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Is there a potential market for seaweed?

A framed field experiment on consumer acceptance

Tongzhe Li[1*], Ahsanuzzaman[2], and Kent D. Messer[2]

[1]Food, Agricultural and Resource Economics Department, University of Guelph, [2]Department of Applied Economics and Statistics, University of Delaware, *Corresponding author: tongzhe@uoguelph.ca

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ABSTRACT

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For additional information on this research course, contact:

Tongzhe Li

tongzhe@uoguelph.ca

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Tongzhe Li, Ahsanuzzaman, and Kent D. Messer[1]

Abstract

Novel foods, such as seaweed, often meet resistance in consumer markets even though their cultivation can largely benefit the environment. Therefore, research in consumer acceptance is needed before launching a novel food product into the market. We use a framed field experiment to investigate U.S. consumers' willingness to pay (WTP) for three seaweed products – seaweed salad, kelp noodles, and a seaweed snack. The results suggest that there is a potential market for seaweed food products in the United States as 35% of participants chose to purchase at least one seaweed product. Demographic variables matter in consumers' choices. For instance, we found a negative WTP premium for female shoppers and primary household shoppers and a positive WTP premium for individuals who had a higher level of education and who were interested in improving the healthfulness of their diets.

JEL Codes: Q5, D12, O3, Q22

Keywords: novel foods, seaweed, willingness to pay, framed field experiments

Research Highlights:

- Production of novel foods such as seaweed can provide positive environmental externalities.
- Data from a framed field experiment is used to gauge consumers' willingness to pay for seaweed products.
- 35% of participants agreed to purchase at least one seaweed product at a market price.
- The data suggest that higher levels of education increase the likelihood of U.S. consumers purchasing seaweed food products.
- Individuals who are relatively interested in the healthfulness of their diets are more likely to consume seaweed food products.

1. Introduction

U.S. consumers often resist purchasing novel new foods, even when these foods provide positive externalities, such as improvements to environmental conditions (Heidenreich and

[1] Li is the corresponding author and is from the University of Guelph. Ahsanuzzaman and Messer are from the University of Delaware, Newark, DE. We thank James Geisler, Maddi Valinski, Julia Parker, Kaitlynn Ritchie, Stephen Wemple, and Jake Nelson for their research assistance. Funding support for this research came from the USDA-NIFA CONSERVE (20166800725064) project and the USDA Economic Research Service (59-6000-4-0064) through the Center for Behavioral and Experimental Agri-Environmental Research (CBEAR).

Kraemer, 2015; Kleijnen et al., 2009; Coetsee, 1999; Ram and Sheth, 1989). Therefore, it is important to gain a deeper understanding of consumers' decision-making processes regarding novel products to identify factors that contribute to resistance and/or lead consumers to try them. Studies are particularly needed for food products, such as seaweed, that can contribute to food security, increase the environmental quality of marine ecosystems, and improve human health (Kim et al., 2017; Rasmus et al., 2016; Zava and Zava, 2011). Although there has been an exponential increase in global seaweed aquaculture production (Figure 1), little attention has been paid to the consumer preferences for the related food products (Lucas and Gouin, 2019, for example, on French consumers) which is non-existent based on the U.S consumers.

A common method of marketing food products is to "improve" them by adding additional ingredients such as vitamins, minerals, and ingredients such as kale and seaweed (Kotler, 2000; Martinez and Bojnec, 2017). The few studies that have addressed the value of such added characteristics for new, novel products (Chen and Kuo, 2017; Kleijnen et al., 2009) have used surveys and other non-experimental approaches. We conduct a framed field experiment to elicit consumers' willingness to pay (WTP) a premium for food products made with seaweed and test the effects of marketing seaweed as "Lettuce of the Sea" versus simply "seaweed" and of additional information about where the products can be purchased, from specialty Asian stores, grocery stores, and upscale restaurants.

Seaweed production provides multiple environmental services. It provides food for humans and animals and is used to produce biofuels, thus contributing to a potential transformational change in global food security and the environment (Rasmus et al., 2016).

Its production also removes excess nitrogen and phosphorous from the marine environments in which it is grown, assimilates carbon, and improves environmental quality by not requiring land area or using fresh water for its production (Chopin, 2014; Landschützer et al., 2014; Hughes et al., 2012; Radulovich, 2011; Duarte et al., 2009; Diana, 2009). Rasmus et al. (2016) extrapolated the ecosystem services generated by 500 million tons (dry weight) of seaweed, finding that, globally, it could reduce annual withdrawals of fresh water by 14%, area of land used for crops by 6%, and carbon emissions added to oceans from greenhouse gasses by 6% while providing biofuel energy equivalent to 1% of annual global energy use. It also could remove 61% of the phosphorous inputs and 18% of the nitrogen inputs added to oceans through fertilizers and completely replace fish oil and fish meal in animal feeds. Table 1 provides details about the benefits derived from seaweed.

