable aquaculture positively impacted US coastal participant's perceptions of—and support for—the industry. Moreover, recent surveys indicate that the public is open to learning more about aquaculture; in a national online survey in 2020, 84% of participants reported a desire for "more information than they currently receive about aquaculture" (Rickard et al., 2020). However, community communication needs can vary geographically. In regions such as the Pacific Northwest (Hall & Amberg, 2013) and British Columbia (Flaherty et al., 2019), the public's memory of negative media coverage regarding salmon farming strongly influenced consumer preference for wild-caught products. In contrast, farms' aesthetics and their perceived interference with recreational activities have driven negative perceptions of aquaculture in Rhode Island (Dalton & Jin, 2018). Ultimately, building public support for seafood farming will require addressing the US public's lack of awareness through messaging that clarifies the potential benefits of the industry and resonates with these community-specific contexts (Gegg & Wells, 2019; Mather & Fanning, 2019).

Garnering support for expansion will also require more thoughtful consideration of the role of community members as capable and influential participants in resource development, rather than as passive receivers of information

(Eisenack et al., 2014; Henríquez-Antipa & Cárcamo, 2019; McAfee et al., 2019; Moser & Ekstrom, 2010; Zahara et al., 2016). The value of communicating positive outcomes when motivating public action (e.g., support for expansion) is well documented in the fields of conservation (McAfee et al., 2019), climate adaptation and risk communications (Eisenack et al., 2014), and renewable energy (Flaherty et al., 2019). Studies specific to the seafood farming sector emphasize this role of trusted and devoted individuals ("key agents") in uniting community priorities around MA expansion (Billing, 2018). However, few studies provide granular insight into how more recent, widely circulated, messages regarding specific sustainability benefits of seafood farming expansion could be influencing support in coastal residents—those who are ultimately most impacted by expansion.

Here, we employ two online, quota-sampled surveys in nine western and northeastern US coastal states to provide an exploratory examination of baseline opinion and shifts in attitudes toward seafood farming sectors (here: MA broadly and seaweed farming [SW] specifically). Previous assessments have found that online US panel surveys can overrepresent white, educated, active Internet users (Lehdonvirta et al., 2021, and references therein). However, recent work suggests that the approach we utilize in this study can perform as effectively as more traditional probability sampling by balancing the demographic compositions of their respondent populations (Lehdonvirta et al., 2021; Radford et al., 2022). We also implement a unique tool (comprehensive comparative message testing) to evaluate how specific benefits of seafood farming could impact opinions regarding the expansion of its industries. Altogether, this work suggests that communicating the potential benefits of seafood farming expansion has the potential to shift public perceptions among residents of western and northeastern states in the United States.

2 | MATERIALS AND METHODS

2.1 | Survey development

Surveys were designed and conducted by an opinion research consulting firm, Prime Group LLC., that was contracted by the Aquarium of the Pacific's Seafood for the Future program. No personally identifiable information was collected in the surveys. Institutional Review Boards (IRB) from University of Massachusetts Boston, Santa Clara University, and University of Southern California granted authors IRB exemption under 45 CFR 46.104(d)(4) secondary research for which consent is not required.

The MA survey was designed to test the efficacy of the Aquarium of the Pacific's six-part video series, *Ocean to Table* (Aquarium of the Pacific, 2018), as well as to explore the extent to which a variety of written messages about MA benefits resonate with the broader public. The written messages were developed to capture the potential benefits of MA that are commonly reflected in established public forums regarding seafood sustainability (e.g., content from Monterey Bay Aquarium's Seafood Watch program and Aquarium of the Pacific's Seafood for the Future program, and best practices created by Marine Stewardship Councils).

The SW survey was designed to explore what messages about SW resonate most with residents of western and northeastern US coastal states. Similar to the MA survey, the SW survey messages were developed to reflect potential benefits of SW commonly mentioned in public discourse; message content was based on the extensive experience of an expert panel composed of the Aquarium of the Pacific's Seafood for the Future program and World Wildlife Fund's aquaculture team, which includes a former commercial seaweed farmer. To pretest message content and refine the design of the SW survey, 15 coastal residents from four targeted regional areas (Alaska [$n = 2$]; Oregon/Washington [$n = 3$]; California [$n = 4$]; and New England [$n = 3$]) participated in a 3-day, moderated, asynchronous online discussion. Participants logged on twice or more per day to evaluate messages, images, and video content, respond to questions posed by the moderator, and react to comments from other participants.

Although the MA and SW surveys were developed and executed independently, they both addressed public attitudes regarding the expansion of seafood farming sectors. Therefore, so that we could compare and contrast the data from the two surveys, we used only the subset of respondents to the MA survey from the same nine western

and northeastern US coastal states that participated in the SW survey. See Supporting Information Files S1 and S2 for survey questions and response options.

2.2 | Survey recruitment and data collection

Participants of both surveys did not know the topic of the survey before participating in order to mitigate topical self-selection bias. The MA survey was an online survey conducted from June 12 to June 20, 2019 and sampled 800 complete responses from a US nationwide population. Participants for the MA survey were recruited by Dynata, a research vendor that maintains a nationwide nonprobability panel of individuals who have agreed to participate in online surveys on a variety of topics. Participants were balanced on gender, race/ethnicity, and geographic region to match census demographics for the country using the 2018 US Census. For the purposes of this article, we focused only on those nine coastal states that overlapped with the SW survey participants, for a total of 154 complete responses (see Supporting Information Maps S1–S3 and Table S1). There were no other screening criteria for the MA survey.

The SW survey was also an online survey conducted from April 21 to May 14, 2021, and drew from counties in Alaska ($n = 65$), California ($n = 234$), New England (Connecticut, Massachusetts, Maine, New Hampshire, and Rhode Island [$n = 200$]), and the Pacific Northwest (Oregon & Washington; $n = 207$). Participants for the SW survey were drawn by the research vendor Lucid from nationwide nonprobability panels of individuals who have agreed to participate in online surveys. Participants were quota-sampled on gender and age to match census demographics for each individual state represented using the 2018 US Census (Supporting Information Table S2). All counties in Alaska and Maine were eligible to participate in the SW survey; participants from other eligible states (California, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Oregon, and Washington) were required to confirm their current residence in a coastal county in order to participate. Importantly, participants did not know the topic of the survey before participating to mitigate topical self-selection bias. Note that the two surveys sample different populations, as the MA survey draws on residents of coastal states while—aside from Alaska and Maine—the SW survey more narrowly focuses on coastal counties within those same states (Supporting Information Maps S1–S3 and Table S3).

