Seafood Safety Perceptions and Their Effects on Anticipated Consumption under Varying Information Treatments

Cathy Roheim Wessells, Jeffrey Kline, and Joan Gray Anderson

This paper identifies factors that influence consumers' seafood safety perceptions and examines how these perceptions affect consumers' anticipated consumption when consumers are provided with additional information relevant to seafood. A recursive system of equations is specified describing consumers' safety perceptions as a function of past experience with seafood, recreational harvest activities, and risk-taking behavior, and describing the influence of safety perceptions on consumers' anticipated demand response to hypothetical information concerning seafood. A telephone survey of randomly selected Rhode Island consumers provided data for the analysis.

The seafood supply in the United States is associated with a diverse but controllable set of health risks. Consumers most at risk are those who consume raw shellfish such as oysters, clams, and mussels that have been exposed to environmental contamination or naturally occurring bacteria or toxins (National Academy of Sciences). Also at risk are consumers of recreational fishery products harvested from sites posted with government warnings about water quality. Minimization of these risks is, in part, the responsibility of regulatory agencies that administer programs such as water quality monitoring. However, a significant amount of control over seafood-related health risks lies in the hands of the consumer, who is ultimately responsible for the selection and preparation of seafood for home consumption.

Several studies have shown that the nation's seafood supply is generally safe and nutritious (GAO; FDA; CDC; NAS; Hurley and Liebman). However, results from other studies suggest that many consumers continue to perceive the seafood supply as somewhat unsafe (Anderson and Morrissey; Lin, Milon, and Babb; Brooks; AUS Consultants; Lin and Milon; Wessells and Anderson). In general, researchers have found (1) that consumers do perceive that there are risks associated with the consumption of seafood, and (2) that these perceptions have implications for consumer demand for seafood. For example, Brooks concludes that perceived risks associated with the consumption of mussels had a significant and negative impact on consumers' willingness to purchase mussels. Wessells and Anderson conclude that consumers are willing to pay a significant amount above the market price per unit of seafood for specific types of seafood safety assurances that convey a level of safety above what is currently perceived in the marketplace.

Recently, the Food and Drug Administration (FDA) proposed a new and comprehensive inspection system to ensure the quality and safety of the nation's seafood supply (Yin). An expanded inspection system, such as the one proposed by the FDA, may provide the consumer with assurances of seafood safety, but this new information will exist within the context of prevailing seafood safety perceptions. As a result, it is uncertain what impact this new information will have on future seafood consumption behavior. Devising effective marketing and policy strategies to increase consumers' confidence in seafood will depend on understanding what factors influence consumers' perceptions of seafood safety, and how these perceptions in turn influence future consumption decisions.

The purpose of this paper is to identify factors that influence consumers' seafood safety perceptions and examine how these perceptions affect consumers' seafood demand choices when consumers are provided with additional information

The authors are associate professor and graduate research assistant, Department of Environmental and Natural Resource Economics, and associate professor, Consumer Affairs Program, University of Rhode Island. The authors wish to thank James L. Anderson and three anonymous reviewers for their comments. Funding for this project was provided by the Rhode Island Sea Grant Program, USDA Cooperative State Research Grant No. 94-34276-6963, and the Rhode Island Experiment Station, AES Contribution No. 3202.

relevant to seafood. A recursive system of equations is specified which describes consumers' safety perceptions as a function of past experience with seafood, recreational harvest activities, and risk-taking behavior, and describes the influence of safety perceptions on consumers' anticipated demand response to hypothetical events concerning seafood. A telephone survey of randomly selected households in Rhode Island provided data for the analysis.

The first section of this paper presents an overview of the conceptual framework used in the analysis. The framework is based in part on the "lens" model (Brunswik; Kinnucan, Nelson, and Hiariey), in which perceptions of product attributes are considered endogenous in the product choice decision. This section is followed by a discussion of the survey data used in the analysis. The third section of the paper discusses the econometric results of the model, while the final section considers the implications of the study's results.

Conceptual Framework and Model

Slovic, Fischoff, and Lichtenstein, Viscusi and Magat, and Weinstein suggest that, for most decisions that involve risk, perceptions of risk stem from a broad range of personal experiences and related knowledge. Regarding household seafood consumption decisions, several factors can be expected to influence perceptions of seafood safety. Lin, Milon, and Babb show that consumers' assessments of oyster safety are related to their past frequency of consumption of oysters, to prior illness from oysters, to exposure to negative publicity about shellfish, and to other demographic factors. A frequent seafood consumer might a priori be expected to perceive seafood as safer than a consumer who does not consume seafood often, because the frequent seafood consumer has developed a stock of experience with the product. Their empirical analysis corroborates the hypothesis that individuals who consume oysters more frequently rate oysters as more safe.

