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Assessing high school students' perceptions and preferences for aquaculture versus wild-caught seafood: The case of Oʻahu, Hawaiʻi

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Abstract

An increasing population and demand for seafood have provoked a need to understand the factors affecting consumers' perceptions of aquaculture and wild-caught seafood to ensure the sustainability of ocean resources. A survey was developed to assess Hawaiʻi's high school students' perceptions and preference for aquaculture and wild-caught seafood using a cognitive mapping framework. The survey was administered to three high schools across urban, suburban, and rural areas of the island of Oʻahu, Hawaiʻi. Using descriptive statistics, analysis of variance (ANOVA) tests, and mental modeling techniques the following results from the survey indicated that most students had some knowledge of aquaculture. Residence and gender demographics of students make a difference in their preference for aquaculture and wild-caught seafood. Overall, the students indicated a higher preference for wild-caught seafood as compared to aquaculture in terms of taste and the reverse is true for environmental impacts. However, rural residents and male students showed a significant preference for aquaculture seafood. The implications of this study provide the information needed to improve public perceptions of aquaculture and promote sustainable seafood

practices and consumption. Furthermore, education focused on aquaculture can be introduced into school curricula to enhance their knowledge of environmental, health, and nutrition impacts.

1 | INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) estimates that approximately 3.3 billion people worldwide depended on fish for 20% of their animal protein intake in 2020 (FAO, 2020). Per capita fish consumption rose from 9.0 kg in 1961 to 20.2 kg in 2020 and is expected to increase to 21.4 kg per capita in 2030 (FAO, 2022). Seafood consumption in Hawai'i is estimated to be about two to three times higher than the national average per capita (Baker et al., 2020; Davidson et al., 2012). These trends have shown that the growing demands for seafood have surpassed the sustainable yield of the ocean's resources (Tidwell & Allan, 2001). In response, aquaculture production has become an alternative source of meeting these growing demands (Gephart & Pace, 2015; Tidwell & Allan, 2001). The aquaculture industry has been playing a significant and growing role in providing a sustainable seafood supply while lessening the pressure on overfished capture fisheries. Since 1990, total production from aquaculture fisheries has grown exponentially as compared to capture fisheries (FAO, 2020). While many natural fish stocks have reached and are producing at their sustainable maximum yield, the sustainability of marine fishery resources remains of significant concern as the percentage of sustainably fished stocks has decreased to 64.6% in 2019, a 1.2% decline from 2017 (FAO, 2022). Aquaculture production is growing at an average rate of 5.3% per year and playing an increasingly important role in supplying the world with seafood (FAO, 2020). The FAO states, "more needs to be done to feed the world's growing population while enhancing the sustainability of stocks and fragile ecosystems and protecting lives and livelihoods in the long-term" (FAO Liaison Office in Brussels, 2022). Therefore, it has become critical for aquaculture to supply consumers with high-quality, safe, environmentally friendly, and affordable fish, and seafood products. However, studies (Bacher, 2015; Carrassón et al., 2021; Claret et al., 2014; Verbeke et al., 2007) have shown that consumers find wild-caught seafood tastier, healthier, and environmentally friendlier than aquaculture-produced seafood. In order for aquaculture to carry its weight in supplying seafood, particularly in the Pacific region, we first need to understand public perceptions of aquaculture and what drives the perceptions or misconceptions about food safety, health, and environmental stewardship.

2 | PROBLEM STATEMENT

According to data from FAO (National Marine Fisheries Service, 2021a), the United States is the world's second-largest consumer of seafood after China. While the National Oceanic and Atmospheric Administration has reported efforts to rebuild natural fisheries stocks in the United States, more needs to be done regarding successful policies that ensure fisheries and aquaculture are sustainable around the world (National Marine Fisheries Service, 2021b). Sustainable fisheries are vital to the value of U.S. fisheries, fishing communities, and healthy marine ecosystems. Although it is clearly in the best interest of consumers to support the sustainable development of aquaculture, the industry struggles with hurdles regarding the perceptions of aquaculture and aquaculture products. Some studies on the subject have concluded that consumer perceptions have inhibited the growth of the industry, often citing

