The Welfare Effects of Pfiesteria-Related Fish Kills:
A Contingent Behavior Analysis of Seafood Consumers

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Abstract:

We used contingent behavior analysis to study the effects of pfiesteria-related fish kills on the demand for seafood in the Mid-Atlantic region. We estimated a set demand difference models based on individual responses to questions about seafood consumption in the presence of fish kills and with different amounts of information provided about health risks. We used a random-effects Tobit model to control for correlation across each observation and to account for censoring. We found that 1) pfiesteria-related fish kills had a significant negative effect on the demand for seafood even though the fish kills pose no known threat to consumers through seafood consumption, 2) seafood consumers were not responsive to expert risk information designed to reassure them that seafood is safe in the presence of a fish kill, and 3) a mandatory seafood inspection program largely eliminated the welfare loss incurred due to misinformation.

Key words: pfiesteria, seafood demand, non-market valuation

1. Introduction

Pfiesteria piscicida is a single-celled microorganism, a toxic dinoflagellate, found in the sediments of many estuaries in the Mid-Atlantic region of the United States. It has been identified as the cause of many fish kills in this region. Thousands, even millions, of fish can die in a single kill.

During periods of warm weather and high nutrient concentrations, pfiesteria becomes a toxic predator to certain species of fish. While the scientific evidence suggests that these outbreaks are lethal to the fish, they appear to pose no health risk to humans in the seafood market. Nevertheless, media coverage of pfiesteria-related fish kills has led to rather large reductions in seafood consumption during periods of an outbreak. The associated loss in economic welfare is potentially quite large and is seemingly due to misinformation.

In this paper we measure the welfare effects of a hypothetical pfiesteria outbreak using contingent behavior analysis in a seafood demand model. We also consider the effects of different forms of information provision on attenuating the losses due to misinformation.

Our research follows a framework developed by Shulstad and Stoevener (1978) who measured the welfare losses incurred by Oregon's pheasant hunters in reaction to news of mercury contamination in pheasants. Since then, researchers have considered the impact of news-induced 'health scares' on the demand for a variety of goods. See, for example, Swartz and Strand (1981), Smith et al. (1988), Brown and Schrader (1990), Wessels et al. (1994), and Wessels et. al. (1995). Ours is the first to consider pfiesteria-related fish kills and the first to use contingent behavior techniques to elicit consumers' stated preferences in this context. We begin with a brief discussion of our survey and study design before turning to the model.

2. Survey and Study Design

Contingent behavior or stated preference techniques are often used to measure consumer preferences. Individuals are asked to respond to survey questions pertaining to a market or non-market good. The provision of the good is altered in some fashion and the respondents are asked how they might respond to that change. In our case, respondents are asked how their seafood consumption might change in the presence of a pfiesteria-related fish kill.

We conducted a phone-mail-phone survey of seafood consumers over the age of 18 in Delaware, Maryland, Washington DC, Virginia, and North Carolina in 2001. The sample frame was stratified based on a 50/50 split between North Carolina and the other four areas.

The initial phone survey was designed to collect information on seafood consumption patterns, costs, knowledge of pfiesteria, and socioeconomic information. In addition, each respondent was asked how their number of seafood meals consumed (monthly) would change if the price of seafood were to rise and to fall. These contingent behavior questions were designed to infer the slope of the seafood demand function. The actual questions appear in Table 1 as Questions 1 and 2.

Individuals were recruited in the initial phone survey to participate in a follow-up phone survey. Between phone calls, individuals were sent a packet of materials which included

- information describing pfiesteria and its health risks
- information describing typical pfesteria-related fish kills
- a hypothetical press release describing a pfesteria-related fish kill
- a two-sided color pamphlet describing a new seafood inspection program

The information describing pfiesteria and its health risks came in three different forms: (i) no information, (ii) a brochure, or (iii) a brochure and insert. Each respondent received one or the other of these packets split about equally across our sample. The brochure explains what pfiesteria is and notes that the risks of eating seafood are not changed as a result of the fish kills related to pfiesteria outbreaks. The insert is more direct and emphasizes that there is no scientific evidence linking pfiesteria outbreaks to increased health risks in seafood consumption. The press release described either a major or a minor kill. A major kill involved hundreds of thousands of fish over a large area of a river. A minor kill involved fewer fish over a smaller area. Each respondent received one or the other of these press releases again split about equally across our sample. The text of the information sent to respondents appears in the Appendix (For the actual color versions with photographs, please contact the authors.)