Other experience with seafood, such as risk-taking behavior, may also be related to safety perceptions. In the case of seafood, risk-taking behavior includes the consumption of raw fish and shellfish, and the consumption of portions of fish and shellfish that tend to be biological receptacles for toxins. Celsi, Rose, and Leigh suggest that such behavior could be explained by (1) consumers' confidence in their ability to choose a safe product, or (2) consumers' extrapolation from previous experiences where they have not been harmed, that they will not be harmed from continuing such risk-taking behavior. Furthermore, Akerlof and Dickens's theory of cognitive dissonance postulates that habitual behavior may induce consumers to adjust their beliefs to rationalize their behavior. For example, an individual who continues to consume raw shellfish may believe that raw shellfish does not pose a health risk. In fact, focus groups held by the FDA's Office of Seafood indicate that eating raw oysters is seen as an informed choice. Oyster consumers view the consumption of raw oysters as an acceptable risk given their fondness for oysters (Levy).

The conceptual framework used in this paper is based in part on a modified "lens" model similar to that used by Kinnucan, Nelson, and Hiariey. In this model, consumers' perceptions of a product are endogenous and part of a larger system of equations that describe preferences for seafood products and frequency of consumption. Perceptions of product attributes are considered endogenous because they are based on experiences with the product (Brunswik). These perceptions are formed by taking the bundle of attributes of a particular product and abstracting them into a smaller group of labels, for example, quality, odor, and flavor. Brunswik suggests that perceptions are moderated by psychosocial cues, which have been defined to include marketing influences such as advertising (Hauser and Simmie). In the case of seafood, these marketing influences may also include negative publicity related to seafood safety.

The Kinnucan, Nelson, and Hiariey framework describes behavior as proceeding in stages. Perceptions of product attributes are a function of experience with the product, in addition to other socioeconomic characteristics. These perceptions, in turn, influence consumers' preferences for various types of seafood products (whether or not they purchase these products) and consumers' frequency of consumption of specific seafood products. By modifying this structure, a basis for a structural model of the current perceptions of seafood safety and anticipated changes in consumption given hypothetical events can be specified. The model used in this analysis is specified as:

$$(1) \qquad R = f(E, Z_1)$$

$$(2) \qquad CC_i = g_i(R, Z_2)$$

where R is consumers' safety rating of seafood, E is a vector of variables representing consumers' experience with seafood, CC_i is consumers' anticipated consumption change due to the given hypothetical event i, where $i = 1, \ldots, 7$, and Z_1 and Z_2 are vectors of socioeconomic characteristics.

Consumers' past experiences with seafood can be described by past monthly consumption frequency of fish, shellfish, and crustaceans. The more frequently consumers have consumed seafood, the more likely the consumer is to think of seafood as safe. Other influences on seafood safety perceptions may include risk-taking behavior such as consumption of raw seafood. If consumers rationalize their risk-taking behavior, as hypothesized by Celsi, Rose, and Leigh and Akerlof and Dickens, consumption of raw seafood may result in the perception that seafood is relatively safe. Recreational harvest activity may also influence consumers' seafood safety ratings. Perceptions of seafood safety among consumers may differ depending on whether or not the seafood in question is personally harvested. For example, consumers in households that harvest seafood may be more aware of potential problems associated with water contamination.

In this study, equation (2) is a set of seven equations, each depicting consumers' anticipated consumption response resulting from one of seven different hypothetical events, as a function of their current safety rating and other socioeconomic variables. The hypothetical events include (1) the advent of seafood labeling with catch date information; (2) the institution of a federally mandated inspection system for seafood; (3) an increase in respondents' knowledge concerning seafood selection and preparation; (4) the appearance of media news stories reporting an oil spill in Narragansett Bay; (5) the closure of Narragansett Bay to all fishing; (6) a drop in the price of seafood by 25%; and (7) the opening of a new seafood vendor in the consumer's neighborhood. The first three events represent positive information and may increase consumers' confidence in seafood safety, thus increasing anticipated future consumption. The fourth and fifth events represent negative information and may decrease consumers' confidence in seafood safety, thus decreasing anticipated future consumption. The last two events represent positive information, without being directly related to seafood safety perceptions, and imply greater convenience and lower prices associated with seafood consumption.