negative dialogue as a driver of misconceptions. According to Olsen and Osmundsen (2017, p. 25), "the media give risks more prominent coverage than benefits." In concurrence, an FAO report by Bacher (2015) thoroughly synthesizes social research on the perceptions of aquaculture-produced seafood in developed and developing countries. Based on previous studies, the author identified the health and safety of farmed products as the strongest consumers' concerns, and a perception of wild fish as more *natural* than farmed fish in results from Western countries (Bacher, 2015). A study investigating aquaculture perceptions in Europe similarly found that "respondents have less trust in the production and consumption of farmed fish than in their wild counterparts, as the former are perceived as unnatural and unfamiliar" (Schlag & Ystgaard, 2013, p. 209). In contrast, perceptions are more positive in areas where aquaculture has directly benefited communities, leading the report to conclude that "apart from objective knowledge [in aquaculture]—personal experiences, preconceived ideas, and the demographic and regional context strongly influence perceptions of aquaculture." (Bacher, 2015, p. 27). Therefore, it is safe to say that aquaculture is not well understood by the general public, and as a result, we are missing out on opportunities to improve our food security, economy, and even environment. It is important to overcome the communication obstacles and, as FAO recommends in its report, actively shape the debate on aquaculture because "a lack of information leaves room for speculation" (Bacher, 2015, p. 27). This is especially true if we are going to meet the growing national and global demands for seafood. Furthermore, the FAO report recommends investing in education to provide more fact-based information to consumers to address the various perceptions that impact the growth of the aquaculture industry. If we are to advance the promotion of seafood and in particular aquaculture products, it is important to understand what information consumers are currently using to convey consumption preferences regarding its *origin* (wild-caught vs. aquaculture-produced seafood). In addition, consumers are becoming more health and safety conscious about how their food is grown and where it comes from. To advance the promotion of aquaculture, we first have to evaluate consumer perceptions of aquaculture and wild-caught seafood.

Consumer acceptance starts from a young age, as the food preferences of adolescents are critical in determining their food preferences as adults (Yosi et al., 2020). A previous study states that childhood food habits exert an important influence on personal future food decisions (Fernández-Polanco et al., 2010). Adolescents represent a unique consumer group as they represent three markets: consumers, future consumers, and their influence on parents' consumption (Fernández-Polanco et al., 2010). Focusing our efforts on adolescents allows us to understand how their perceptions influence personal consumption preferences and their parent's consumption preferences. Furthermore, our research can have positive impacts on the way adolescents perceive aquaculture seafood and improve the image of aquaculture for future generations.

3 | OBJECTIVES

The primary purpose of this study is to increase consumer consumption and acceptance of aquaculture in Hawai'i. Specifically:

1. To discover the perceptions of major factors determining their consumption of wild-caught versus aquaculture-produced seafood
2. To simulate the impact of enhanced knowledge on changes in perception
3. To make recommendations on education modules based on survey results on their misguided (misinformed) perceptions regarding aquaculture.

We will assess high school students' perceptions of aquaculture and aquaculture products. A key assumption from our study is that adolescents can influence the perception of the whole family and drive their purchase preferences.

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4 | MATERIALS AND METHODS

This section starts with the methodology by describing the mental model framework, survey creation, and the study sample. Based on objectives one and two, the major factors influencing a consumer's preference for wild-caught versus aquaculture-produced seafood must be determined. First, a literature review was conducted on consumption perception including the appropriate way of measuring how young adults can verbalize their causal beliefs on their consumption preferences. Then, we decided to use a mental modeling framework to create a cognitive map to collect data and conduct analysis. A mental modeling framework has been used to study perceptions on value-based issues such as climate change, sustainability, conservation farming practices, and technology adoption. It is versatile and easy to explain and also has the ability to predict the impact of external factors such as education to see how it would change consumption preferences. Then based on the study location, Oʻahu, Hawaiʻi, in the next section, we describe the schools in the study sample that ranged from urban, suburban, and rural areas.

To determine the most relevant factors influencing seafood consumption preferences, a panel of diverse experts on consumption and aquaculture was assembled. With the experts' information, the team created a cognitive map for seafood consumption preferences, depicted in Figure 1, with the components of influences and perceptions. Then a survey based on the cognitive map was created and data was gathered from the students with parental and student consent to participate. With the data, the causal relationships from the mental model for seafood consumption preferences were calculated. Below is a description of the mental model framework.