The video "interventions" in the two surveys differed. MA survey participants were randomly assigned to watch one of six brief videos about MA originating from Aquarium of the Pacific's *Ocean to Table* series (Aquarium of the Pacific, 2018). The videos were originally designed to introduce broader public audiences to the various cultivated species and methods of MA in the United States and were segmented into shorter videos for survey use (see segments here). In contrast, all SW survey participants watched the same 2.5-min segment on SW produced by CBS (Finkelstein, 2018). Participants of both surveys were required to view the entirety of their assigned video before proceeding through the survey. After viewing their respective video, participants were asked their post-opinion of MA or SW.

To identify which messages in support of seafood farming were perceived as the most compelling, we asked respondents to repeatedly rank 10 messages describing the potential benefits of MA broadly (MA survey) or SW specifically (SW survey) (see Supporting Information Files S1 and S2, respectively). Messages were tested using a maximum difference scaling (MaxDiff) module through Sawtooth Software Lighthouse Studio, which is a methodology that allows researchers to determine the relative preferences of respondents for a series of items (Kotcher et al., 2019; Orme, 2009; Sawtooth Software, 2020). Under this approach, each respondent viewed a series of 8 screens listing 4 messages (out of the 10 total messages per survey) and was asked to select the message on each screen that they found "strongest" and the message on that screen that they found "weakest." Each message was re-tested against different competing messages multiple times, with each message appearing an average of three times throughout the exercise. These two selections provide five data points per screen on a respondent's preferences about the four messages displayed. For example, if messages A, B, C, and D are shown, and a respondent

selects message A as the strongest and message D as the weakest, we learn that: A > B; A > C; A > D; B > D; C > D. In this scenario, the only thing that cannot be inferred is whether message B is preferred to C, or vice versa.

These data points—40 per respondent from the eight screens—allow for the calculation of individual respondent-level utility scores for each of the messages tested. These utility scores allow for a contingent ranking of the relative "strength" of each message in comparison to the other messages tested within each survey. A basic method for calculating utility scores is a counts analysis, which takes the percent of times each item was selected "strongest" less the percent of times each item was selected "weakest." Here, we utilize hierarchical Bayes multinomial logit models, developed by Sawtooth Software. This approach improves upon a simple counts analysis by taking into account the strength of competing items from each choice (Orme, 2009; Sawtooth Software, 2020). This method leads to more reliable individual-level score estimations, especially for smaller sample sizes (Orme, 2009).

Since the MaxDiff process retests messages against each other, there are no "ties" in utility scores, allowing us to organize utility scores into a rank order of the 10 messages for each survey respondent. The two surveys yielded a total of 34,360 data points for the MaxDiff exercises (153 and 706 survey respondents × 40 data points), resulting in a high level of precision and confidence in the aggregated utility scores. Raw utility scores from the multinomial logit analysis have positive and negative values, but these are probability scaled to have a range of 0–100. We used the aggregate data to generate heat maps in which the intensity of shading represents the preference for each message relative to the others (Figures 3 and 4).

Finally, we assigned each message to one of three categories (post hoc) that align with the concept of the "triple bottom line" of benefits from sustainable industries (Shou et al., 2019): (1) emphasizing primarily environmental benefits, (2) emphasizing primarily economic benefits, or (3) emphasizing primarily social benefits. Here, "social" benefits relate to human health and well-being, specifically the potential for more affordable, reliable, and/or healthy food sources. "Economic" benefits focus primarily on livelihood enhancements (jobs, profits, etc.), and "environmental" benefits relate to alleviating or minimizing impacts to ecosystems (see Supporting Information Tables S4 and S5 for full post hoc thematic categorization of messages).

2.3 | Statistical analyses

Data from the two surveys were analyzed separately. We used SW survey responses to assess the effect of baseline familiarity on baseline opinion of MA and SW; the MA survey did not ask an analogous question about familiarity.

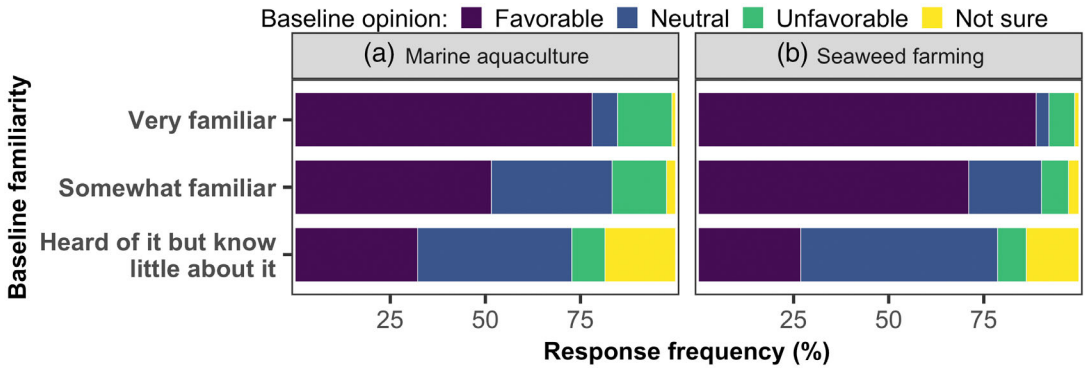

FIGURE 1 (a, b) Baseline opinions of marine aquaculture (panel a; $n = 621$) and seaweed farming (panel b; $n = 525$). Colored bars represent each opinion response level. Response frequency (horizontal axis) is calculated for each baseline familiarity group (vertical axis). Data are from the SW survey only, and participants who had never heard of the sector in question (panel a; $n = 84$; panel b; $n = 175$) were not asked for their baseline opinion.

SW participants had four options for baseline familiarity: "never heard of it," "heard of it but know little about it," "somewhat familiar," and "very familiar." In both surveys, baseline opinion scores were gathered on a five-point Likert scale with a sixth option for "not sure." For ease of interpretation, we report our findings on a collapsed opinion scale where 1 = unfavorable and very unfavorable, 2 = neutral, and 3 = favorable and very favorable. We justify using this approach because we found no differences in our results when we analyzed the data using the full five-point Likert scale (see data availability file). Additionally, our "not sure" and "never heard of it" response levels had no clear placement along our ordered scale, so they were analyzed separately as described below.