Survey Data and Qualitative Results

A telephone survey of 156 randomly selected Rhode Island households was conducted during the summer of 1990. The survey consisted of questions targeting information on seafood consumption by species and perceptions of seafood quality and safety. The sample was drawn using a random-digit-dial computer program that generated 300 potential Rhode Island telephone numbers. Business and invalid numbers were eliminated. Each remaining number was called a maximum of three times at varying periods of the day, weekday and weekend. Some people refused to participate or could not speak English. The survey was completed by the household member who was the primary purchaser of food for the household. Approximately twenty minutes were required to complete the survey, although some respondents who enjoyed talking about seafood spoke for significantly longer than that. A detailed description and tabulation of the survey results can be found in Anderson et al.

All 156 respondents consumed seafood. Respondents were asked: "Approximately how many times per month does your household eat shellfish?" and responded with the number of times per month, at home and at a restaurant. (Shellfish include mussels, clams, and oysters, in other words, those shellfish that are typically consumed raw.) The same question was asked for finfish. The average monthly consumption frequency of finfish was 3.2 times per month at home and 1.8 times per month at restaurants. Similarly, the average monthly consumption frequency of shellfish was 2.8 times per month at home and 2.4 times per month at restaurants. Respondents were also asked about consumption of twenty-one species of shellfish, finfish, and crustaceans. The most frequently consumed finfish among these Rhode Island consumers were cod, flounder, haddock, and swordfish. The most frequently consumed shellfish were clams and scallops, while the most frequently consumed crustaceans were lobster and shrimp.

Survey respondents were asked to rate their perception of the safety of the nation's seafood supply with the question: "In general, how safe do you think seafood is?" Just over 21% believed seafood to be safe, 48.0% believed seafood is somewhat safe, and 30.8% believed that seafood is somewhat unsafe. The average monthly consumption frequency of those respondents who believed that seafood is safe was 5.4 times per month for finfish, 1.4 times per month for shellfish, and 2.5 times per month for crustaceans. The average monthly consumption frequency of those respondents who felt that the seafood supply is somewhat safe was 5.6 times per month for finfish, 1.8 times per month for shellfish, and 2.9 times per month for crustaceans. The average monthly consumption frequency of those respondents who believed that seafood is somewhat unsafe was 3.9 times per month for finfish, 1.9 times per month for shellfish, and 2.8 times per month for crustaceans. The differences in average finfish consumption across respondents' safety rating categories are significant at the 5% level. The differences in average shellfish and crustacean consumption across respondents' safety rating categories are not statistically significant. Of respondents who believed seafood to be only somewhat safe or somewhat unsafe, 73.2% cited ocean pollution as a specific concern, followed by chemical toxins (23.6%), food poisoning (17.9%), and handling (20.6%). Many respondents (40.7%) also stated that they were specifically concerned about the safety of shellfish.[1]

One objective of the survey was to determine to what extent consumers assume risk-taking behavior when they consume seafood. Respondents were asked: "When you eat finfish, do you (a) eat the skin; (b) eat the fatty portions; (c) eat the dark portions of the flesh; (d) eat the liver or organs; (e) eat the roe; and (f) eat it raw?" Answers were given as yes or no to each part (a through f) of the question. In addition, respondents were asked: "Do you commonly eat any shellfish raw? (yes or no, and which species?)"; "Do you commonly eat other parts of the lobster, such as the tomalley?"; and, "Do you commonly eat the roe of lobster?" Forty-six percent of respondents reported that they consume raw shellfish, while 7.7% reported that they consume raw finfish. Various portions of fish and crustaceans, such as the tomalley of lobster, and the skin, fatty portions, dark flesh, organs, or roe of finfish, are known to accumulate toxins if they are present in the aquatic environment. Fifty-three percent of respondents reported that they consume one or more of these portions of lobsters and finfish.