4.1 | Mental model framework

To assess the current perceptions and consumption of aquaculture-produced seafood, this study used Fuzzy-Logic Cognitive Mapping (FCM) which is a participatory approach (Gray et al., 2012). An FCM is a mathematical mental
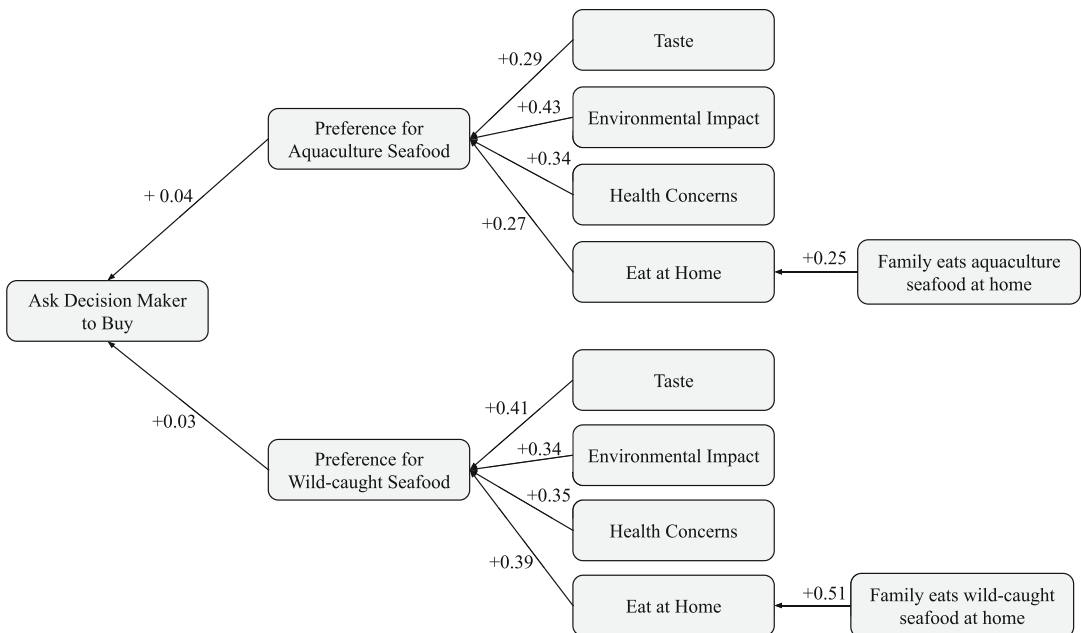
FIGURE 1 Fuzzy-logic Cognitive Mapping results representing the relationships between the students' preferences based on "taste," "environmental impact," "health concerns," and "what they eat at home" and how their preferences influence their family members' purchase decisions.

model that graphically represents relationships between variables by connecting concepts in a direct linkage (Gray et al., 2013). Mental models may be used to explain how people interpret and express the complexity of their environment and experiences (Gray et al., 2014; Kosko, 1986; Özesmi & Özesmi, 2004). An individual's mental model is a way to inform researchers of her/his assessment of risks and benefits, and how her/his choices are made. The FCM approach combines knowledge, preferences, and values with quantitative estimations of the perceived relationships between the variables to measure change (Gray et al., 2014). This approach has been applied in various scientific disciplines to understand the belief systems of individuals and groups (Özesmi & Özesmi, 2004; Vasslides & Jensen, 2016). In this study, we employed this method of cognitive mapping to represent and analyze the initial dynamics of students in an aggregate mental model that integrated students' perceptions and preferences, and other relevant variables centered around wild-caught and aquaculture-produced seafood.

We formulated the third section of the survey instrument based on the FCM approach. This section of the survey addresses how people filter, process, and store information, as well as how these perceptions may guide individuals' decisions and actions (Gray et al., 2014). In the FCM, respondents are asked about the causal relationships developed by experts, the direction of the relationship of the variables to each other, and the strength/weight of the relationship between the variables. In this study, respondents were first asked about how often they ask their family members to purchase seafood and whether they define the source of seafood. Second, respondents were asked whether they had a preference for wild-caught or aquaculture seafood based on the following variables: "taste," "environmental impact," "health concerns," and "what they eat at home" with a Likert scale to specify the level of agreement.