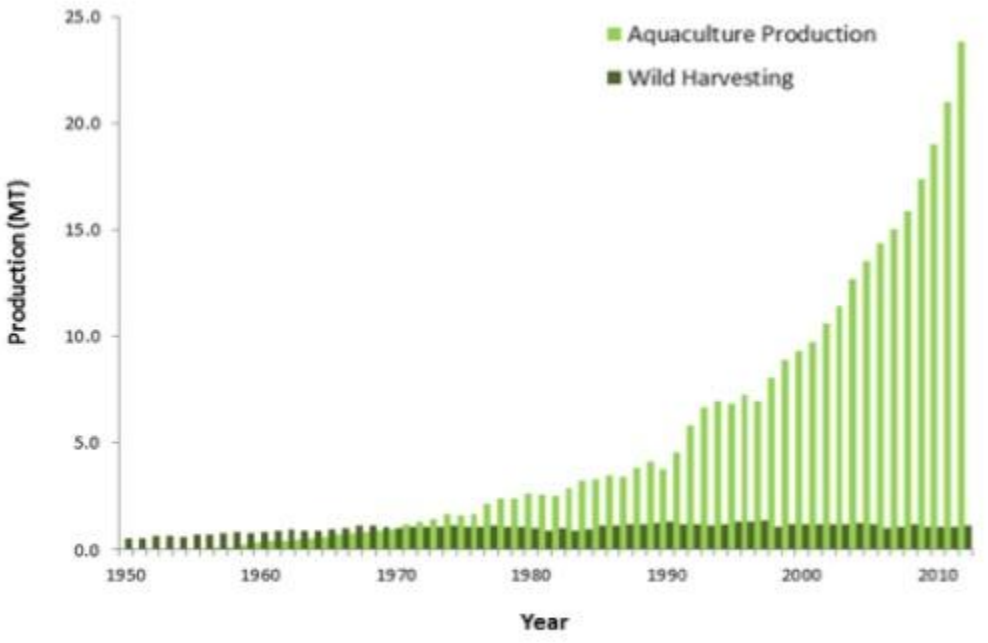

Figure 1. **Global seaweed aquaculture production (1950-2014). FAO (2015)**

While seaweed has been consumed, mostly in Asia, for about 70 years, it has not become a regular part of Americans' meals (Kim et al., 2017; Dilehay et al., 2008) and is viewed as a novel (unfamiliar) product. Given the multi-dimensional benefits of producing and consuming seaweed products, the United States has much to gain in terms of environmental and human health by expanding production and effectively marketing these products to consumers. Thus, it is important to identify factors that influence U.S. consumers' decisions regarding this novel food so that marketing promotions can be targeted effectively.

Kotler (2000) report that labeling and product information are important factors in consumers' decisions regarding whether to try the products. The effects of label information regarding ecological benefits and origins for other kinds of seafood (fish such as tuna and salmon and shellfish) on consumer preferences have been extensively studied (Morgan et al., 2018; Kecinski et al., 2018; Petrolia et al., 2017; Kecinski et al., 2017; Li et al., 2017; Skuras and Vakrou, 2002), but there has been no such systematic study of consumer preferences for macroalgae products such as seaweed.

Existing literature have examined the consumer preferences for seafood products that includes production method (Vanhonacker et al., 2013; Davidson et al., 2012; Gempesaw et al., 1995), food labeling (Brayden et al., 2018; Hanss and Bohm, 2012; Teisl et al., 2002; Payne et al., 1988; Thøgersen et al., 2012). While there are studies portraying the health benefits and sustainability of environment associated with the production and consumption of seaweed products (Roohinejad et al., 2017; Radulovich et al., 2015; Spiegel et al., 2013), little attention has been paid to understanding consumers' preferences for seaweed products (Lucas and Gouin, 2019; Brayden et al., 2018) particularly using

experiment using the U.S. consumers. Given this backdrop, promotion of seaweed food products in the United States will require an understanding of the factors that influence consumers to buy them.

To help develop a better understanding of what would be the best way to market seaweed, we use a framed field experiment to investigate factors that influence consumers' WTP for three different seaweed products, eliciting their preferences for seaweed salad, kelp noodles, and a seaweed snack. To understand how naming of the products might affect their preferences, we compare their WTP for the products when labeled simply as "Seaweed" and when labeled as "Lettuce of the Sea." And to determine whether the novelty of the products affects their decisions, we test information treatments in which the products are identified as available at Asian food stores, grocery stores, and upscale restaurants, as previous research has shown that the type of store where a novel food is offered can make a difference on how consumers respond (Martinez and Bojnec, 2017).