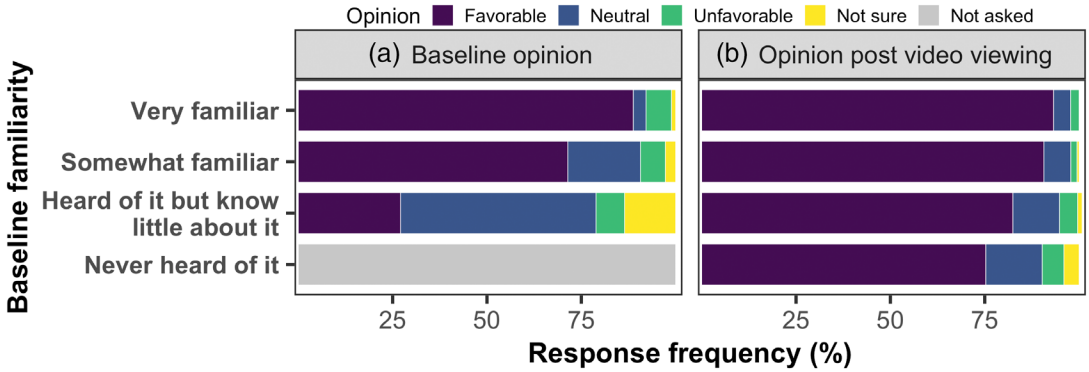

FIGURE 2 (a, b) Opinions of seaweed farming grouped by baseline familiarity. Frequency (% responses) of opinions of seaweed farming (a) at baseline, before viewing ($n = 525$) and (b) after viewing ($n = 696$) a short video promoting the benefits of seaweed farming. Axes match methods used for Figure 1a,b.

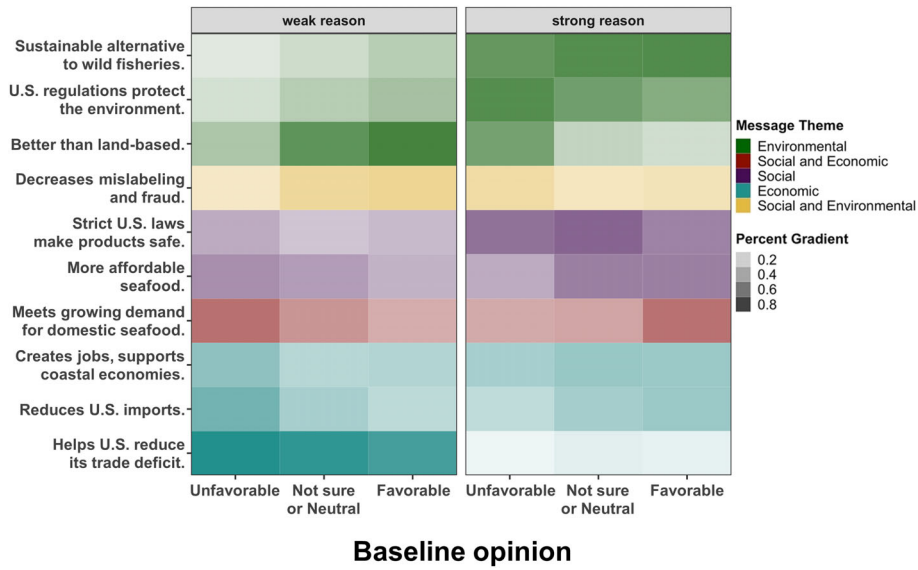

FIGURE 3 Heatmaps of participant rankings of messages from the MA survey ($n = 153$) ordered by baseline opinions (horizontal axis) of the respective industry. Darker color saturation indicates a higher frequency (% response) of the message as weak or strong (with rankings of neutral omitted for ease of interpretation). Messages (vertical axis) are presented with abbreviated but descriptive text and are color-coded based on their sustainability theme (see Supporting Information Table S4 for complete MA messages).

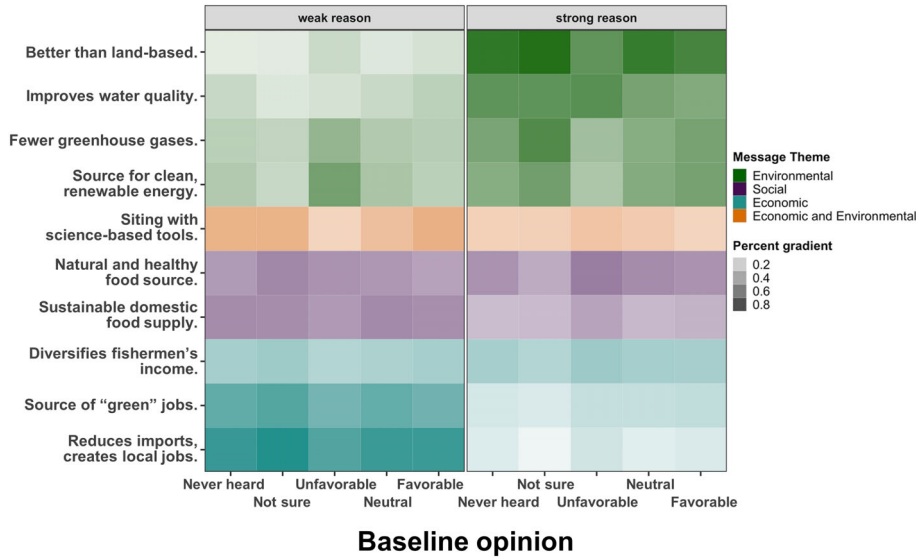

FIGURE 4 Heatmaps of participant rankings of messages from the SW survey ($n = 706$) ordered by baseline opinions (horizontal axis) of the respective industry. Only the SW survey included an option for "never heard of it." Darker color saturation indicates a higher frequency (% response) of the message as weak or strong (with rankings of neutral omitted for ease of interpretation). Messages (vertical axis) are presented with abbreviated but descriptive text and are color-coded based on their sustainability theme (see Supporting Information Table S5 for complete SW messages).

We used multilevel ordered logistic regressions to test the effect of familiarity (categorical predictor) on baseline opinion (ordered response variable). Where significance was detected, we used post hoc analyses on estimated marginal means using the emmeans package. We also tested whether sociodemographic factors (age, education, race, and region) might affect baseline familiarity (SW survey only) or baseline opinion (SW and MA surveys). Because of the ordered but nonparametric nature of some of our data, and failure to meet the parallel regression assumption for ordered regressions, we used rank-based Kruskal–Wallis H tests to correlate baseline opinion and baseline familiarity levels with age, education, race, and region as categorical predictors. Where significance was detected, we used Dunn's test with a Benjamini–Hochberg *p*-value adjustment for post hoc comparisons of all response levels.

To determine how opinions of seafood farming changed after viewing survey videos, we asked participants for their "post-opinion" of MA broadly (MA survey only) and of SW specifically (SW survey only). The SW survey asked baseline questions about both MA and SW but did not ask for post-opinion of MA—instead it probed post-video attitudes only for SW. Post-opinion scores were gathered on the same scale as baseline opinions, with the option for "never heard of it" removed. We performed Wilcoxon signed rank tests on our ordinal paired data, comparing baseline opinion scores to post-opinion scores. In both surveys, $\lesssim$1% of respondents reported "not sure" as their post-opinion; these individuals were removed from the analysis. Participants who began the survey having "never heard of" the sector in question were not asked their baseline opinion and were not included in this analysis. Their opinions after video viewing are presented using descriptive metrics.