A software developed by Steven Gray (n.d.) known as Mental Modeler was used to construct the FCM in Figure 1. The software was also used to simulate how aquaculture education would impact the respondents' preferences via four scenarios. The four scenarios in Figure 3 represent educational activities and the effect of each educational activity. These scenarios assume that aquaculture education positively increases students' perception.

4.2 | Survey development

The survey was developed to document and assess students' perceptions, and consumption preferences for seafood based on *origin* (i.e., sourced from aquaculture production or wild-caught by commercial fisheries or individuals) and to gauge knowledge of aquaculture production. Data was collected using a structured questionnaire consisting of three sections. The first section focuses on the socio-demographic data (school, grade, gender, and area of residency) of the respondent. The second section focuses on students' knowledge of fish production, seafood consumption, and how COVID-19 may have impacted their fish consumption. We included questions about the potential impacts of the COVID-19 pandemic, as many capture and aquaculture fisheries were affected (OECD, 2020). The third section of the survey questionnaire consists of structured mental model questions that focus on students' preferences for aquaculture versus wild-caught seafood and how that influences the family's seafood purchases at home. We carefully formulated the mental model questions to measure the degree of influence that the four factors: "taste," "environmental impact," "health concerns," and "what they eat at home" have on the respondents' preferences and how their preferences impact their family members' purchase decisions.

To construct the questionnaire, we conducted a thorough review of previous literature studies and surveyed experts' opinions and knowledge to determine the factors that have the greatest impact on a consumer's seafood consumption preferences. Based on the literature, we identified that the most influential factors affecting seafood preference included sociodemographics, taste, food safety, health benefits, and fisheries sustainability (Davidson et al., 2012; Fernández-Polanco & Luna, 2012). Expert knowledge was gathered in July and August of 2020 through interviews with nine individuals with backgrounds in Biology and Aquaculture, Economics and Aquaculture, Economics and Agriculture, and Education and Aquaculture. In addition to taste, environment, and health variables, results from the experts indicated the three variables having the greatest influence on a student's perception of seafood are

education, seafood options offered at school, and the tradition of fishing with family and relatives. These interviews revealed causal relationships between variables such as the origin of the fish and taste, health concerns, environmental impact, and what is eaten at home, as represented in Figure 1. Based on these interviews, we also identified other factors influencing a consumer's preferences including income, easiness to preparation, public information, and culture.

Through the survey, students were asked to rate consumption preferences based on "taste," "environmental impact," "health concerns," and "what they eat at home". The data collected through the FCM model identified the factors exerting a relative influence on perceptions about aquaculture and wild-caught seafood. The direction and magnitude of the factors in relation to consumption preferences were represented by arrows in a FCM in Figure 1. The mental model was used to provide insight into how knowledge gaps and different perceptions affect consumption preferences. The estimated model was then used to simulate "What if" scenarios to gauge the impacts of the introduction of different educational activities (Kosko, 1986). Through scenarios, our aim was to demonstrate how the factors within the mental model influence one another. In FCM, the scenarios are estimated by increasing or decreasing the strength of the relationship of specific factors on a scale by increasing to 1, 0 being no change and 1 representing maximum change. We used relevant and feasible educational activity scenarios to determine which types of educational themes provide the greatest impact to increase consumption of aquaculture-produced seafood and the families' purchase decisions. We defined each "What if" scenario to be a plausible educational activity that focuses on four factors ("taste," "environmental impact," "health concerns," and "what they eat at home") that may influence a student/consumer's preference for aquaculture seafood.

5 | STUDY SAMPLE

5.1 | School selection

To address adolescent perceptions surrounding aquaculture, we focused our efforts on high school students from three high schools within Oʻahu, Hawaiʻi. Focusing on high school students allows us to identify what type of education should be implemented in the school curriculum to overcome misconceptions driving seafood preferences.