The results of this study suggest that, in addition to price, consumers' choices to purchase the seaweed meals were influenced by gender, status as the household's primary shopper, education level, and current attempts to make their diets healthier. Female and primary household shoppers were less likely to purchase seaweed products than other participants. Participants with relatively high levels of education and an interest in improving their diets were more likely to purchase seaweed products than other participants, leading to positive premiums. The results show that none of the labeling and information treatments influenced participants' choice of seaweed products and that the main determinants of demand were price and several demographic characteristics. These

findings identify segments of consumers who are more likely to purchase seaweed meals and are willing to pay a positive premium for them.

2. Literature review

The processes by which consumers make choices in marketplaces are sophisticated. Shoppers employ simplifying heuristics (Payne et al., 1990) to reach satisfactory solutions with minimal effort using factors such as prices, trusted brands, and repeating previous choices (Thøgersen et al., 2012). Thus, understanding those choice processes is an important step in identifying markets and marketing strategies for new and novel products. Kotler (1997), for example, recommended adding information about the features of new products as an effective strategy to elevate consumers' interest in them. This practice is common for everyday products and for specialized products such as environmentally friendly "green" products, novel foods (including functional foods that promote their ability to improve health, and genetically modified, ethnic, and organic products (Martinez and Bojnec, 2018; Landolfi, 1997). The same holds for goods characterized as improving environmental, ethical, and/or health concerns (Thøgersen et al., 2012; Clark et al., 2003; Ginsberg and Bloom, 2004; Meyer, 2001; Schlegelmilch et al., 1996).

Novel foods often are developed to address multiple objectives, including health benefits, environmental benefits, and reductions in waste. The literature on consumer preferences suggests that there is a general tendency among consumers to avoid trying unfamiliar foods (Savchenko et al., 2019; Messer et al., 2017; Barrena and Sanchez, 2013; Barnett, 1963). As a part of identifying factors influencing choice of novel foods, literature

has found that factors such as social influence (Addessia et al., 2005), additional food attributes in food label (Annunziata and Vecchio, 2013) influence novel food choices. Consumers often respond to a particular food's general label based on perceptions they have about the product (Bhat et al., 2017). Hence, identifying effective labeling is very important. The potential labels might include highlighting the benefits of a novel food to society could be an important marketing strategy because consumers demonstrated positive attitudes toward pro-environmental products that benefitted themselves and others (Yang et al., 2015; Dahl and Hoeffler, 2004).

Another reason for development of novel products is to meet increasingly stringent demands by consumers in highly competitive, globalized markets (Barrena and Sanchez, 2013). Often, there exists misalignment between the features novel foods offer and the consumers' understanding about it. As a result, marketers must change consumers' perceptions about a novel food, which can be accomplished through various initiatives, such as adding sufficient information about the product's benefits to labels and marketing strategies (Martinez and Bojnec, 2018).

The type of product being considered influences how involved consumers are in choosing whether to buy it. Potentially toxic cleaning products and foods that involve large amounts of plastic packaging are two examples of products that increase the attention consumers pay to their decisions. Promotions that emphasize new features of a product, such as its being "green" and "environment-friendly," can successfully convert a decision from low to high consumer involvement (Thøgersen et al., 2012; Kotler, 1997; Landolfi, 1997). New features can be emphasized in many different ways, even by simply renaming a product, which can attract consumers' attention. Thus, how features are presented affects

their ability to increase the likelihood that consumers will purchase the product and expand its foothold in the market (Ginsberg and Bloom, 2004).

Prior studies of the effects of adding features to "green" products and making them available in the marketplace have revealed that consumers relied on the same basic decision-making process for novel products but became more efficient in making choices in response to the additional information (Thøgersen et al., 2012). Consequently, the number of "green" products introduced into developed and emerging markets has grown dramatically in the past 20 years (Thøgersen et al., 2012; Chan, 2000, 2001; Thøgersen and Zhou, 2012) for a broad range of products, including food (Tanner and Wölfing Kast, 2003; Thøgersen, 2002; Thøgersen et al., 2010), energy (Bang et al., 2000; Clark et al., 2003; Rowlands et al., 2002), paper products (Mobley et al., 1995), and clothing (Meyer, 2001). In particular, product names are often changed to reflect their environmentally friendly qualities and differentiate them from conventional products (Wood, 2000). The name change/promotion generally serves two objectives: making the product widely recognizable and guaranteeing that consumers will search for it.

It is important to note that, while there are numerous studies of consumer preferences for goods in response to labeling of their attributes, few have investigated the effects of a name change on consumer purchase decisions or preferences in response to information related to locations at which the products can be purchased. Also, only a small number of studies have addressed consumers' acceptance of various finfish products and of seaweed products and none, to our knowledge, have used experimental approaches.