The second phone survey then focused on three contingent behavior questions: Questions 3, 4, and 5 in Table 1. Question 3 asked individuals how they would change their seafood consumption if the pfiesteria-related fish kill reported in the press release were to occur. Question 4 asked the same question, but told respondents to assume that the government safety inspection program described in the pamphlet was in operation. Question 5 asked the same question but told respondents that the safety program was in operation and that the price of seafood would increase as a result. These questions were designed to ascertain whether the seafood demand function shifted in the presence of a fish kill and if the inspection program attenuated that shift. The different treatments also allowed us to examine the extent to which demand shifts differ with different size fish kills and different information provided about health risks.

The first phone survey generated a sample of 1,790 respondents. The response rate was 61% -- completed interviews divided by contacts where contacts include refusals and completed interviews. Of these 1,790 respondents, 845 completed the second phone interview -- a response rate of 47%. Table 2 shows some selected sample statistics on our population. All statistics are weighted to account for the sample stratification. There was some item non-response over the contingent behavior questions, so the sample size over the questions is slightly unbalanced, but this is quite small.

3. Model

Utility Theory and Demand Model

We treat a pfiesteria-related fish kill as a factor affecting an individual's perception of the health risks associated with consuming fish. That perception, in turn, affects the individual's demand for seafood meals. In our analysis a seafood consumer has an indirect utility function over a fixed time period of the form

(1) $v = v(p, q, y, h(\mathbf{s}); \mathbf{c})$,

where p is the price of a seafood meal, q is the price of a composite of all other goods, y is income for the relevant time period, h is the perceived quality of seafood, **s** is a vector of attributes that govern an individual's perception of quality, and **c** is a vector of individual characteristics accounting for heterogeneity of the population. Following conventional consumer theory, we expect

$$\frac{\partial v}{\partial p} < 0, \ \frac{\partial v}{\partial q} < 0, \ \frac{\partial v}{\partial y} > 0, \text{ and } \frac{\partial v}{\partial h}\frac{\partial h}{\partial s_i} \geq or \leq 0.$$

The term s_i is one of i elements in the vector **s.** The elements can affect perceived health risks positively or negatively and in our application will pertain to the hypothetical pfesteria-related fish kill and information on the health risked associated with a kill presented in our contingent behavior question. Recall that our population includes seafood consumers only. For people who do not consume seafood, the term $h(\mathbf{s})$ is unlikely to enter the utility function.

Roy's Identity implies an uncompensated demand function for seafood meals of the form

$$(2) \qquad -\frac{\partial v}{\partial p} / \frac{\partial v}{\partial y} = x(p, q, y, h(\mathbf{s}); \mathbf{c})$$

In our application we use linear forms for h(**s**) and $x(p, q, y, h(\mathbf{s}); \mathbf{c})$ to estimate seafood demand and the impact of fish-kills on demand[1]

$$(3) \qquad h = \boldsymbol{\alpha}'\mathbf{s}$$

[1] We also considered a semi-log form for x(.). The results were so similar to the linear model that we choose to present the simpler one only.

(4) $x = \beta_p p + \beta_q q + \beta_y y + \beta_h(\boldsymbol{\alpha}'\mathbf{s}) + \boldsymbol{\beta}_{\mathbf{c}}'\mathbf{c}.$

Now, consider the contingent behavior questions for a change in the price of seafood. Individuals are asked how much their quantity demanded would change with a hypothetical change in price. Let Δx be the reported change in the quantity demanded and Δp be the size of the hypothetical price change.

In terms of our demand model, we have

(5) $x_0 = \beta_p p + \beta_q q + \beta_y y + \beta_h \boldsymbol{\alpha}'\mathbf{s} + \boldsymbol{\beta}_{\mathbf{c}}'\mathbf{c}$

as the quantity demanded at the current price *p*. And,

(6) $x_1 = \beta_p (p + \Delta p) + \beta_q q + \beta_y y + \beta_h \boldsymbol{\alpha}'\mathbf{s} + \boldsymbol{\beta}_{\mathbf{c}}'\mathbf{c}$

as the quantity demanded at the new price $p + \Delta p$. Subtracting equation (5) from equation (6) gives a demand-difference

(7) $\Delta x = \beta_p \Delta p$

where $\Delta x = x_1 - x_0$ is the reported change in the quantity consumed in response to the hypothetical price increase. The term $\beta_q (q - q) + \beta_y (y - y) + \beta_h \boldsymbol{\alpha}'(\mathbf{s} - \mathbf{s}) + \boldsymbol{\beta}_{\mathbf{d}}'(\mathbf{d} - \mathbf{d})$ drops out of the demand difference by design. In the contingent behavior question there is no variation in income, other prices, risk factors, or individual characteristics between the current state and the hypothetical state.