Each participating school was screened based on several variables that allowed our working group to provide a more thorough assessment of different communities. We selected high schools (grades 9–12) with different demographics to represent the diverse socio-economic backgrounds of student families and communities throughout Oʻahu, Hawaiʻi. This will allow us to investigate through the survey and data analysis if there are any differences in how aquaculture and wild-caught seafood are perceived in communities of varying demographics. We partnered with three high schools on Oʻahu: Aiea High School, Waipahu High School, and Waianae High School. The selected high schools came from a list of potential High Schools from the College of Education at the University of Hawaiʻi at Mānoa. Through this connection, we were able to connect with Aiea High School, located in an urban/suburban inland community. Through the Center for Tropical and Subtropical Aquaculture (CTSA), we connected with administrators and teachers at Waianae High School, located in a rural seaside community that is home to a large population of Native Hawaiians. Through connections with Future Farmers of America, we connected with Waipahu High School, an inland suburban community.

The survey was administered online via google forms to these three participating schools in Fall 2021 after Institutional Review Board (IRB) approval. We first contacted the teachers and gathered assent forms from both parents and students. The assent forms from both parents and students were mandatory for students under 18 to participate in the study, but all participation was voluntary. Following the assent forms, we sent out the survey via the students' email and through the engagement of the teachers. In total, we gathered 107 student survey responses, 54 from Aiea High School, 31 from Waipahu High School, and 21 from Waianae High School. The geographical scope of these schools provided insight into how demographics play a role in students' knowledge and perceptions of seafood.

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6 | RESULTS AND DISCUSSION

6.1 | Survey

The results are focused on respondents that consume seafood. Nine of the respondents said they do not eat seafood. Therefore, 98 out of 107 were used in the following analytical results. The survey included survey respondents from a wide geographical scope with diverse ethnic backgrounds as depicted in Table 1. Results from the first section of the survey reflect the respondent's socio-demographics. The majority of the respondents in all areas of residency claimed to be of multiple ethnicities, Asian descent being the largest with the second largest being a pacific islander. Gender is evenly distributed in each area of residency.

Results from the second section of the survey reflect the respondent's knowledge of aquaculture, seafood consumption, and the impacts of COVID-19. Almost half (46%) of the respondents claimed they know what aquaculture is. Approximately 15% of the respondents claimed they did not know what aquaculture is and 39% that they are not sure what aquaculture is. Those who responded as knowing what aquaculture is said they learned about aquaculture from school and/or school field trips. When asked "When you hear the term aquaculture, what comes to your mind?", the majority of the students said growing seafood and growing aquatic plants for seafood. These results reflect the students' knowledge of aquaculture, and that school is a necessary component in where the students learn this information. In addition, there is no correlation between residency and a person's level of knowledge of aquaculture.

COVID-19 has had an impact on some of the respondents' frequency of fish consumption. Approximately 35% of the respondents claimed that they have consumed less seafood since COVID-19. However, more than half of the respondents said COVID-19 did not affect their consumption of seafood. When asked "Since the COVID-19 Pandemic, have you consumed more wild-caught or aquaculture seafood?", the majority of the respondents claimed they did not know the source of their seafood. These results indicate that COVID-19 had various impacts on different families and the respondents are likely unaware of the origin of the seafood they are consuming.

Results from the third section of the survey reflect the respondents' preferences for aquaculture and wild-caught seafood consumption. The respondents selected which type of seafood they prefer based on the following factors: "taste," "environmental impact," "health concerns," and "what they eat at home" as represented in Figure 2. "Taste" had the greatest influence on the respondent's preference for wild-caught seafood, with 74.5% of the respondents preferring wild-caught seafood because of taste. Whereas "environmental impact" had the greatest influence on the respondents' preference for aquaculture seafood, with 74.5% of the respondents preferring aquaculture seafood because of its environmental impact. Overall, the majority of the respondents had a higher

TABLE 1 Survey respondents' socio-demographics and knowledge of aquaculture based on the area of residency.

| Place of residence (no. of respondents) | Gender | | | Ethnicity[a] | | | | |
	Female (%)	Male (%)	Other[b] (%)	Asian (%)	Pacific islander (%)	Caucasian (%)	Latino or Hispanic (%)	Other (%)
Urban area—25	44.0	48.0	8.0	72.0	68.0	32.0	24.0	28.0
Suburban area–53	35.8	58.5	5.7	92.5	24.5	13.2	11.3	9.4
Rural area—15	53.3	40.0	6.7	80.0	60.0	13.3	13.3	6.7
Total—93	40.9	52.7	6.5	84.9	41.9	18.3	15.1	14.0