To assess what messages participants considered strong (or weak) reasons to support aquaculture expansion, we performed binary logistic regressions on message rankings. Data from the two surveys were tested separately. We used MaxDiff utility scores to place messages in order of lowest to highest for each respondent. We then grouped messages into binary categories: ranks 1–4 = weak (0), and ranks 7–10 = strong (1). Ranks 5–6 were omitted as "neutral." We tested rank (weak or strong) as the binary response variable with message as the categorical

predictor. We also tested for an interactive effect of message × baseline opinion, and message × region as categorical predictors. Post hoc analyses were performed on estimated marginal means using the emmeans package with Tukey's adjusted *p*-values.

All assumptions for statistical analyses were met unless otherwise noted. All statistical analyses were completed in R statistical software (R Core Team, 2020). For package citations, see the provided data availability file.

3 | RESULTS

The MA and SW surveys results reveal strikingly similar patterns across these surveyed residents of western and northeastern US coastal states, despite the fact that these surveys were developed and executed independently. In the results presented below, we first examine initial participant familiarity with and opinions about MA in general, and of SW specifically (henceforth: "baseline familiarity" and "baseline opinion"). Second, we explore the malleability of opinions regarding these activities. Finally, we examine our message-testing results, revealing the relative strengths of messages that describe the various benefits of aquaculture.

3.1 | Study samples

The subset of MA responses from residents of coastal states generally mirrored the full survey population's balance on gender, race/ethnicity, and geographic region, which matched census demographics for the country (Supporting Information Table S1). Because of low participation from Alaska, we ultimately excluded this region from the MA survey analyses ($n = 1$). Respondents for the MA survey were a majority male (53.9%), white (71.4%), and had completed some college, vocational training, or a bachelor's degree (66.9%). Nearly half of the respondents were either ages 18–29 (24.7%) or 40–49 (24%) (Supporting Information Table S2). SW survey participants were balanced on gender and race/ethnicity to match 2018 US Census demographics for each individual US region (Supporting Information Table S3). Our study sample for the SW survey was a majority female (53.4%), non-Hispanic White (62.5%) and had completed some college, vocational training, or a bachelor's degree (58.5%). The largest proportions of our SW survey sample population were either ages 18–29 (22.7%) or 30–39 (20.7%). See Supporting Information Maps S1–S3 and Table S2 for comparison of MA versus SW survey demographics.

3.2 | Positive baseline attitudes about seafood farming correlate with prior familiarity

A significant fraction of survey respondents reported no, or low, familiarity with seafood farming: 49% of participants had "never heard" of or "knew little about" MA and 61% of participants had "never heard" of or "knew little about" SW (Table 1). The likelihood that respondents held a positive opinion of the sector in question increased with higher baseline levels of familiarity ($p < 0.0001$ for both sectors; Figure 1a,b; Table 2a,b; also see Supporting Information Tables S6ab and 7ab). Respondents who were "very familiar" with MA were more likely to begin the survey with a positive opinion than those that "knew little about" or were "somewhat familiar" with the sector ($p < 0.0001$; $p = 0.0001$, respectively; Figure 1a; Table 2a). The same trend held true with baseline opinions of SW ($p < 0.0001$; $p = 0.008$, respectively; Figure 1b; Table 2b). For paired contrasts of each familiarity level, see Table 2. Overall, positive baseline opinions outweighed negative baseline opinions in those who reported some familiarity with seafood farming by a factor of 3.6 for MA and by a factor of 7.3 for SW (Supporting Information Table S8).

Although we anticipated factors such as age, education, geography, and race might influence baseline opinions about MA and SW, we found only a handful of associations to completed education level ($p = 0.0004$ MA; $p = 0.0002$ SW; Supporting Information Tables S9–S14) and age ($p = 0.002$ MA; $p = 0.03$ SW; Supporting

Information Tables S9–S14). Specifically, older generations were less familiar with both sectors, and participants who held a bachelor's degree or less were more likely—compared with those with graduate levels of education—to have never heard of, be unsure of, or hold negative opinions about the sector in question (see Supporting Information Tables S10, S12, and S14 for all paired contrasts).

3.3 | Opinions about seafood farming are malleable

All six of the MA survey videos from the *Ocean to Table* series (Aquarium of the Pacific, 2018) had the effect of either maintaining positive opinions or shifting a majority of respondents to more positive opinions of MA ($p < 0.0001$; Table 3). Fifty-seven percent of respondents who began with a less-than-favorable opinion of MA shifted to a favorable opinion after the videos (Tables 3 and 4). Notably, a majority of those who started out with an unfavorable baseline opinion of MA switched to a favorable post-opinion (58%; Table 4).

For the SW survey, we observed similar shifts from negative baseline opinions to positive post-opinions of SW ($p < 0.0001$; Figure 2a,b; Table 3); 76% of participants who began with a less-than-favorable opinion of SW shifted to a favorable opinion after the video (Figure 2b; Table 4). Further, as was the case with the MA survey, the majority (65%) of those who started out with an unfavorable opinion switched to a favorable post-opinion after they were given information about benefits (Table 4).

TABLE 1 Baseline levels of familiarity.

	Baseline familiarity			
Sector	Never heard of it	Heard of it but know little about it	Somewhat familiar	Very familiar
Marine aquaculture	12% (84)	37% (264)	36% (252)	15% (105)
Seaweed farming	25% (175)	36% (255)	26% (183)	13% (89)

Note: Seaweed farming (SW) survey participants were asked their familiarity with marine aquaculture ($n = 705$) and seaweed farming ($n = 702$). Observed counts of respondents are provided in parentheses. All complete responses are included, and responses are from the SW survey only; the marine aquaculture survey did not include analogous questions assessing baseline familiarity.

TABLE 2 Post hoc pairwise comparisons of the effects of baseline familiarity on opinion.

Baseline familiarity contrast	Estimate ± standard error	*z* ratio	Adjusted *p*
(a) Marine aquaculture			
**Very familiar—Somewhat familiar	1.10 ± 0.27	4.05	0.0001
***Very familiar—Heard of it but know little about it	1.43 ± 0.27	5.23	<0.0001
†Somewhat familiar—Heard of it but know little about it	0.33 ± 0.18	1.86	0.06
(b) Seaweed farming			
*Very familiar—Somewhat familiar	1.17 ± 0.39	2.98	0.008
*Very familiar—Heard of it but know little about it	2.73 ± 0.38	7.22	<0.0001
*Somewhat familiar—Heard of it but know little about it	1.56 ± 0.22	7.24	<0.0001

Note: Baseline indicates that respondents had not yet viewed pro-aquaculture videos and messages. Ordinal regressions indicated that respondents with higher baseline familiarity tend to hold more positive baseline opinions of both marine aquaculture (Likelihood ratio χ^2 (2) = 31.1., $p < 0.000$, $n = 565$) and seaweed farming (Likelihood ratio χ^2 (2) = 105.6, $p < 0.0001$, $n = 484$). *p*-values below are adjusted using the Benjamini–Hochberg method for multiple hypothesis testing. *$p \leq 0.01$; **$p \leq 0.001$; ***$p < 0.0001$; †$p < 0.05$.