Econometric Estimation of the Recursive Model

Equation (1): Seafood Safety Rating

The first equation models perceptions of seafood safety as a function of seafood consumption experience and socioeconomic variables. The dependent variable (safety rating) is recorded as a discrete variable, 0 = somewhat unsafe, 1 = somewhat safe, and 2 = safe. The ordered probit model used to estimate the model is specified as

$$y^* = \boldsymbol{\beta}'\mathbf{x} + \epsilon \qquad (3)$$

[1] Respondents were allowed to mention all their concerns so the percentages will not sum to 100.

where $\mathbf{y}^*$ is a vector of unobserved values, $\mathbf{x}$ is a matrix of explanatory variables, $\boldsymbol{\beta}$ is a vector of parameters, and ϵ is a vector of error terms. What is observed is that

$$y = 0 \text{ if } y^* \leq 0, \qquad (4)$$

$$y = 1 \text{ if } 0 < y^* \leq \mu_1 \qquad (5)$$

$$y = 2 \text{ if } \mu_1 < y^* \leq \mu_2 \qquad (6)$$

where $0 < \mu_1 < \mu_2$. If we assume that ϵ is normally distributed across observations and the mean and variance are normalized to zero and one, respectively, then the following probabilities are obtained:

$$\text{Prob}(y = 0) = \Phi(-\boldsymbol{\beta}'\mathbf{x}) \qquad (7)$$

$$\text{Prob}(y = 1) = \Phi(\mu_1 - \boldsymbol{\beta}'\mathbf{x}) - \Phi(-\boldsymbol{\beta}'\mathbf{x}) \qquad (8)$$

$$\text{Prob}(y = 2) = 1 - \Phi(\mu_2 - \boldsymbol{\beta}'\mathbf{x}) \qquad (9)$$

where $\Phi(\cdot)$ is the cumulative normal density function evaluated at the vector of regression parameters and explanatory variables. The log-likelihood function, L, which is maximized is

$$L(Y|\boldsymbol{\beta},\mu_1,\mu_2) = \Sigma_{i=1}{}^{N}\Sigma_{j=1}{}^{J}\, Y_{ij} \log(\Phi_{ij} - \Phi_{ij-1}) \qquad (10)$$

where N is the sample size and J is the number of indicator variables (three).

The marginal effects of the regressors, $\mathbf{x}$, on the dependent variable (probabilities) are not equal to the coefficients as in linear regression analysis. Instead, these marginal effects are equal to the partial derivative of equations (7)–(9) with respect to each regressor (Greene 1993, p. 674). All equations in this study were estimated using LIMDEP, version 6.0 (Greene 1992). Table 1 provides definitions and descriptive statistics of the variables used in the analysis.

Experience with seafood is hypothesized to be described by average monthly frequency of seafood consumption over the past year, disaggregated into consumption of finfish, shellfish, and crustaceans, and specified as continuous variables. A significant number of survey households recreationally harvested seafood from either the Narragansett Bay or the ocean, where it is possible to catch finfish, shellfish, and crustaceans (lobsters and squid). To incorporate the effects of recreational harvest on seafood safety perceptions, the monthly consumption frequencies were segregated into groups, those who harvested and those who did not, for each of the seafood categories. For example, monthly consumption of finfish is specified by two variables: one variable, "FishCons_H," is equal to average monthly consumption of finfish if

Table 1. Variable Descriptions and Means

Variable	Description	Mean	Standard Deviation
Exogenous Variables			
HarvFi	1 = do recreationally harvest finfish, 0 = do not recreationally harvest finfish	0.27	0.45
HarvSh	1 = do recreationally harvest shellfish, 0 = do not recreationally harvest shellfish	0.22	0.42
HarvCr	1 = do recreationally harvest crustaceans, 0 = do not recreationally harvest crustaceans	0.09	0.28
FishCons_H	Monthly frequency of finfish consumption for those who recreationally harvest finfish	1.36	2.75
FishCons_NH	Monthly frequency of finfish consumption for those who do not recreationally harvest finfish	3.62	4.40
ShellCons_H	Monthly frequency of shellfish consumption for those who recreationally harvest shellfish	0.60	1.52
ShellCons_NH	Monthly frequency of shellfish consumption for those who do not recreationally harvest shellfish	1.18	1.56
CrustCons_H	Monthly frequency of crustacean consumption for those who recreationally harvest crustaceans	0.28	1.04
CrustCons_NH	Monthly frequency of crustacean consumption for those who do not recreationally harvest crustaceans	2.54	2.25
Increase	1 = did increase seafood consumption in previous two years, 0 = did not increase seafood consumption in previous two years	0.35	—
Decrease	1 = did decrease seafood consumption in previous two years, 0 = did not decrease seafood consumption in previous two years	0.13	—
Age	Age of respondent	49.7	15.0
Education	1 = less than high school, 2 = high school, 3 = some college, 4 = college, 5 = M.S. or Ph.D.	3.26	1.23
Risk	1 = eat other finfish and lobster parts, or raw seafood, 0 = do not eat such foods		
Endogenous Variables			
Safety Rating	0 = somewhat unsafe, 1 = somewhat safe, 2 = safe	0.93	0.72
Price	1 = increase in seafood consumption if price drops by 25%, 0 = no change in consumption	0.61	—
Vendor	1 = increase in seafood consumption if new seafood vendor opens in neighborhood, 0 = no change in consumption	0.27	—
Learn	1 = increase in seafood consumption if learn more about selecting and preparing seafood, 0 = no change in consumption	0.45	—
Inspect	1 = increase in seafood consumption if federal inspection system instituted, 0 = no change in consumption	0.45	—
Label	1 = increase in seafood consumption if seafood labeled with catch date information, 0 = no change in consumption	0.56	—
Oil Spill	1 = decrease in seafood consumption if there are media news stories about oil spill in Narragansett Bay, 0 = no change in consumption	0.66	—
Closure	1 = decrease in seafood consumption if Narragansett Bay is closed to all fishing, 0 = no change in consumption	0.64	—