[a]Ethnicity, respondents were able to choose more than one ethnicity.
[b]Other, prefer not to answer or left blank.
Source: Aquaculture Survey conducted in 2021–2022.
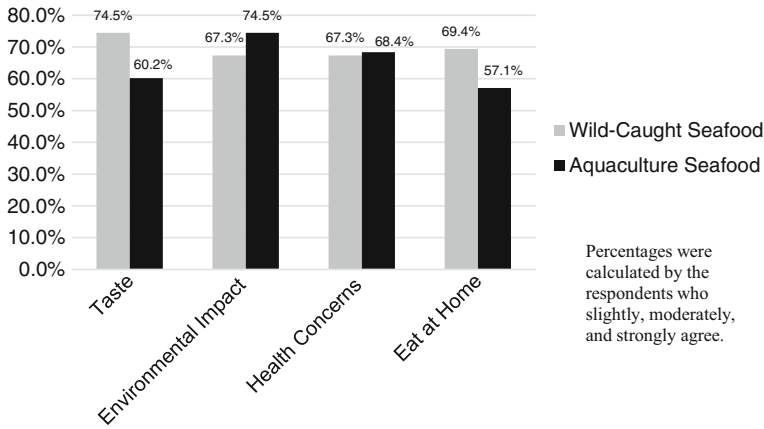
FIGURE 2 Factors that influence respondents' consumption preferences for wild-caught versus aquaculture seafood.
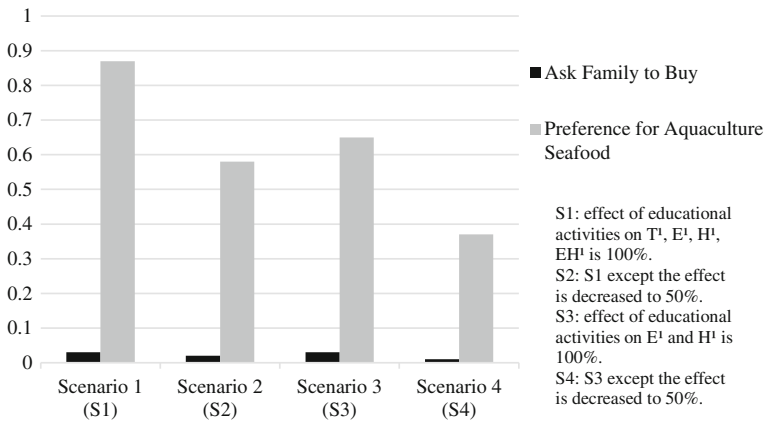
FIGURE 3 Results of the "What if" scenarios on preference and asking families to purchase aquaculture seafood. E, environmental impact; EH, eat at home; H, health concerns; T, taste.

preference for wild-caught seafood as compared to aquaculture seafood. This section also focuses on the respondents' influence on their family members' purchase decisions as measured by how often they ask their family members and whether they specify the source of seafood. Half of the respondents ask their parents to purchase seafood and approximately 87% have no preference between wild-caught and aquaculture seafood. Out of our sample size, there were 11% of respondents claimed they asked their families to purchase seafood from a specific source. These results indicate that adolescents may influence their parents' purchase decisions, but rarely define the source of seafood. More than half (51%) of the respondents agreed that it would be best for the environment if in Hawai'i we ate both wild-caught and aquaculture seafood, seven (7%) of the respondents agreed that it would be best if we only ate wild-caught seafood, thirteen (13%) of the respondents agreed it would be best if we only ate aquaculture seafood, twenty-eight (28%) of the respondents agreed they do not know which option would have the best impact on the environment. Given these results, it is clear that the majority of the respondents are aware that a healthy balance between wild-caught and aquaculture seafood consumption is needed to ensure a sustainable future.