3. Experiment design

We conducted a framed field experiment to elicit consumer WTP for seaweed products that differed according to the names given on the labels and information provided about locations at which they could be purchased. The experiment was conducted in front of a university store that sold a variety of food products, including coffee, ice cream, sodas, and various university merchandise. The venue attracts both students and individuals who live nearby, allowing us to recruit a sufficient number of representative adult participants. Administrators recruited participants over the age of 22.

Participants signed a consent form approved by university's Institutional Review Board. The experiment was conducted on Surface Pro tablets programmed with Willow, a Python-based program for economic experiments. Participants first completed the choice tasks that elicited their WTP for the seaweed products and then filled out a survey that collected demographic information. The experiment took five to ten minutes to complete on the tablets, and participants each were endowed with $5 as compensation at the beginning of the experiment that they could keep or use to purchase the products offered to them (see Appendix A for the experiment roadmap).

The experiment presented an artefactual "store" similar to an actual online marketplace in which participants could buy seaweed products at market prices. The products considered in the choice decisions were provided at a tent set up next to the experiment site so that the participants could view the items before making a purchase decision. The experiment offered each participant three opportunities to buy a seaweed product, one for each type (seaweed salad, a seaweed snack, and kelp noodles), at prices

representative of actual market prices at the time. The prices were randomly drawn from a normal distribution with a mean of $1.50 and standard deviation of $0.50, which represents the market prices commonly found for these products at the time of data collection.

They completed three choice tasks pairing a market price with a seaweed product, a product name, and information treatment about where the product is commonly sold. Participants indicated whether they wanted to buy the product as described and at the stated price, making single-bounded dichotomous decisions by selecting either "yes" or "no" for each purchase opportunity.

To ensure incentive-compatibility, one of the three purchasing decisions was randomly selected at the end of the experiment for implementation. Participants who chose not to purchase the product in the selected decision received the full $5 participation compensation and no seaweed product. Participants who chose to purchase the product in that decision received the selected product. Its cost was deducted from the $5 compensation fee and they received the balance of the cash.[2]

To reveal consumers' preferences for the seaweed products based on the name used to describe it and the location at which it was available to purchase, we incorporated a 2x3 between-subject treatment by labeling each product with one of the two names and one of the three purchase locations.

Name: "Seaweed" and "Lettuce of the Sea"

Location: Asian stores, Grocery stores, and Upscale restaurants

[2] The amount of money these participants took home depended on the price of the seaweed product selected for purchase. If the product's market price was $1, they received the product and $4 in cash. This arrangement was explained to the participants at the beginning of the experiment.

The experiment was completed by 246 participants who made three yes/no decisions, resulting in 738 observations.

4. Empirical strategy

We use a single-bounded dichotomous-choice model to estimate consumers' preferences for the seaweed products offered in the experiment. Each respondent faced a posted price for product j, p_j, that was randomly drawn from a set of seaweed market prices with $p \sim N(1.5, 0.5)$. Each participant chose whether to purchase the three seaweed products, resulting in the following discrete outcomes for product j:

$$D_j = \begin{cases} 0 & if\ WTP < p_j \\ 1\ if\ WTP \geq P_j \end{cases} \qquad (1)$$

in which $D = 1$ indicates that the participant chose to purchase the seaweed product at price p and $D = 0$ indicates that the participant chose not to purchase the product. That is, participants chose to purchase seaweed product j only when their WTP for it was greater than or equal to the posted price. The probability of each outcome for individual i can be expressed as

$$\Pi_{ij} = \Pr(Y = D) = \begin{cases} F\left(V_{ij}(p_{ij}, \mathbf{X_i}, \mathbf{Z}_i)\right) \\ 1 - F\left(V_{ij}(p_{ij}, \mathbf{X_i}, \mathbf{Z}_{\mathrm{i}})\right) \end{cases} \quad \text{for } D = \begin{cases} 0 \\ 1 \end{cases} \qquad (2)$$

where $F(\cdot)$ is a cumulative distribution function, V_{ij} is the difference in indirect utility of individual i between consuming and not consuming product j, p_{ij} is the price of product j faced by individual i, $\mathbf{X}_i'$ represents the set of individual i's socio-economic characteristics, and $\mathbf{Z}_i$ is the set of treatments to which individual i was exposed.

The participant's decision is based on random utility:

$$V_{ij}(p_{ij}, \mathbf{X}_i, \mathbf{Z}_{ij}) = \alpha + \delta p_{ij} + \mathbf{X}_i'\beta_1 + \beta_2 \mathbf{Z}_i + \epsilon_{ij} \qquad (3)$$

where α, δ, and **β** are the parameters of interest and represent the changes in utility associated with one-unit changes in the price of the seaweed product, the individual's demographic characteristics, and the type of seaweed product (seaweed salad, seaweed snack, and kelp noodles), respectively. The set of treatments includes both the name and information treatments ("Seaweed," "Lettuce of the Sea," and the location information: Asian stores, grocery stores, and upscale restaurants). The demographic characteristics included in **X** are age, highest level of education, income level, gender, primary shopper status, and attitude regarding healthy diets.