3.4 | Messages of seafood farming's environmental benefits rank highest

We found differences in how specific messages resonated with participants ($p < 0.0001$ for both surveys; see Supporting Information Table S15a). In both surveys, messages that focused on environmental benefits of seafood farming ranked highest, while those focused on economic benefits ranked lowest (Figure 3, Supporting Information Tables S4 and S5). For example, in the MA survey, participants favored "providing a sustainable alternative to wild fisheries" by a factor of ~7 compared with the weakest message (odds ratio = 0.05, 95% confidence interval = 0.01): "expanding marine aquaculture will help the United States reduce our trade deficit" (Supporting Information Table S4). Of particular interest, participants who started with a negative opinion of MA were most likely to highly rank the message "marine aquaculture is an environmentally friendly alternative to land-based food" ($p = 0.0006$ for baseline favorable contrast; $p = 0.002$ for baseline neutral/not sure contrast; Figure 3; Supporting Information

TABLE 3 Opinions of seafood farming sectors.

	n	Baseline mean	Post-mean	Baseline-post difference	*W*	*p*-value
Overall						
Marine aquaculture (MA survey)	154	3.48	4.04	0.56	2600	<0.0001
Seaweed farming (SW survey)	480	3.71	4.38	0.67	36,436	<0.0001
By baseline familiarity level (SW survey)						
Heard of it but know little about it	216	3.28	4.17	0.89	11,235	<0.0001
Somewhat familiar	176	3.89	4.47	0.58	4600	<0.0001
Very familiar	88	4.43	4.67	0.24	310	0.011

Note: Results of opinion responses before (baseline) and after (post-) viewing pro-aquaculture videos in each survey. Significance is tested with Wilcoxon signed rank paired sums tests. All complete responses were included in the analysis.

TABLE 4 Changes in opinion scores.

Post video viewing						
			Unfavorable	Not sure	Neutral	Favorable
Baseline opinion	Unfavorable	MA ($n = 19$)	26% (5)	0%	16% (3)	58% (11)
		SW ($n = 37$)	19% (7)	0%	16% (6)	65% (24)
	Not sure	MA ($n = 15$)	7% (1)	7% (1)	40% (6)	47% (7)
		SW ($n = 40$)	0%	5% (2)	12% (5)	83% (33)
	Neutral	MA ($n = 50$)	4% (2)	2% (1)	34% (17)	60% (30)
		SW ($n = 168$)	4% (7)	<1% (1)	18% (30)	77% (130)
	Favorable	MA ($n = 69$)	4% (3)	0%	7% (5)	88% (61)
		SW ($n = 277$)	1% (3)	2% (7)	<1% (1)	96% (266)

Note: Observed percentages of opinions of marine aquaculture (MA) and seaweed farming (SW) before (baseline) and after (post) viewing a short video promoting the benefits of seaweed farming. Values shaded in gray along the diagonal are counts of people whose opinions remained the same, green shaded values above the diagonal are individuals who shifted to a more favorable opinion, and red shaded values below the diagonal are those who shifted to a less favorable opinion. Shifts between neutral and not sure are treated as no shift in opinion. All participants who responded to both questions are included ($n = 153$ for MA; $n = 522$ for SW). The SW survey assessed post-opinion only of seaweed farming, not of MA in general.

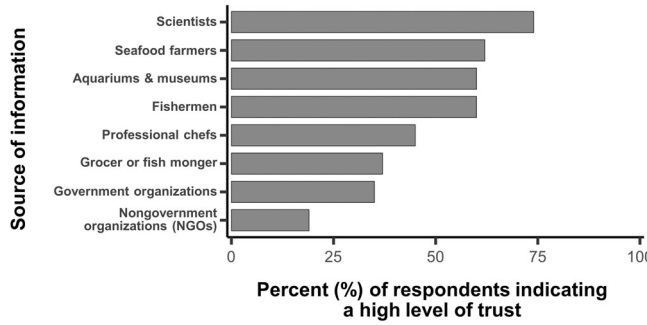

FIGURE 5 Frequency (in percentage) of participants with a high level of trust in sources (vertical axis) of information about seaweed farming. The sample size for the percentages reported (horizontal axis) ranged between 703 and 706 for each source of information.

Table S15b). Notably, we found no statistically significant difference in how participants from different regions (i.e., California, Pacific Northwest, and New England) ranked the MA survey messages ($p = 0.08$; Supporting Information Table S16).

In the SW survey, most messages of environmental benefits consistently ranked highly (Figure 4). However, seaweed as an "… efficient source of clean, renewable energy" was the one environmentally focused message that did not highly resonate across all groups (Supporting Information Table S5). This trend was driven by participants who had an unfavorable baseline opinion of the sector and were three times more likely to rank "source of clean energy" as a weak message, compared with those with a favorable baseline opinion ($p = 0.005$; Figure 4; Supporting Information Table S15b). The overall highest ranked message among all respondents focused on environmentally friendly food production (i.e., "… which makes [seaweed] much more environmentally friendly than producing food from animals or land-based vegetables."; Figure 4; Supporting Information Table S5). Respondents preferred that message by a factor of 7 compared with the weakest message: "… encouraging more seaweed farming can begin to close the [trade] gap, reduce imports, and create good local jobs." (odds ratio = 0.03, 95% confidence interval = 0.05–0.11; Figure 3b; Supporting Information Table S5). Similar to the MA survey, we found no statistically significant regional differences in how participants ranked the SW survey messages ($p = 0.65$; Supporting Information Table S16).

3.5 | Identifying trusted information sources

After completing the video and message testing, we asked SW survey participants to rate the level of trust they would place in certain organizations or individuals (e.g., scientists, aquaria and museums, government) to share accurate and fair information about SW (Supporting Information File S2). We collected responses on a Likert scale from 1 (would not trust at all) to 5 (trust completely). Responses of 4 and 5 were combined to form one category, indicating "trust" in the various sources of information. Respondents' trust in different sources ranged from a low of 23% for a grocer or fishmonger to a high of 76% for scientists (Figure 5).