We estimate β_p using equation (7). Variation in price comes from the survey design – individuals receive different Δp's in the contingent behavior questions. For a price increase Δp takes on a value of either \$1, \$3, \$5, or \$7 (Question 1 in Table 1). For a price decrease it takes on a value of \$-1, \$-2, \$-3, or \$-4 (Question 2 in Table 1).

We estimated separate equations for price-up and price-down. These are

$$\begin{aligned} \Delta x_{Q1} &= \beta_{pu} \Delta p_{up} + \varepsilon_{Q1} \\ \Delta x_{Q2} &= \beta_{pd} \Delta p_{down} + \varepsilon_{Q2} \end{aligned} \tag{8}$$

Recall that everyone in the sample is asked both questions, so the equations in (8) are over the same people. The error terms are assumed to be correlated across observations and truncated such that individuals cannot reduce their consumption beyond what they presently eat (eg., an individual cannot reduce the number meals consumed by 5 if current consumption is only 3 meals).

The method is the same for estimating shifts in demand due to the fish kill and inspection programs analyzed in last three contingent behavior questions. In this case, we have

$$x_0 = \beta_p p + \beta_q q + \beta_y y + \beta_h \boldsymbol{\alpha}' \mathbf{s} + \boldsymbol{\beta}_{\mathbf{c}}' \mathbf{c} \tag{9}$$

as the quantity demanded without the fish kill, and

$$x_1 = \beta_p p + \beta_q q + \beta_y y + \beta_h \boldsymbol{\alpha}' (\mathbf{s} + \boldsymbol{\Delta}\mathbf{s}) + \boldsymbol{\beta}_{\mathbf{c}}' \mathbf{c} \tag{10}$$

as the quantity demanded with the hypothetical fish kill. $\boldsymbol{\Delta}\mathbf{s}$ is a vector of the change in the factors that affect perceptions of risk. Subtracting equation (9) from equation (10) gives

$$\Delta x = \beta_h \boldsymbol{\alpha}' \boldsymbol{\Delta}\mathbf{s} \tag{11}$$

$\Delta x = x_1 - x_0$ is the reported change in the quantity consumed in response to the hypothetical fish kill and $\beta_p(p-p)+\beta_q(q-q)+\beta_y(y-y)+\boldsymbol{\beta}'_{\mathbf{c}}(\mathbf{c}-\mathbf{c})$ drops out of the demand difference since there is no change in $p,\ q, y,$ and $\mathbf{c}$ between the current and hypothetical states in the contingent behavior question. The elements in **s**, however, do change and this gives rise to the specification in equation (11).

The vector $\Delta\mathbf{s}$ includes the following elements in our application

$\Delta\mathbf{s} =$
major-kill (=1 if the fish kill is major in the hypothetical press release)
minor-kill (=1 if the fish kill is minor in the hypothetical press release)
brochure (=1 if the respondent recevied a brochure only)
brochure & insert (=1 if the respondent received a brochure and an insert)
inspection (=1 if the insepection program is operational)
price for inspection (= price of the inspection program per seafood meal).

All other elements in **s** that affect perceptions of health risk are assumed to be constant.

The coefficients on *major-kill* and *minor-kill*, are expected to be negative. The hypothesis is that individuals have misperceptions about the dangers of seafood consumption -- believing it is dangerous to eat after a pfiesteria-related fish kill when in fact the dangers are slight.

The coefficients on *brochure, brochure & insert,* and *inspection* are expected to be positive – information on risks shifts demand "back" to the right. The hypothesis is that the safety information counters the misperception of seafood health risks and reduces the extent of the leftward shift. The latter is a recovery of lost welfare due to poor information. Introduction of a seafood inspection program, *inspection,* would also presumably work to shift demand "back" to the right. And finally, the coefficient on *price for inspection,* is expected to be negative dampening the extent of the rightward shift since consumers realize they have to pay for the program.