Using a sample of *n* independent observations, the log-likelihood function for estimating the parameters of interest in equation 3 (α, δ, and **β**) can be expressed as

$$lnL = \sum_{i=1}^{n}\{I_{D=0} \ln F(\alpha + \delta p_{ij} + X_i'\boldsymbol{\beta}_1 + \boldsymbol{\beta}_2 Z_i) + I_{D=1} \ln [1 - F(\alpha + \delta p_{ij} + X_i'\boldsymbol{\beta}_1 + \boldsymbol{\beta}_2 Z_i)\} \qquad (4)$$

where $I_{D=\{0,1\}}$ is an indicator variable representing individual *i*'s purchase decision for product *j* (yes, *D* = 1; no, *D* = 0) and $F(\cdot)$ represents a standard logistic distribution.

5. Results

The demographic characteristics of the 246 adult participants are summarized in Table 2 and correlation among explanatory variables are shown in Table 3. Their average age was 38.8 years, 63% were women, and 66% were their households' primary shoppers. Their household incomes have a skewed distribution, indicating that our participants had relatively higher incomes than the population in general. Their political affiliations were

relatively diverse; 40% described themselves as moderate, 37% as liberal, and 23% as conservative. Approximately 90% of the participants had completed at least some college education and 66% had completed a degree.

The survey also asked participants to rate their agreement with statements regarding their interest in healthier foods using a Likert scale of 1 (extremely disagree) to 5 (extremely agree). On average, the participants were very interested in eating more-healthful foods (4.08) and were already working on improving their diets (3.92). They generally expressed a willingness to try new foods that have been scientifically proven to be healthy (4.25). Correlation among explanatory variables are generally low, with the highest between income and children in house variables (Table 3).

The results of this study suggest there is a potential market for seaweed in the United States as between 36% and 43% of the participants agreed to purchase the products at the given prices. To determine how likely the participants were to purchase seaweed food items and their relative WTP for the products in response to the treatments, we estimated equation 3 using two random-effects logit models, one that included the demographic characteristics as variables and one that did not. In the models, the name "Lettuce of the Sea" was compared to the baseline of "Seaweed" and the seaweed snack and salad were compared to kelp noodles as the baseline product. Table 4 reports the coefficients estimating the likelihood of the seaweed products being purchased, corresponding standard errors, and marginal effects associated with the variables. Positive coefficients indicate an increased likelihood of purchase relative to the baseline product and negative coefficients indicate a decreased likelihood. The estimated marginal effects show the

change in probability of purchasing the seaweed product for any change in the associated variables. Table 5 presents the estimates of WTP premiums.

The estimates show that, as expected, the likelihood of purchasing a seaweed product decreases as the price increases. Female participants were 18% less likely than male participants to purchase the seaweed products, and primary household shoppers were 20% less likely to purchase the products than other members of the household. Those with relatively greater education were 6% more likely to purchase the products. And an active interest in adopting a more-healthful diet (already working on improving their diets) increased the likelihood of purchasing by 10% relative to those not already moving toward more-healthful diets.

None of the treatments associated with the name of the seaweed product ("Seaweed" and "Lettuce of the Sea") or the location at which they could be purchased (Asian grocery stores, grocery stores, and upscale restaurants) resulted in a statistically significant effect (see Table 3). Therefore, marketing seaweed as "Lettuce of the Sea" did not increase the participants' interest in the products. The seaweed snack was most likely to be purchased (at least 10% more likely) compared to the baseline product, kelp noodles).

We used the following equation (Hanemann, 1984) to estimate WTP at the mean of all of the variables:

$$WTP_{means} = \frac{1}{\hat{\delta}}\left(\hat{\alpha} + \widehat{\beta_1}\bar{X} + \widehat{\boldsymbol{\beta}_2}\bar{Z}\right) \qquad (5)$$

in which the delta method was used to estimate standard errors, construct the confidence interval, and test the significance of the WTP estimates at the means (WTP_{means}). We find that average WTP is not significantly statistically different from 0.

We also estimated the WTP premiums associated with each variable in the model using the following equation (Hole, 2007):

$$MEWTP = -\frac{\boldsymbol{\beta}_k}{\delta} \quad (6)$$

in which $\boldsymbol{\beta}_k$, k = {1,2} is the coefficient of the corresponding variable and δ is the coefficient of the price variable. The delta method was used to construct the confidence intervals for these estimates of WTP. To check for robustness, we constructed a bias-corrected confidence band for the WTP values using bootstrapped standard errors (500 iterations); those results are reported in Table A1 in Appendix 1.