4 | DISCUSSION

Our findings regarding familiarity with and perceptions of seafood farming generally align with earlier studies, particularly our observations of strikingly low knowledge of the sector (Flaherty et al., 2019; Rickard et al., 2020; Risius et al., 2017). Combined, our survey respondents who "had never heard of," or "knew little about" MA represented 49% of our SW

survey population, and those who had "never heard of" or "knew little about" SW represented 61% of our SW survey population. Such observations are particularly surprising, considering the continued concerted efforts to educate the US public about seafood farming (NOAA Fisheries Office of Aquaculture, 2021; NOAA Office of Education, 2022).

Also consistent with previous studies, we observed some tendency for those with higher levels of education to hold more favorable baseline opinions toward MA and SW (Dalton & Jin, 2018; Flaherty et al., 2019; G. Kim et al., 2017; Rickard et al., 2020). Surprisingly, there was no statistically significant regional difference in baseline opinion or message preference in either of our survey populations, although community histories and contexts have been shown to influence local attitudes about aquaculture practices in previous studies (Dalton & Jin, 2018; Hall & Amberg, 2013). Ultimately, among residents of western and northeastern US coastal states who were already familiar with these seafood farming sectors, favorable views outweighed unfavorable baseline opinions. Additionally, the majority of respondents shifted to more positive opinions about MA and SW after exposure to short videos and messages highlighting potential benefits of the sectors.

The consistency in preferences for messages highlighting environmental benefits for seafood farming across our surveyed coastal residents provides important fodder for future work. Although concepts of economic and social sustainability are increasingly intertwined with environmental sustainability, our results reveal a consistent preference for messages that highlight specific environmental benefits of seafood farming expansion. This affinity for environmental benefits differs from other studies, including one where perceived economic and social benefits correlated with support for shellfish operations in Rhode Island (Dalton & Jin, 2018). However, our study differs in that the surveys articulated multiple specific environmental benefits associated with aquaculture. In contrast, Dalton and Jin (2018) found that respondents generally assumed shellfish aquaculture had a negative impact on the environment and that assumption correlated with lower support. Their results, considered in tandem with our exploratory findings here, suggest that low public awareness of aquaculture represents an opening to engage community members in more optimistic discussions about the industry's now quantifiable improvements in environmental sustainability practices (Alleway et al., 2019; Theuerkauf et al., 2019; Gephart et al., 2020; Naylor et al., 2021).

Moving forward, who is best to convey messages of seafood farming benefits to coastal communities? To effectively engage with residents in communities impacted by expansion, trust in the messenger matters as much as the message itself (Hoffman, 2015; Lewandowsky et al., 2020; Rickard et al., 2020). Studies have found that information conveyed by trusted sources has a positive impact on public acceptance of aquaculture (Billing, 2018; Ford et al., 2022; Froehlich et al., 2017; Rickard et al., 2020). Our results here suggest that within this coastal survey population, scientists, aquaria and museums, and the seafood industry may be trusted liaisons to convey information about expansion to the public—at least in regards to SW (Figure 5). This exploratory examination of how residents of US coastal states engage with common messages of seafood farming benefits, and who is trusted to share those messages, is a step toward understanding aspects of public opinion that could drive more positive conversations and influence support. Yet further work is needed to understand the best mechanisms or platforms by which trusted messengers can convey these effective messages. Future research is also needed to better understand the balance of communicating positive messaging about the benefits of expansion with those potential risks will be critical to meaningfully build and sustain trust with coastal communities (Gegg & Wells, 2019; Mazur & Curtis, 2008).

It is important to acknowledge several other limitations to the scope and implications of these survey findings. Foremost, we acknowledge that of the 10 messages tested in each survey, those stating MA and SW are a "sustainable alternative to wild fisheries," "better than land-based food production," and "create jobs and support coastal economies" simplify positive aspects of seafood farming that are, in reality, much more complicated than can be presented in a one-sentence message. However, such messages are widely circulated, and we therefore determined it is valuable to understand their impact on perspectives of the individuals surveyed here. Further research is necessary to investigate how respondents perceive and weigh potential benefits (including those presented in our survey, as well as in recent scientific literature) versus potential risks of expanding specific seafood farming sectors in their communities. It is also important to note that our focus here is on short-term changes in opinions regarding seafood farming; how opinions hold over time is a critical area for future research.

Finally, we recognize that given our focus on specific states in the United States, and the survey recruitment approach (i.e., quota-sampled online surveys), our sample populations are potentially not fully representative of residents of all US coastal states, including those states surveyed in this study. Social scientists have been increasingly utilizing online surveys over the past decade, and recent studies highlight the efficacy of imposing quotas to balance key sociodemographic measures and improve the generalizability of results from nonprobability survey panels like those implemented here (Lehdonvirta et al., 2021; Radford et al., 2022). However, the implications of the results from such survey methods remain limited to individuals who are able and interested in participating in online surveys, missing key populations that may not have access to such opportunities (Lehdonvirta et al., 2021). Ultimately, our findings provide an exploratory, albeit not fully representative, snapshot of residents of western and northeastern US coastal states.

5 | CONCLUSION

A growing body of research highlights that—done responsibly—seafood farming has great potential to support a more sustainable and resilient food system while, in some cases, simultaneously providing ecosystem services (Boyd et al., 2020; Costello et al., 2020; Gephart et al., 2020; Naylor et al., 2021; Tlusty et al., 2019). Ongoing and emerging innovations have strengthened the potential for environmentally, economically, and socially responsible seafood farming practices. Yet, our results reaffirm that the residents of western and northeastern US coastal states who may benefit most from sustainable expansion remain relatively uninformed about this potential. Our results here suggest that certain sustainability themes, delivered by trusted sources, can positively shift perceptions, at least in the short term, for the US coastal residents sampled in this study. Altogether, this work suggests that facing aquaculture's communication challenge will require a combination of more salient messaging strategies and engagement across sectors with trusted messengers of information.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data and the code used to analyze data from this study are publicly available at https://github.com/BriKS0213/Shaughnessy-Aquaculture-2022 (DOI: 10.5281/zenodo.6562341).

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REFERENCES

Alleway, H. K., Gillies, C. L., Bishop, M. J., Gentry, R. R., Theuerkauf, S. J., & Jones, R. (2019). The ecosystem services of marine aquaculture: Valuing benefits to people and nature. *Bioscience*, *69*(1), 59–68. https://doi.org/10.1093/biosci/biy137

Aquarium of the Pacific. (2018). *Ocean to table: Stories of food, farming, and conservation*. https://www.aquariumofpacific.org/seafoodfuture/ocean_to_table/.