Now, consider Question 3 in Table 1. Individuals face either a major or a minor fish kill and are given one of three levels of information: (i) no information, (ii) a brochure, or (iii) a brochure and an insert. This gives rise to the following form of our demand-difference

$$\begin{aligned}\Delta x_{Q3} = {} & \beta_h\alpha_1 \cdot \textit{major-kill} + \beta_h\alpha_2 \cdot \textit{minor-kill} + \beta_h\alpha_3 \cdot \textit{brochure} \\ & + \beta_h\alpha_4 \cdot \textit{brochure}\ \&\ \textit{insert} + \varepsilon_{Q3}\end{aligned} \tag{12}$$

In Question 4, everyone is asked how their response to Question 3 would differ if a seafood inspection program had been in place. The other right hand side variables are the same as before. Question 5 is the same as 4 except that individuals are told that the inspection program will increase the price. The price increase may be \$1, \$3, \$5, or \$7.

The equations for Questions 4 and 5 then are

$$\begin{aligned}\Delta x_{Q4} = {} & \beta_h\alpha_1 \cdot \textit{major-kill} + \beta_h\alpha_2 \cdot \textit{minor-kill} + \beta_h\alpha_3 \cdot \textit{brochure} + \beta_h\alpha_4 \cdot \textit{brochure}\ \&\ \textit{insert} \\ & + \beta_h\alpha_5 \cdot \textit{inspection} + \varepsilon_{Q4}\end{aligned} \tag{13}$$

$$\begin{aligned}\Delta x_{Q5} = {} & \beta_h\alpha_1 \cdot \textit{major-kill} + \beta_h\alpha_2 \cdot \textit{minor-kill} + \beta_h\alpha_3 \cdot \textit{brochure} + \beta_h\alpha_4 \cdot \textit{brochure}\ \&\ \textit{insert} \\ & + \beta_h\alpha_5 \cdot \textit{inspection} + \beta_h\alpha_6 \cdot \textit{price for inspection} + \varepsilon_{Q5}\end{aligned} \tag{14}$$

In estimation we stack equations (8), (12), (13), and (14) giving a basic linear model with 8 parameters to be estimated. The eight parameters are β_{pu}, β_{pd}, and $\beta_h\alpha_1$ through $\beta_h\alpha_6$. Since the individual parameters β_h and α_i are not identified in our model, we estimate $\beta_h\alpha_i$ as a single parameter for each *i*. This has no bearing on our final welfare calculations.

Stacking allows us to constrain parameters across equations to be constant and to estimate the model with random effects. Random effects allows the error terms in the model to be correlated across equations for each observation. It stands to reason that the same unobserved elements that influence an individual's shift in demand due to a fish kill without an inspection program will also influence that individual's shift with an inspection program in place. Since all observations in the sample do not make it to the second survey and since there is some attrition due to simple cleaning of the data, an unbalanced version of a random effects model is estimated.

The model is also estimated as a Tobit regression with censoring at $-x$, the negative of the quantity consumed. This is because individuals cannot reduce their consumption of fish by more than the quantity consumed. Since individuals consume different quantities, the censoring point varies across observations.

Demand Model with Interactions

The effects of a price change and perceived heath risk may vary with income and other individual characteristics. For example, if income enters equation (4) interacted with p and **s**, we have

$$(15) \qquad x = \beta_p p + \beta_q q + \beta_y y + \beta_h \boldsymbol{\alpha}'\mathbf{s} + \boldsymbol{\beta}_{\mathbf{c}}'\mathbf{c} + \left\{ \beta_{py}(p \cdot y) + \beta_{hy}\boldsymbol{\alpha}'(\mathbf{s} \cdot y) \right\},$$

and the demand-differences for slope and shift changes become

$$(16) \qquad \begin{aligned} \Delta x &= \beta_p \Delta p + \beta_{py}(\Delta p \cdot y) \\ \Delta x &= \beta_p \Delta s + \beta_{hy}\boldsymbol{\alpha}'(\boldsymbol{\Delta}\mathbf{s} \cdot y) \end{aligned}.$$

In this case, the change in seafood meals consumed in response to a price change or fish kill varies with a person's income. We estimated a model that included three interactions:

income (*income*), a dummy variable for residing in North Carolina (*NC*), and a dummy variable for having consumed a species of fish likely to be viewed as unrelated to the threat of the fish kill (*other-fish*). The species included in *other-fish* are King mackerel, Mahi-mahi, Orange Roughy, Pollock, Salmon, Shark, Swordfish, Tuna, Whitefish, Whiting, Lobster, Shrimp, and Scallops.