The resulting estimates of WTP premiums are reported in Table 5. They indicate that participants were not motivated by different names ('lettuce of sea' compared to simply 'seaweed') to pay a premium for seaweed products. And though participants were more likely to buy the seaweed snack than the kelp noodles (Table 3), they expressed no willingness to pay a premium for the snack. The participants were indifferent to seaweed salad relative to kelp noodles with no difference in WTP.

In terms of demographic influences, female participants were less willing, on average, to pay for seaweed products (–$1.74) than male participants. Primary household shoppers were also less likely to buy seaweed products than other household members (Table 3) but their negative WTP premiums were about the same. Education level, on the other hand, was associated with a positive premium of $0.56 for seaweed products. Also, participants who were already in the process of improving their diets were willing to pay a $0.98 premium relative to participants who were not changing their diets.

Overall, the results indicate that health-consciousness and higher levels of education increase the likelihood of purchasing and WTP for seaweed food products. Women and

primary household shoppers appear to be most skeptical about trying seaweed food products and might be more strongly influenced by promotion of seaweed's health and environmental benefits.

6. Conclusion

Numerous studies have shown that consumers tend to respond favorably to food labeling that emphasizes attributes such as environmentally-friendly while mixed results have come from studies of product names/brands that promote their positive qualities. Another potential promotion tool is labeling that identifies a product as novel or innovative. Using a framed field experiment, we investigated the likelihood that U.S. adult consumers would purchase seaweed food products and estimated their WTP for them. The results show that price is the most significant determinant of seaweed product purchases. Labels marketing the products as novel ("Lettuce of the Sea" or that it is available at Asian food stores and upscale restaurants) did not alter consumers' interest or WTP. Several demographic characteristics were influential. Women and primary shoppers were not enthusiastic about the products while those with relatively high levels of education and an active interest in improving their diets were willing to pay a premium.

Consumers in the study were most interested in trying the seaweed snack and less interested in the salad and kelp noodles, for which there was no significant difference in preference. The snack was relatively more convenient to consume, and that may have influenced their choices.

The treatments aimed at promoting seaweed food products as novel and/or niche products had no significant effect on participants' choices, indicating that efforts to

promote seaweed food products should emphasize other attributes, such as their health and environmental benefits. In our study, there was no positive or negative response to changing the name from simply seaweed to "Lettuce of the sea," but studies have shown that name changes have sometimes led consumers to hesitate to buy products under new labels (Sourdot-Derexel and Gerlica, 2014). Thus, efforts to promote a product through its name and/or highlighting particular attributes can backfire. A greater understanding of characteristics that influence consumers' purchasing decisions is critical.

In sum, our results indicate that there is a potential market for seaweed food products among U.S. consumers and that messages and labeling associated with promoting the products must be carefully tailored to various segments of the market, such as women, primary shoppers, and individuals who are particularly concerned about their health. We find no evidence that marketing the product as novel is effective. Since so many U.S. consumers are not familiar with seaweed food products, price currently is the main driver of decisions to try the products. As those consumers become more familiar with seaweed foods, they might begin to focus more on particular attributes.

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Table 1: Extrapolated ecosystem services from 500 million tons (dry weight) of seaweed

Ocean area required	500,000 square kilometers	Based on average annual yield of 1,000 dry tons per square kilometer under current best practices. Equals 0.03% of the ocean surface area.
Protein for people and animals	50 million tons	Assumes average protein content of 10% of dry weight. Estimated value $28 billion. Could completely replace fish meal in animal feeds.
Algal oil for people and animals	15 million tons	Assumes average lipid content of 3% of dry weight. Estimated value $23 billion. Could completely replace fish oil in animal feeds.
Nitrogen removal	10 million tons	Assumes nitrogen content of 2% of dry weight. Equals 18% of the nitrogen added to oceans from fertilizers.
Phosphorous removal	1 million tons	Assumes phosphorous content of 0.2% of dry weight. Represents 61% of phosphorous inputs into oceans from fertilizers.
Carbon assimilation	135 million tons	Assumes carbon content of 27% of dry weight. Equals 6% of the carbon added annually to oceans from greenhouse gas emissions.
Bioenergy potential	1,250 million megawatt hours	Assumes 50% carbohydrate content converted to energy. Equals 1% of annual global energy use.
Land spared	1 million square kilometers	Assumes 5 tons per hectare average farm yield. Equals 6% of global crop land.
Fresh water spared	500 cubic kilometers	Assumes agricultural use averaging 1 cubic millimeter of water per kilogram of biomass. Equals 14% of annual global withdrawals of fresh water.