Billing, S. L. (2018). Using public comments to gauge social licence to operate for finfish aquaculture: Lessons from Scotland. *Ocean & Coastal Management*, *165*, 401–415. https://doi.org/10.1016/j.ocecoaman.2018.09.011

Billing, S.-L., Rostan, J., Tett, P., & Macleod, A. (2021). Is social license to operate relevant for seaweed cultivation in Europe? *Aquaculture*, *534*, 736203. https://doi.org/10.1016/j.aquaculture.2020.736203

Boyd, C. E., D'Abramo, L. R., Glencross, B. D., Huyben, D. C., Juarez, L. M., Lockwood, G. S., McNevin, A. A., Tacon, A. G. J., Teletchea, F., Tomasso, J. R., Jr., Tucker, C. S., & Valenti, W. C. (2020). Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges. *Journal of the World Aquaculture Society*, *51*(3), 578–633. https://doi.org/10.1111/jwas.12714

Carrassón, M., Soler-Membrives, A., Constenla, M., Escobar, C., Flos, R., Gil, J. M., & Reig, L. (2021). Information impact on consumers' perceptions towards aquaculture: Dismantling the myth about feeds for farmed fish. *Aquaculture*, *544*, 737137. https://doi.org/10.1016/j.aquaculture.2021.737137

Chu, J., Anderson, J. L., Asche, F., & Tudur, L. (2010). Stakeholders' perceptions of aquaculture and implications for its future: A comparison of the U.S.A. and Norway. *Marine Resource Economics*, *25*, 61–76. https://doi.org/10.5950/0738-1360-25.1.61

Costello, C., Cao, L., Gelcich, S., Cisneros-Mata, M. Á., Free, C. M., Froehlich, H. E., Golden, C. D., Ishimura, G., Maier, J., Macadam-Somer, I., Mangin, T., Melnychuk, M. C., Miyahara, M., de Moor, C. L., Naylor, R., Nøstbakken, L., Ojea, E., O'Reilly, E., Parma, A., … Lubchenco, J. (2020). The future of food from the sea. *Nature*, *588*, 95–100. https://doi.org/10.1038/s41586-020-2616-y

Dalton, T., Jin, D., Thompson, R., & Katzanek, A. (2017). Using normative evaluations to plan for and manage shellfish aquaculture development in Rhode Island coastal waters. *Marine Policy*, *83*, 194–203. https://doi.org/10.1016/j.marpol.2017.06.010

Dalton, T. M., & Jin, D. (2018). Attitudinal factors and personal characteristics influence support for shellfish aquaculture in Rhode Island (US) coastal waters. *Environmental Management*, *61*(5), 848–859. https://doi.org/10.1007/s00267-018-1011-z

Eisenack, K., Moser, S. C., Hoffmann, E., Klein, R. J., Oberlack, C., Pechan, A., Rotter, M., & Termeer, C. J. (2014). Explaining and overcoming barriers to climate change adaptation. *Nature Climate Change*, *4*(10), 867–872. https://doi.org/10.1038/nclimate2350

Finkelstein, S. (2018). *Seaweed farming and its surprising benefits*. 60 minutes. https://www.cbsnews.com/video/seaweed-farming-and-its-surprising-benefits-1/.

Flaherty, M., Reid, G., Chopin, T., & Latham, E. (2019). Public attitudes towards marine aquaculture in Canada: Insights from the Pacific and Atlantic coasts. *Aquaculture International*, *27*(1), 9–32. https://doi.org/10.1007/s10499-018-0312-9

Fong, C. R., Gonzales, C. M., Rennick, M., Lahr, H. J., Gardner, L. D., Halpern, B. S., & Froehlich, H. E. (2022). California aquaculture in the changing food seascape. *Aquaculture*, *553*, 738009. https://doi.org/10.1016/j.aquaculture.2022.738009

Ford, E., Billing, S. L., & Hughes, A. D. (2022). The role of community and company identities in the social license to operate for fin-fish farming. *Aquaculture*, *73*(8081), 738081. https://doi.org/10.1016/j.aquaculture.2022.738081

Froehlich, H. E., Gentry, R. R., Rust, M. B., Grimm, D., & Halpern, B. S. (2017). Public perceptions of aquaculture: Evaluating spatiotemporal patterns of sentiment around the world. *PLoS One*, *12*, e0169281. https://doi.org/10.1371/journal.pone.0169281

Galparsoro, I., Murillas, A., Pinarbasi, K., Sequeira, A. M., Stelzenmüller, V., Borja, Á., O'Hagan, A. M., Boyd, A., Bricker, S., Garmendia, J. M., Gimpel, A., Gangnery, A., Billing, S.-L., Bergh, Ø., Strand, Ø., Hiu, L., Fragoso, B., Icely, J., Ren, J., … Tett, P. (2020). Global stakeholder vision for ecosystem-based marine aquaculture expansion from coastal to offshore areas. *Reviews in Aquaculture*, *12*(4), 2061–2079. https://doi.org/10.1111/raq.12422

Gegg, P., & Wells, V. (2019). The development of seaweed-derived fuels in the UK: An analysis of stakeholder issues and public perceptions. *Energy Policy*, *133*, 110924. https://doi.org/10.1016/j.enpol.2019.110924

Gephart, J. A., Golden, C. D., Asche, F., Belton, B., Brugere, C., Froehlich, H. E., Fry, J. P., Halpern, B. S., Hicks, C. C., Jones, R. C., Klinger, D. H., Little, D. C., McCauley, D. J., Thilsted, S. H., Troell, M., & Allison, E. H. (2020). Scenarios for global aquaculture and its role in human nutrition. *Reviews in Fisheries Science & Aquaculture*, *29*(1), 122–138. https://doi.org/10.1080/23308249.2020.1782342

Hall, T. E., & Amberg, S. M. (2013). Factors influencing consumption of farmed seafood products in the Pacific northwest. *Appetite*, *66*, 1–9. https://doi.org/10.1016/j.appet.2013.02.012

Henríquez-Antipa, L., & Cárcamo, P. (2019). Stakeholder's multidimensional perceptions on policy implementation gaps regarding the current status of Chilean small-scale seaweed aquaculture. *Marine Policy*, *103*, 138–147. https://doi.org/10.1016/j.marpol.2019.02.042

Hoffman, A. J. (2015). *How culture shapes the climate change debate*. Stanford University Press. https://doi.org/10.1515/9780804795050

Kim, G., Duffy, L. N., Jodice, L. W., & Norman, W. C. (2017). Coastal tourist interest in value-added, aquaculture-based, culinary tourism opportunities. *Coastal Management*, *45*(4), 310–329. https://doi.org/10.1080/08920753.2017.1327345

Kim, J., Stekoll, M., & Yarish, C. (2019). Opportunities, challenges and future directions of open-water seaweed aquaculture in the United States. *Phycologia*, *58*, 446–461. https://doi.org/10.1080/00318884.2019.1625611

Knapp, G., & Rubino, M. C. (2016). The political economics of marine aquaculture in the United States. *Reviews in Fisheries Science & Aquaculture*, *24*, 213–229. https://doi.org/10.1080/23308249.2015.1121202