NOTE: N = 143.

the respondent's household recreationally harvested some of the finfish the household consumed, and zero otherwise. The other variable, "FishCons_NH," is equal to the average monthly consumption if the respondent's household did not recreationally harvest finfish, and zero otherwise. Likewise, two variables were specified for each of shellfish ("ShellCons_H" and "ShellCons_NH") and crustacean ("CrustCons_H" and "CrustCons_NH") monthly household consumption.

"Risk" is a binary variable equal to one for consumers who accepted risks when consuming seafood, and zero otherwise. Risk-taking behavior includes the consumption of organs, skin, and dark flesh of finfish, or raw seafood.

Respondents were also asked if they had increased or decreased their consumption during the previous two years, and, if so, why. Thirty-five percent of respondents indicated that they had increased their seafood consumption, and their reasons were primarily related to health or to changes in taste and lifestyle. Thirteen percent had decreased their consumption, because of perceptions of high risk or change in lifestyle and taste. Over half of the respondents had not changed their frequency of consumption over the previous two years. Two binary variables were included in the model, "Increase" and "Decrease," to reflect the adjustments respondents had made to their seafood consumption during the previous two years, with those who did not change their consumption omitted to prevent perfect multicollinearity.

Variable coefficient estimates of equation (1) are presented in table 2. Four variable coefficients are statistically significant at the 10% level or better. The regression equation is significant at the 5% level, since the χ^2 statistic for the likelihood ratio test of the estimated regression against a regression of the dependent variable on only the intercept is 20.67, compared with a critical χ^2 value of 19.68 ($\alpha = 0.05$) with 11 degrees of freedom. The associated marginal effects, calculated at the sample means for the continuous variables, are also presented.

Results of the perception equation estimation indicate that recreational harvesting activity and past experience with seafood do influence seafood safety ratings. A priori it was expected that the more frequently respondents consumed finfish, shellfish, and crustaceans, the more likely they were to rate seafood as safe. The coefficient describing finfish consumption of respondents who did not recreationally harvest finfish, "FishCons_NH," is positive and statistically significant at the 5% level. The coefficient describing finfish consumption of respondents who recreationally harvested finfish also is positive. Thus, the a priori expectation that the more frequently respondents consumed finfish, the more likely they were to rate seafood as safe, is confirmed.

In contrast, the coefficient describing shellfish consumption of recreational shellfish harvesters, "ShellCons_H," is negative and statistically significant at the 10% level, and shellfish consumption of nonharvesters, "ShellCons_NH," is also negative. In other words, the more frequently recreational harvesters of shellfish consume shellfish, the less likely they are to rate seafood as safe. The reason for this apparent contradiction with a priori expectations may lie in the nature of the product. Shellfish tend to be recreationally harvested close to shore, often in relatively sheltered coves and inlets. Those respondents who participated in recreational harvests of shellfish may have been more likely to know about periodic closures of these coves and inlets, due to either bacterial contamination or natural contaminations such as those caused by toxic algae blooms. It is possible that, while they were confident of the safety of the shellfish they harvested, knowledge of these potential problems may have made them more wary of the nation's seafood supply.