Consumer Surplus

An individual's monthly consumer surplus for seafood meals is

$$cs = \frac{x^2}{-2\beta_p} \tag{17}$$

We estimate cs for each observation using the reported level of monthly consumption (x) and the estimated value of β_p from the relevant model. For surplus measures in *per meal* terms we divide cs by x, the number of meals consumed per month.

The change in consumer surplus for a hypothetical fish kill is

$$\Delta cs = \left\{ \frac{\left(x + \Delta x\right)^2}{-2\beta_p} - \frac{x^2}{-2\beta_p} \right\} \tag{18}$$

This is simply the difference in the consumer surplus with and without the kill. This is sometimes called avoidance cost – an individual's cost of avoiding fish after a kill.

4. Results

The regression results appear in Tables 3 and 4. These are random effects Tobit regressions with censoring at the negative of the number of meals consumed. Consumer surplus measures per month appear in Table 5. The results are shown for two models: a basic model and a general model (includes interactions).

Table 5 includes the total surplus per seafood meal and the change in surplus due a fish kill per seafood meal under different scenarios. We report avoidance costs separately for major and minor kills for both models assuming (i) individuals have no information, (ii) individuals have a brochure, (iii) individuals have a brochure and an insert, (iv) an inspection program is in place, and (v) an inspection program is in place and there is a price rise.

There are several noteworthy findings. First, the effects of a price increase and a price decrease differ – the slope of the demand function is larger for a decrease than for an increase. In the basic model the coefficient on Δp_{down} is -.346, and the coefficient on Δp_{up} is -.218. The relative difference is about the same in the model with interactions, and the absolute value of the coefficients is larger. In effect, there is a "kink" in the demand function at the point of current consumption. Quantity demanded seems to be more responsive to a price decreases than price increases. This finding appears to be consistent with theories of loss aversion – that individuals value losses more highly than gains of equivalent magnitude. One may be inclined to argue that this is due to individuals' inability to reduce consumption beyond their current level thereby capping the response to price increases. However, keep in mind that we have estimated a Tobit version of the model that accounts for truncation at current consumption.

In our calculation of consumer surplus the coefficient on price appears in the denominator of our surplus measures (see equations (17)-(18)). In Table 5 we report welfare changes using the price-up coefficient since all the measures of surplus we consider are integrated over the portion of the demand curve corresponding to a price increase.

Second, the coefficients on *major-kill* and *minor-kill* are negative and significant as expected. This general result is supported by other studies (see, Anderson (1991) or Ahluwalia et. al. (2000)). What is unexpected is that the effect of a major kill and a minor kill are about the same. There is no statistical difference in their coefficients. The implication is that the size and scope of a fish kill is not particularly important. Hundreds of thousands of dead fish signal an increase in health risk comparable to ten of thousands of dead fish. An alternative interpretation is that our contingent behavior survey failed to pass a scope test (see Hanemann (1994, p.34)).

The avoidance cost associated with the fish kills are reported in Table 5. Ignoring for the moment the cases with information provision and inspection programs, the avoidance cost per meal with a minor or major fish kill is on the order of \$3 to \$4 *per meal*.

Third, information provision in the form of a brochure or a brochure along with insert appears to have limited sway on consumers. The coefficient on *brochure* is statistically insignificant and has the ‘wrong’ sign in both models. The coefficient on *brochure & inset* is statistically insignificant in the basic model and significant in the model with interactions. However, in combination with the interactions, the effect of *inspection* is an insignificant shift in the 'wrong' direction as shown in the welfare measures. The avoidance cost associated with the fish kills assuming individuals have a brochure or have a brochure and the insert then is about the same as the cost with no information. Again, see Table 5. This finding seems to suggest that simply providing information based on experts' judgments carries little weight in altering individuals' perceptions. It is also possible that the manner in which the information was packaged and presented was the cause for the limited impact – people ignored it or found that it lacked credibility. For a discussion of the credibility of the sources of information for example see Hovland and Warren (1969), and Sternthal et al. (1978).