6.2 | Fuzzy-logic cognitive map

The FCM depicted in Figure 1 represents the interactions between respondents' preferences and their influence on their family members' purchase decisions. Results from the FCM confirm the degree of understanding or misunderstanding of relationships that drive consumption preferences and household purchases. These results suggest that overall, the respondents do not have a strong preference between aquaculture and wild-caught seafood based on the following factors: "taste," "environmental impact," "health concerns," and "what they eat at home". In comparison, respondents had a slightly higher preference for wild-caught seafood based on "taste," "health concerns," and "what they eat at home." "Environmental impact" was the only factor where respondents preferred aquaculture seafood over wild-caught seafood. Based on the FCM results, respondents' preferences did not translate into asking their families for seafood from a specific source. However, there are still other factors limiting their consumption preferences that could play a role in asking their families. In order to increase aquaculture seafood consumption, more needs to be done to influence their families' purchases, such as focusing efforts on educating families as a whole.

6.3 | Simulation

The simulation exercises are to evaluate what types of educational activities can change their consumption behavior (i.e., objective 3). To simulate education activities, one would change the causal relationship value in the estimated mental model from what it is (which is less than one) to one such as in the case of "environmental impact" on consumption preference from 0.43 to 1 in the model. Changing the relationship strength models the assumption that knowledge on "environmental impact" is 100% through education. In response to the change or the "What if" scenario, the model would predict what would that do to a preference for aquaculture-produced seafood. The simulation of the "What if" scenario exercise would evaluate which education subjects or outreach activities will produce the greatest impact in terms of impact on preferences and the families' purchase decisions of aquaculture seafood. In cases where resources for education are limited, results from the simulation exercise help one prioritize the educational activity with the most impact. Scenarios 1 and 2 represent education activities focused simultaneously on "taste," "environmental impact," "health concerns," and "what they eat at home." The difference between Scenario 1 and 2 is that Scenario 1 is changing the causal relationships to 1 and Scenario 2 is when the relationships are changed to 0.5 from the estimated values. Scenarios 3 and 4 represent education activities focused only on two factors: "environmental impact" and "health concerns." Similarly, Scenario 3 is changing the relationships to 1 and Scenario 4 is changing the relationships to 0.5 from the estimated values. Scenarios 1 and 3 result in the educational activities leading to 100% of the respondents preferring aquaculture over wild-caught seafood. Scenarios 2 and 4 result in the educational activities leading to 50% of the respondents preferring aquaculture over wild-caught seafood. The difference between the scenarios is the exposure to specific educational activities and the level of effectiveness that the education has on respondents' preferences and their families' purchase decisions for aquaculture seafood.

Overall, scenario 1 produced the highest impact on enhancing the preference for aquaculture seafood as compared to all the other scenarios. Scenario 3 produced the second highest impact on preference for aquaculture seafood whereas scenario 4 produced the lowest impact on preference for aquaculture seafood when educational activities are based on two factors. These differences account for the effectiveness of the educational activities and how much the respondents' perceptions change in response to the education. Education focused on the environmental and health benefits of aquaculture can have a high impact in terms of preferences for aquaculture but is dependent on the effectiveness of the educational activities. Reducing the effectiveness by half did not reduce the impact proportionally by half, meaning the rate of impact is not proportionally related, but rather decreasing at a decreasing rate. Therefore, we can only suggest that education and outreach activities that focus on all four factors

will have the greatest impact on increasing preference for aquaculture seafood consumption. In areas where resources are limited, education should focus on the environmental and health benefits of aquaculture to maximize educational efforts.

6.4 | ANOVA tests

To evaluate socio-demographics' significance on students' preferences, we selected their self-reported "place of residence" (i.e., urban, suburban, or rural) and "gender" (i.e., male and female). We conducted a one-way ANOVA to test if the responses from different groups had equal variance considering the preference for aquaculture produced over wild-caught seafood because of "taste," "environmental impact," "health concerns," and "what they eat at home." Results between groups (F [2, 50] = 5.041, p = 0.010) revealed that the means of at least two groups are significantly different at α < 0.05 regarding the preference for aquaculture-produced seafood because it tastes better compared to wild-caught seafood. We applied Tukey HSD for multiple comparisons to assess differences between groups. The mean scores were significantly different for rural and suburban (p = 0.007) and rural and urban (p = 0.011) places of residence. The higher average scores suggest a more favorable perception by students in rural areas (M = 2.333) compared to suburban (M = 1.414) and urban (M = 1.357) groups. ANOVA results for the "place of residence" were not significant at α < 0.05 for any of the other three dimensions. One-way ANOVA for gender was only statistically significant for preference associated with eating farm-raised seafood at home. The results (F [1, 52] = 5.26, p = 0.026) revealed a significant difference between the mean scores for male (M = 1.900) and female (M = 1.375) students. These outcomes suggest that "place of residence" and "gender" affect students' perceptions of aquaculture seafood, contributing to more diversity in perceptions in the classroom. This information is valuable for curriculum development and planning of in-class activities that focus on aquaculture education initiatives.