Thirty-eight percent of respondents who rated seafood as somewhat unsafe harvested shellfish recreationally, as did 49% of those who rated seafood as somewhat safe. Conversely, only 14% of those respondents who rated seafood as safe harvested shellfish recreationally. The mean frequency of shellfish consumption among those who harvested shellfish recreationally was 2.7 times per month, compared with 1.5 times per month for those who did not, and this difference is significant

Table 2. Estimated Coefficients and Marginal Effects for Equation (1): Seafood Safety Perceptions

			Marginal Effects		
Variable	Coefficient	*t*-ratio	Prob (y = 0)	Prob (y = 1)	Prob (y = 2)
Constant	0.554	1.07	−0.033	0.007	0.026
FishCons_H	0.062	1.13	−0.015	0.003	0.012
FishCons_NH	0.058**	2.00	−0.017	0.003	0.014
ShellCons_H	−0.142*	−1.72	0.051	−0.010	−0.040
ShellCons_NH	−0.057	−0.67	0.015	−0.003	−0.012
CrustCons_H	0.001	0.84	−0.004	0.001	0.003
CrustCons_NH	−0.000	−0.84	0.001	0.000	−0.000
Age	0.000	0.64	−0.003	0.001	0.002
Education	−0.073	−0.81	0.014	−0.003	−0.011
Risk	0.394*	1.79	−0.136	0.028	0.108
Increase	−0.383	−1.47	0.110	−0.023	−0.088
Decrease	−0.531**	−1.99	0.202	−0.041	−0.161

Summary statistics: Number of observations = 143,
Value of the log-likelihood function = −149.65,
Chi-square statistic = 20.67** (with 5 degrees of freedom).
*Indicates significant at 10% level, **indicates significant at 5% level.

at the 5% level. Thus, while many respondents were skeptical about the safety of the nation's seafood supply, they may have felt more confident about the shellfish they consumed because they were personally responsible for its harvest. It also is possible that frequent consumers of shellfish were more knowledgeable about the actual risks associated with shellfish. Therefore, greater experience with shellfish may be linked with increased consumer savvy regarding seafood.

The coefficient for the binary variable "Risk" is significant at the 10% level and positively related to safety perception. This suggests that individuals who willingly took risks such as eating finfish and shellfish raw, and eating the dark portions of flesh, the skin, fatty portions, roe, or organs, were more likely to rate the seafood supply as safe than individuals who did not take risks. This result is consistent with Akerlof and Dickens's theory of cognitive dissonance.

The variable "Decrease" is significant at the 5% level, while "Increase" is insignificant. Those respondents who had decreased their seafood consumption over the previous two years were less likely to rate the seafood supply as safe.

The variable "Age" is the age of the head of household with a mean value of just over 49 years. "Education" is a five-level discrete variable describing the highest level of education obtained by the head of household. Unfortunately, the survey respondents' gender was not consistently noted by the interviewers and cannot be included in the model. Both age and educational level of the household head added little to the explanatory power of the equation, in contrast to the findings of Lin, Milon, and Babb. Initial model estimation included an income variable, but this was found to be highly correlated with the education variable and was omitted from the final equation. An alternative specification, allowing for differing effects of education across education levels, decreased the significance of the equation, and individual education variables were all statistically insignificant. Other socioeconomic variables such as presence of children in the household and ethnicity similarly proved insignificant and reduced the goodness-of-fit of the model. Therefore, the effects of the socioeconomic variables on the probability of rating seafood as safe were statistically insignificant for this sample of consumers.

Equation (2): Consumption Response to Varying Information Treatments

The second set of equations in the recursive system consists of the anticipated consumption change equations, given varying available information. Survey respondents were asked to anticipate whether their seafood consumption would increase, stay the same, or decrease as a result of several hypothetical events. These events included (1) the advent of seafood sold with labels containing catch date information; (2) the institution of a federally mandated inspection system for seafood; (3) an increase in respondents' knowledge concerning seafood selection and preparation; (4) the appearance of media news stories reporting an oil spill in Narragansett Bay; (5) the closure of Narragansett Bay to all fishing; (6) a drop in the price of seafood by 25%; and, (7) the opening of a new seafood vendor in the respondent's neighborhood. The first five events have implications for safety, while the latter two do not. These events are considered independent of one another for this analysis.