Kotcher, J., Maibach, E., & Choi, W. T. (2019). Fossil fuels are harming our brains: Identifying key messages about the health effects of air pollution from fossil fuels. *BMC Public Health*, *19*(1), 1079. https://doi.org/10.1186/s12889-019-7373-1

Lehdonvirta, V., Oksanen, A., Räsänen, P., & Blank, G. (2021). Social media, web, and panel surveys: Using non-probability samples in social and policy research. *Policy & Internet*, *13*(1), 134–155. https://doi.org/10.1002/poi3.238

Lewandowsky, S., Cook, J., & Lombardi, D. (2020). *Debunking handbook 2020*. https://doi.org/10.17910/B7.1182

Mather, C., & Fanning, L. (2019). Social licence and aquaculture: Towards a research agenda. *Marine Policy*, *99*, 275–282. https://doi.org/10.1016/j.marpol.2018.10.049

Mazur, N. A., & Curtis, A. L. (2008). Understanding community perceptions of aquaculture: Lessons from Australia. *Aquaculture International*, *16*(6), 601–621. https://doi.org/10.1007/s10499-008-9171-0

McAfee, D., Doubleday, Z. A., Geiger, N., & Connell, S. D. (2019). Everyone loves a success story: Optimism inspires conservation engagement. *Bioscience*, *69*(4), 274–281. https://doi.org/10.1093/biosci/biz019

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, *107*(51), 22026–22031. https://doi.org/10.1073/pnas.1007887107

Murphy-Gregory, H. (2018). Governance via persuasion: Environmental NGOs and the social licence to operate. *Environmental Politics*, *27*(2), 320–340. https://doi.org/10.1080/09644016.2017.1373429

Murray, G., & D'Anna, L. (2015). Seeing shellfish from the seashore: The importance of values and place in perceptions of aquaculture and marine social–ecological system interactions. *Marine Policy*, *62*, 125–133. https://doi.org/10.1016/j.marpol.2015.09.005

Naylor, R. L., Hardy, R. W., Buschmann, A. H., Bush, S. R., Cao, L., Klinger, D. H., Little, D. C., Lubchenco, J., Shumway, S. E., & Troell, M. (2021). A 20-year retrospective review of global aquaculture. *Nature*, *591*(7851), 551–563. https://doi.org/10.1038/s41586-021-03308-6

NOAA Fisheries Office of Aquaculture. (2021). *Aquaculture literacy at NOAA*. https://www.fisheries.noaa.gov/national/aquaculture/aquaculture-literacy-noaa.

NOAA Office of Education. (2022). *Aquaculture literacy*. https://www.noaa.gov/office-education/aquaculture-literacy.

Orme, B. (2009). *Maxdiff analysis: Simple counting, individual-level logit, and HB*. Sawtooth Software Research Paper Series.

R Core Team. (2020). *R v.4.0.4: A language and environment for statistical computing*. R foundation for statistical computing. http://www.R-project.org/.

Radford, J., Green, J., Quintana, A., Safarpour, A., Simonson, M. D., Baum, M., Lazer, D., Ognyanova, K., Druckman, J. N., Perlis, R., Santillana, M., & Volpe, J. D. (2022). *Evaluating the generalizability of the COVID states survey—A large-scale, non-probability survey*. OSF Prints. https://doi.org/10.31219/osf.io/cwkg7.

Rickard, L. N., Britwum, K., Noblet, C. L., & Evans, K. S. (2020). Factory-made or farm fresh? Measuring U.S. support for aquaculture as a food technology. *Marine Policy*, *115*, 103858. https://doi.org/10.1016/j.marpol.2020.103858

Rickard, L. N., Noblet, C. L., Duffy, K., & Christian Brayden, W. (2018). Cultivating benefit and risk: Aquaculture representation and interpretation in New England. *Society & Natural Resources*, *31*, 1358–1378. https://doi.org/10.1080/08941920.2018.1480821

Risius, A., Janssen, M., & Hamm, U. (2017). Consumer preferences for sustainable aquaculture products: Evidence from in-depth interviews, think aloud protocols and choice experiments. *Appetite*, *113*, 246–254. https://doi.org/10.1016/j.appet.2017.02.021

Sawtooth Software. (2020). *The MaxDiff system technical paper*. Sawtooth Software Technical Paper Series, 9. https://sawtoothsoftware.com/resources/technical-papers/maxdiff-technical-paper.

Shou, Y., Shao, J., Lai, K. H., Kang, M., & Park, Y. (2019). The impact of sustainability and operations orientations on sustainable supply management and the triple bottom line. *Journal of Cleaner Production*, *240*, 118280. https://doi.org/10.1016/j.jclepro.2019.118280

Theuerkauf, S. J., Morris, J. A., Jr., Waters, T. J., Wickliffe, L. C., Alleway, H. K., & Jones, R. C. (2019). A global spatial analysis reveals where marine aquaculture can benefit nature and people. *PLoS One*, *14*(10), e0222282. https://doi.org/10.1371/journal.pone.0222282

Tlusty, M. F., Tyedmers, P., Bailey, M., Ziegler, F., Henriksson, P. J., Béné, C., Bush, S., Newton, R., Asche, F., Little, D. C., Troell, M., & Jonell, M. (2019). Reframing the sustainable seafood narrative. *Global Environmental Change*, *59*, 101991. https://doi.org/10.1016/j.gloenvcha.2019.101991

Weitzman, J., & Bailey, M. (2019). Communicating a risk-controversy: Exploring the public discourse on net-pen aquaculture within the Canadian media. *Aquaculture*, *507*, 172–182. https://doi.org/10.1016/j.aquaculture.2019.04.025

Yang, J. Z., Rickard, L., Liu, S., & Boze, T. (2021). Seafood stories: The effect of video message type on U.S. support for sustainable aquaculture. *Journal of Applied Communication Research*, *50*, 1–17. https://doi.org/10.1080/00909882.2021.1939403

Young, N., & Liston, M. (2010). (Mis) managing a risk controversy: The Canadian salmon aquaculture industry's responses to organized and local opposition. *Journal of Risk Research*, *13*(8), 1043–1065. https://doi.org/10.1080/13669877.2010.514429

Zahara, A., Keeling, A., & Bell, T. (2016). *Social license to operate: Background and state of knowledge report*. Report prepared for the memorial dialogue on social licence to operate, Department of Geography, Memorial University.

Zajicek, P., Corbin, J., Belle, S., & Rheault, R. (2021). Refuting marine aquaculture myths, unfounded criticisms, and assumptions. *Reviews in Fisheries Science & Aquaculture.*, *0*, 1–28. https://doi.org/10.1080/23308249.2021.1980767

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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