7 | POLICY IMPLICATIONS

The potential impacts of this research extend beyond high school. There is great potential for policy to promote sustainable seafood to reach a wide range of consumers. Aquaculture has been proven to play an increasingly important role in the growing demand for seafood consumption. However, the lack of recognition that aquaculture can fight hunger and provide food security is a shortcoming in the policy. A study mentions that "fish within a food systems perspective can lead to innovative policies and investments that promote nutrition-sensitive and socially equitable capture fisheries and aquaculture." (Bennett et al., 2021, p. 981). Aquaculture is inextricably linked to food and nutrition security. Policies that recognize the value of sustainable seafood as a source of nutrition could strengthen global food security and help world hunger (Bennett et al., 2021). Providing access to diverse, nutritious, safe, and affordable food is necessary to reach a broad range of consumers.

The results from this study provide policymakers with a baseline understanding of public perceptions of aquaculture and wild-caught seafood. The "What if" scenarios provided by the FCM approach emulate the likely outcomes of implementing effective educational activities. This information informs policymakers about the constraints limiting consumption preferences and the necessary actions that need to be taken to promote sustainable seafood consumption. Based on the results, consumers care most about the environmental impact and taste of seafood as these two factors were the greatest driving forces for consumer consumption preferences. Therefore, focusing policy efforts on supporting the production of environmentally friendly and tasty aquaculture seafood can have positive impacts. Educational policies that reinforce the positive benefits of aquaculture are essential in the acceptance of aquaculture to debunk misconceptions.

8 | LIMITATIONS

The limitations of this study include sampling beyond Oʻahu, Hawaiʻi, and COVID-19. Unforeseen circumstances, like COVID-19 prolonged the implementation of our study. As a result of social distancing requirements, the assent forms and survey results were collected virtually via email communication with the teachers and Google forms. This may have affected our ability to collect a larger sample size and reach out to more schools. Future research should be aware of these limitations when designing and implementing similar studies. The scope of our research provides a baseline understanding of high school students' knowledge and preferences for aquaculture and wild-caught seafood in Hawaiʻi. Further research can implement the educational activities as modeled in Figure 3 to determine a change in students' perceptions and consumption preferences.

9 | CONCLUSION

This project provides a unique approach to the aquaculture industry-wide issue of public perceptions by conducting a baseline survey to assess students' perceptions and utilizing a mental model framework to simulate various scenarios. Data collection on socio-demographics, knowledge, individual and family seafood consumption patterns, and seafood preferences provides information to understand how these variables are linked and affect one another. This allows us to tailor specific educational strategies to target knowledge gaps and misconceptions surrounding aquaculture. Our results indicate that socio-demographics on where the respondents reside have a low influence on a consumer's knowledge and preference for seafood. The greatest factor influencing consumers' preference for wild-caught seafood is taste and for aquaculture is an environmental impact. Identifying the factors that have the strongest influence on a student's preference can be useful to schools in designing a curriculum to reach a broad set of consumers. The results from this study can be utilized to further improve education and community perceptions in schools to address knowledge gaps surrounding aquaculture. The implications of this study assert that education and outreach are needed to promote consumer acceptance of aquaculture.

Furthermore, to secure the future of sustainable seafood in the United States, we must first invest in education—which begins with teachers and students and trickles down to the larger community—to share information and resources about aquaculture and improve community support for local farming efforts. Ultimately, fundamental changes in the way we produce, access, and consume seafood need to be made to maintain sustainable seafood yields and effective fisheries management.

CONFLICT OF INTEREST STATEMENT
No potential competing interest was reported by the authors.

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