These coefficients seem to be in line with the argument that positive information has less of an effect on consumer behavior than negative media coverage. The 'negative' press releases shifted demand significantly; the 'positive' brochures shifted it only slightly. Kroloff (1988) found that the impact of media exposure gives negative news quadruple weight compared with positive news. Sherrell et al. (1985) calculated that it takes five times more positive information to offset the effects of any negative information.

Fourth, the presence of an inspection program, unlike information provision, shifts the demand function significantly rightward – returning it close to its pre-fish kill position. The coefficient on *inspection* nearly perfectly offsets the initial shift due to the hypothetical fish kill. The coefficient is also statistically significant. This result is consistent with Wessels and Anderson (1995) who considered the role of a variety of measures of providing seafood safety assurances and found that consumers placed a high value on seafood inspection programs. So, the cost of the kill, with an inspection program in place, drops dramatically as shown in Table 5.

Fifth, the impact of a rise in seafood prices due to an inspection program is about the same as a general price rise – a sensible result. The coefficient on Δp_{up} is -.218 and on *price of inspection* is -.183 in the basic model, and -.30 and -.27 in the general model. This has the potential of offsetting some of the recaptured losses by the inspection program. In Table 5 we present the welfare loss for a fish kill assuming an inspection program is in place and raises the price of fish $1.

Sixth, incorporating interactions into the demand difference model has little effect on our qualitative or quantitative results. We introduced three interactive variables, income, a dummy for residence in North Carolina, and a dummy for consumption of non-threatened fish. Our intention was to see whether or not the relevant slopes and shifts in seafood demand would vary with these covariates. The three covariates added 24 new parameters to the demand difference model. Of these, only three were statistically significant.

We included the income variable reasoning that the effects of price changes may be different across different income groups and that the response to fish kills and information provision may differ across classes. Our results show some evidence of varying responses to price but not to information provision. Higher income groups appear to be less responsive to price increases and more responsive to price decreases then lower income groups.

The dummy for residence in North Carolina (*NC*) was included to pick up any difference that may occur between northern and southern respondents. Given differences in the populations and location of the fish kill, it seems likely that there may be a difference in the demand slopes and shifts. This does not appear to be the case. None of the North Carolina interactions in the linear model are significant. The signs imply that North Carolina residents are generally less responsive to counter information than northern residents and more responsive to price declines. Otherwise, the slopes and demand shifts appear to be about the same across the two areas.

Finally, we include a dummy for consumption of a species of fish thought to be unrelated to our kill scenarios. Our reasoning here is that individuals who consume such fish may be less inclined to alter their consumption of fish in response to the kill since their preferred species are less likely to be involved in the kill and perceived as being associated with the attendant risks. There is some weak evidence of this effect. The coefficients on *other-fish* when interacted with *major-kill* are positive with some statistical significance. Again, the *other-fish* variable has drawbacks. First, anyone can switch to a non-threatened species and thereby not reduce overall consumption. And second, which species people actually perceived as threatened may diverge from our list.

5. Conclusions

As expected, individuals react to fish kills by reducing consumption of fish even though the nature of the fish kill is unlikely to pose increased health risks. This result has been documented elsewhere in the literature and suggests that there may be a role for government in providing information to consumers about risks.

When individuals reduce seafood consumption they are said to incur "avoidance costs." If the real risk of eating seafood is low, these avoidance costs are in a sense incurred mistakenly by individuals. The benefit of a government information program then is the avoidance cost saved by informing consumers. The avoidance costs in question here appears to be rather large. Using our model, the aggregate cost over the four state region is on the order of $100 million per month depending on the amount of risk information provided to individuals.

We found that consumers were not responsive to “expert” risk information sent in a mail packet in the form of a brochure. The brochure emphasized that eating fish after a kill was safe. For the most part, individuals behaved as they would have without the information. Hence, the savings in avoidance cost was small. Perhaps experts have little sway in how individuals form perceptions of risk. Or, perhaps our information packets and method of dissemination failed to communicate the risk meaningfully or individuals simply ignore it.