Note: Adapted from Rasmus et al., 2016.

Table 2: Summary of demographic variables

Variable	Mean/Proportion of Responses	Std. Dev.
Age (years)	38.78	16.73
Gender (Female = 1; 0 otherwise)	0.63	0.48
Primary shopper (1 = Yes; 0 = No)	0.66	0.47
Highest education level		
Some high school	0.008	0.09
High school graduate	0.09	0.28
Some college	0.24	0.43
Bachelor's degree	0.33	0.47
Advanced or graduate degree	0.33	0.47
Household income		
Less than $10,000	0.073	0.26
$10,000–$24,999	0.091	9.09
$25,000–$34,999	0.062	6.20
$35,000–$74,999	0.230	23.55
$75,000–$99,999	0.160	15.70
$100,000–$149,999	0.220	21.90
$150,000–$249,999	0.130	12.81
$250,000 or more	0.031	3.31
Political affiliation		
Conservative	0.23	0.422
Moderate	0.40	0.49
Liberal	0.37	0.48
Respondents' attitudes regarding healthy diet:		
Include healthy food[a]	4.08	1.04
Making changes[b]	3.92	0.97
Try scientific food[c]	4.25	0.89

Notes: a: Need to include healthy food more in the diets; b: Making changes toward healthier foods; c: Participant likes to try scientifically proven healthy foods.

Table 3: Correlation among variables in the model

	Age	Gender	PS	Edu.	Inc.	Child	White	Need Healthy	Change to healthy	Scientific.
Age	1.00									
Gender	-0.07	1.00								
PS[a]	0.14	0.26	1.00							
Edu	0.09	0.02	0.15	1.00						
Income	0.17	0.04	-0.17	0.18	1.00					
Child[b]	0.05	0.01	-0.01	0.16	0.41	1.00				
White	0.25	0.06	0.06	-0.05	0.21	0.01	1.00			
Need Healthy[c]	0.07	-0.11	-0.03	-0.02	0.06	0.17	-0.07	1.00		
Change to healthy[d]	-0.02	0.08	0.24	0.00	0.05	0.21	-0.02	0.08	1.00	
Scientific.[e]	-0.01	0.01	-0.07	0.00	0.12	0.10	-0.04	0.06	0.25	1.00

Notes: a: Primary shopper; b: Children in house; c: Need to include healthy food in diet; d: I am making changes to healthy diet; e: I like to try scientifically prove foods.

Table 4: Estimates of likelihood of purchasing seaweed products

Variable	Excluding Demographic Variables			Including Demographic Variables		
	Coeff.	Std. Error	ME	Coeff.	Std. Error	ME
Price	-0.42***	0.16	-0.09	-0.44***	0.17	-0.10
Age (years)				-0.01	0.01	0.00
Gender (1 = Female; 0 otherwise)				-0.77**	0.31	-0.18
Primary shopper				-0.82**	0.32	-0.20
Education level				0.25**	0.11	0.06
Income level				-0.02	0.06	0.00
Children in household				-0.29	0.33	-0.07
White				-0.36	0.35	-0.09
The participant						
Feels the need to include more healthy food				-0.23	0.15	-0.05
Is making change to improve healthfulness of diet				0.43***	0.16	0.10
Is willing to try scientifically proven healthy food				0.12	0.16	0.03
Snack	0.44*	0.23	0.10	0.46*	0.25	0.11
Salad	0.15	0.23	0.03	0.07	0.24	0.02
Constant	-0.15	0.47		-0.71	1.39	

Notes: The robust standard errors are estimated. ***, **, and * imply statistical significance at 1%, 5%, and 10% respectively. We also included the dummy variables associated with different names of the seaweed products (seaweed vs. lettuce of the sea) and locations they can be found (Asian store; grocery store; and upscale restaurant).

Table 5: WTP estimates associated with the variables and confidence intervals for the seaweed products

	Excludes Demographic Variables			Includes Demographic Variables		
Variable	MEWTP	Lower	Upper	MEWTP	Lower	Upper
Age (years)				-0.02	-0.05	0.02
Gender (1 = Female; 0 otherwise)				-1.74	-3.65	0.17
Primary shopper				-1.85	-3.79	0.09
Education level				0.56	-0.07	1.20
Income level				-0.05	-0.31	0.22
Minor in house				-0.66	-2.20	0.87
White				-0.82	-2.47	0.84
Need to include more healthy food				-0.53	-1.25	0.20
Need change to healthier diet				0.98	-0.02	1.98
Willing to try scientifically proven healthy food				0.26	-0.48	1.01
Snack	1.06	-0.22	2.34	1.03	-0.23	2.29
Salad	0.37	-0.69	1.42	0.16	-0.92	1.24
WTP at means	-0.02	-0.57	0.53	0.15	-0.42	0.73

Note: The delta method was used to construct the 95% confidence intervals of corresponding WTP estimated using equation 6.