For each of the seven events, the set of responses was never greater than two. For example, given the advent of catch date labels, all respondents answered either that their consumption would increase or that it would remain the same. None of the respondents replied that their consumption would decrease, even though that was a possible answer. Similarly, given the closure of Narragansett Bay to all fishing, all respondents replied that their consumption would decrease or remain the same, while none responded that it would increase. Thus, each of the consumption change regressions is individually modeled as a probit regression, where the dependent variable is either a zero or a one.

The probit model (Maddala) assumes that there is a vector of underlying response variables y_i^* defined by the regression relationship

$$y_i^* = \mathbf{B}'x_i + \mu_i \tag{11}$$

where $i = 1, \ldots, N$. In practice y_i^* is unobservable. What is observed is a vector of dummy variables y_i defined by

$$y_i = 1 \text{ if } y_i^* > 0 \tag{12}$$

$$y_i = 0 \text{ otherwise} \tag{13}$$

From equations (11), (12), and (13) the following can be derived:

$$\begin{aligned} \text{Prob}(y_i = 1) &= \text{Prob}(\mu_i > \beta' x) \\ &= 1 - F(-\beta' x_i) \end{aligned} \tag{14}$$

where F is the standard normal cumulative distribution function for μ_i. Thus, the likelihood function to be maximized with respect to $\boldsymbol{\beta}$ and $\boldsymbol{\sigma}^2$ is:

$$L = \Pi_{y_i=0} F(-\boldsymbol{\beta}' x_i)\, \Pi_{y_i=1} [1 - F(-\boldsymbol{\beta}' x_i)] \tag{15}$$

The equations are specified with socioeconomic variables "Age" and "Education" as well as "Increase" and "Decrease," as in the equation for safety perceptions discussed above. In this second set of equations, the endogenous variable, perceptions of seafood safety, is specified as the binary variables "Somesafe" and "Someunsafe." "Somesafe" equals one if the respondent answered that seafood is somewhat safe, and zero otherwise, and "Someunsafe" equals one if the respondent answered that seafood is somewhat unsafe, and zero otherwise. "Safe" is the third possibility, which is omitted to prevent perfect multicollinearity. Finally, to incorporate information on recreational harvest activity, three binary variables, "HarvFi," "HarvSh," and "HarvCr" are specified, where each is equal to one if the respondent engaged in recreational harvest of finfish, shellfish, and crustaceans, respectively, and zero otherwise.

Of the seven equations estimated, four are statistically significant at the 10% level or above. These include the equations for learning more about preparation and handling of seafood ("learn"), mandatory inspection of seafood ("inspect"), media publicity about an oil spill in Narragansett Bay ("oil spill"), and closure of fishing in Narragansett Bay ("closure"). Econometric results for these anticipated consumption change equations are reported in table 3.

In all four equations, the explanatory variable "Someunsafe" is positive and statistically significant at the 10% level or higher. The positive coefficient for the variable "Someunsafe" implies that respondents who were less confident about seafood safety were more likely to anticipate an increase in their seafood consumption following positive information concerning seafood, relative to respondents who were more confident about seafood safety. Likewise, respondents who were less confident about seafood safety were more likely to anticipate a decrease in their seafood consumption following negative information.

The remaining variables whose coefficients are statistically significant vary by equation. For example, respondents who had increased their consumption of seafood over the previous two years were more likely to increase their consumption of seafood further if they learned more about the preparation and handling of seafood. Likewise, re-

Table 3. Estimated Coefficients and Marginal Effects of Equation (2): Anticipated Consumption Changes under Varying Information Treatments