Appendix A – Experiment Design Roadmap

Step 1. Experimental questions design. This step included stakeholder input, such as industry experts, restaurant owners and policymakers.

Step 2. Location scouting: This step also included recommendations from stakeholders. We also arranged for professional oyster shucking services, which accompanied us to each experiment. Locations included: Department of Motor Vehicles (DMV), 16 Mile Brewery, Famous Joes Tavern, AG Day 2016.

Step 3. Design Implementation using dichotomous choice experiments. 486 Participants responded either *yes* or *no* to 8 dichotomous choice questions.

a. Participants were set up with $5.

b. Participants made 3 dichotomous choice decisions.

c. Participants filled out a survey (Appendix B)

d. Random selection of one of the participant's decision – a roll of the dice determined which one of the three decisions would be implemented (ensured incentive compatibility).

e. If random draw selected a *yes* decision, the participants paid for the seaweed product and would receive the seaweed product as indicated in their choice in (b); if the random draw resulted in a no decision, the participant would receive the $5 and no seaweed product.

Step 4. Data analysis and preparation of manuscript, outreach activities.

Survey

1. How do you identify your race?
    - ○ White
    - ○ Black/African-American
    - ○ Asian
    - ○ Latino/Hispanic
    - ○ Other (please specify)

2. Are you the primary shopper in your household?
    - ○ Yes
    - ○ No

2. Is there any minor in your house?
    - ○ Yes
    - ○ No

6. Are you the primary seafood shopper in your household?
    - ○ Yes
    - ○ No

7. What is your age?

8. What gender do you identify yourself as?
    - ○ Male
    - ○ Female

9. What is your profession?
    - ○ Government

- ○ Academia
- ○ Business
- ○ Agriculture
- ○ Other (please specify)

10. Are you:
    - ○ Politically liberal
    - ○ Politically moderate
    - ○ Politically conservative
    - ○ Other (please specify)

11. Which category best describes your household income (before taxes) in 2014?
    - ○ Less than $10,000
    - ○ $10,000-$14,999
    - ○ $15,000-$24,999
    - ○ $25,000-$34,999
    - ○ $35,000-$49,999
    - ○ $50,000-$74,999
    - ○ $75,000-$99,999
    - ○ $100,000-$149,999
    - ○ $150,000-$199,999
    - ○ $200,000-$249,999
    - ○ $250,000 and above

12. What is the highest level of education that you have completed?
    - ○ Grade school
    - ○ Some high school
    - ○ High school graduate
    - ○ Some college credit
    - ○ Associate degree
    - ○ Bachelor's degree
    - ○ Graduate degree/Professional

13. In a 1-5 scale where 1 indicates 'disagree' and 5 indicates 'strongly agree', how do you rate your preference in response to the statement: "I need to make changes to a healthier diet"?

14. In a 1-5 scale where 1 indicates 'disagree' and 5 indicates 'strongly agree', how do you rate your preference in response to the statement: "I am making changes toward a healthier diet"?

15. In a 1-5 scale where 1 indicates 'disagree' and 5 indicates 'strongly agree', how do you rate your preference in response to the statement: "I like to try scientifically prove food"?

Table A1: Bootstrapped standard errors and bias-corrected confidence intervals

	Excludes Demographic Variables					Includes Demographic Variables				
			Bootstrap	Conf. Interval				Bootstrap	Conf. Interval	
Variable	WTP	Bias	Std. Err.	Lower	Upper	WTP	Bias	Std. Err.	Lower	Upper
Age (years)						-0.02	0.00	0.09	-0.09	0.02
Gender (1=Female; 0 otherwise)						-1.74	-0.40	2.07	-5.46	-0.59
Primary shopper						-1.85	-0.90	6.16	4.79	-0.56
Education Level						0.56	0.14	1.19	0.17	1.68
Income level						-0.05	-0.01	0.18	-0.34	0.27
Minor in house						-0.66	-0.24	1.45	-2.96	0.47
White						-0.82	-0.38	2.33	-2.88	0.46
The participant:										
Feels the need to include more healthy food						-0.53	-0.17	1.50	-1.56	0.06
Is making changes to improve healthfulness of diet						0.98	0.80	12.25	0.29	2.50
Is willing to try scientifically proven healthy food						0.26	0.08	0.44	-0.57	1.20
Snack	1.06	-35.36	807.32	-0.15	3.74	1.03	0.21	1.30	-0.22	4.46
Salad	0.37	0.02	0.82	-0.93	2.05	0.16	0.23	7.05	-1.53	1.98

Notes: 500 iterations were used to obtain bootstrapped standard errors of WTP to construct bias-corrected 95% confidence intervals.

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