	Learn (1 = increase, 0 = same)		Inspect (1 = increase, 0 = same)		Oil Spill (1 = decrease, 0 = same)		Closure (1 = decrease, 0 = same)	
Variable	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Constant	−0.125	−0.050	−0.360	−0.142	−0.015	−0.005	−0.992*	−0.367
	(−0.21)		(−0.60)		(−0.02)		(−1.63)	
Somesafe	0.403	0.159	0.265	0.105	0.032	0.011	0.234	0.086
	(1.34)		(0.90)		(0.11)		(0.82)	
Someunsafe	0.552*	0.218	0.917**	0.363	0.703**	0.251	0.693**	0.256
	(1.72)		(2.85)		(2.08)		(2.14)	
Education	−0.034	−0.013	−0.065	−0.026	0.146	0.052	0.171*	0.063
	(−0.37)		(−0.70)		(1.50)		(1.80)	
Age	−0.010	−0.004	0.001	0.000	−0.012	−0.004	0.008	0.003
	(−1.33)		(0.12)		(−1.47)		(0.96)	
Increase	0.672**	0.266	−0.374	−0.148	0.395	0.141	0.155	0.057
	(2.78)		(−1.51)		(1.56)		(0.62)	
Decrease	0.223	0.088	−0.195	−0.077	0.739*	0.264	0.556	0.205
	(0.65)		(−0.56)		(1.83)		(1.48)	
HarvFi	−0.271	−0.107	0.334	0.132	0.010	0.035	−0.028	−0.104
	(−0.93)		(1.16)		(0.33)		(−0.96)	
HarvSh	0.285	0.113	0.507*	0.200	0.254	0.091	0.405	0.150
	(0.96)		(1.66)		(0.78)		(1.25)	
HarvCr	−0.030	−0.012	−0.615	−0.243	0.636	0.227	−0.150	−0.055
	(−0.07)		(−1.35)		(1.30)		(−0.36)	
χ^2-statistic (d.f. = 9)	16.23		18.35		21.68		15.26	
Significance level	0.062		0.031		0.001		0.084	

NOTE: t-ratios are in parentheses.
*Indicates significant at 10% level, **indicates significant at 5% level.

spondents who had increased their consumption were more likely to increase their consumption further as a result of mandatory seafood inspection, although this coefficient is significant only at the 13% level. Conversely, respondents who had decreased their consumption of seafood over the previous two years were more likely to decrease their consumption of seafood further if there were media news stories of an oil spill in Narragansett Bay. The coefficient for the variable "Decrease" is also positive, describing anticipated consumption change given the closure of Narragansett Bay to fishing. Thus, it appears that positive information may motivate those who are already predisposed to increasing their seafood consumption to further increase their consumption, while negative information simply reinforces the predisposition to reduce consumption among those who have decreased consumption over the previous two years.

Respondents who recreationally harvested shellfish were more likely to increase their consumption if information became available that a mandatory federal seafood inspection program was implemented. Given the Congressional debate over the benefits of such a mandatory program (Wessells and Anderson), this finding provides evidence that inspection would benefit the seafood industry via increased demand. Presumably, consumers would also benefit, (1) from having more confidence in the safety of the seafood supply, and (2) from the positive nutritional benefits of seafood in the diet.

The estimated models indicate that changes in future consumption given information not directly related to seafood safety, such as a price drop of 25% and the opening of a new vendor in the neighborhood, are not significantly related to seafood safety perceptions or any of the other explanatory variables. This finding suggests that lower seafood prices or greater convenience in acquiring seafood (such as a new local vendor) will not entice respondents who are not confident in seafood safety to increase their consumption any more or less than respondents who are confident in seafood safety.

Conclusions

Results from the model of consumers' safety ratings of the nation's seafood supply suggest that consumers' perceptions of seafood safety were influenced by consumers' past experiences with seafood, including their frequency of consumption of finfish and shellfish, their recreational activity, and their risk-taking behavior, such as consumption of raw seafood. Socioeconomic variables did not significantly explain seafood safety perceptions of the sample population. The model corroborates the hypothesis that seafood safety perceptions were linked to consumers' past familiarity and experience with seafood.

Analysis of anticipated changes in consumption under varying information treatments suggests that information which had implications for seafood safety was likely to have the greatest impact on the consumption frequency of those consumers who were least confident about the safety of the nation's seafood supply. The consumption frequency of consumers who were most confident about the safety of the nation's seafood supply would be impacted the least. Positive information such as selection and preparation techniques and mandatory seafood inspection were likely to provide incentives to consumers to increase their seafood consumption. Likewise, prevention of events such as oil spills and fishing closures in Narragansett Bay, or at a minimum accurate information in press coverage, could counteract anticipated reductions in seafood consumption by bolstering consumer confidence. While lower prices and greater buying convenience may help to increase consumers' familiarity with seafood, consumers' reactions to such market information were not sensitive to existing safety perceptions.

Though several studies show that the nation's seafood supply is generally safe, other studies suggest that consumers remain skeptical. Improving consumers' perceptions of seafood safety could rely in part on improving their familiarity with seafood by providing consumers with incentives to increase consumption. While market-based incentives such as lower prices and greater convenience may help to increase the seafood consumption of some consumers, providing information that specifically focuses on safety issues may better target those consumers least confident in the safety of the nation's seafood supply. Such information also would help alleviate some of the health risks associated with seafood by improving consumers' decision-making about seafood.

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