On the other hand, we found that consumers were quite responsive to seafood inspection programs. Avoidance costs are nearly eliminated by the hypothetical program used in our experiment. This suggests that consumers have confidence in such programs and that concrete action by government authorities can affect consumer decisions. But, we also found the much of gain in surplus realized by such programs can easily dissipate if individuals believe it will lead to a rise, even a small rise, in the price of fish.

There were a number of other interesting findings. Individuals did not seem to differentiate between major and minor sized fish kills. We surmised that there is some threshold level that triggers a response by consumers and that our kills surpassed that threshold. We also found the people responded asymmetrically to price increases and price decreases – people were more responsive to price decreases.

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TABLE 1

FIVE CONTIGENT BEHAVIOR QUESTIONS

Question #	Wording
Question 1: *Price up*	Seafood prices change over time. For example, if a lot of fish are caught, prices go down. When fewer fish are caught, prices go up. Suppose the price of your portion of your average seafood meal goes up by $X but the price of all other foods stays the same. Compared to the [NUMBER] meals you ate last month, do you think you would eat more, less, or the same number of meals next month with the higher price? (X is randomly assigned $1, $3, $5, or $7) *Then,* About how many more/less seafood meals do you think you will eat next month?
Question 2: *Price down*	Now suppose the price of your average seafood meal goes down by $X, but the price of all other foods stays the same. Compared to the [NUMBER] meals you ate last month, do you think you would eat more, less, or the same number of meals next month with the lower price? (X is randomly assigned $1, $2, $3, or $4) *Then,* About how many more/less seafood meals do you think you would eat next month with the lower price?
Question 3: *Fish kill*	Thinking about seafood meals again, suppose that the average price of your seafood meals stays the same. Compared to the [NUMBER] meals you ate last month, do you think you would eat more, less, or the same number next month after the fish kill? *Then,* About how many more/less seafood meals do you think you would eat next month after the fish kill?
Question 4: *Fish kill with Inspection*	Now suppose the average price of your seafood meals stays the same. Compared to the [NUMBER] meals you ate last month, do you think you would eat more, less, or the same number next month after the fish kill and with the mandatory seafood inspection program? *Then,* About how many more/less seafood meals do you think you would eat next month?
Question 5: *Fish kill with inspection and price increase*	Suppose that with the mandatory seafood inspection program the price of your portion of your average seafood meal goes up by $X, but the price of all other food stays the same. Compared to the [NUMBER] meals you ate last month, do you think that you would eat more, less, or the same number next month after the fish kill? (X is randomly assigned $1, $3, $5, or $7) *Then,* About how many more/less seafood meals do you think you would eat next month?

TABLE 2

DEMOGRAPHICS OF SAMPLE (n=1790)

	Number of Respondents by State
Delaware	236
Maryland	218
Virginia	218
Washington DC	47
North Carolina	1071

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
Income	Thousands of Dollars	54.28	26.13	5.00	100.00
Age	Years	46.84	17.02	18.00	100.00
Education	Number of years of education	14.17	2.69	0.00	20.00
Male	Male if equal to 1	0.36	0.48	0.00	1.00
Household	Number of people in the household under the age of 18	2.72	1.37	0.00	8.00
Children	Number of children	0.72	1.04	0.00	5.00
White	White if equal to 1	0.71	0.45	0.00	1.00

TABLE 3

BASIC MODEL: REGRESSION RESULTS

Random Effects Tobit Model with Censoring at the Negative of the Number Meals Purchased Per Month

Variable		***Parameter Estimates for Equations 8, 12-14*** **Coefficient**	**t-statistic**
Δp_{up}	Amount of price increase	-.218	13.7
Δp_{down}	Amount of price decrease	-.346	14.3
major-kill	Dummy variable for major fish kill	-1.19	8.0
minor-kill	Dummy variable for minor fish kill	-1.27	9.2
brochure	Dummy variable for brochure included	-.089	0.7
brochure & insert	Dummy variable for information insert included	.076	0.6
inspection	Dummy variable for inspection program in place	1.06	8.0
price for inspection	Amount of price increase due to seafood program	-.183	6.8
Sigma(v)		2.14	197.7
Sigma(u)		.191	1.5

TABLE 4

GENERAL MODEL:
REGRESSION RESULTS

Random Effects Tobit Model with Censoring at the Negative of the Number Meals Purchased Per Month

Variable		**Parameter Estimates for Equations 8, 12-14** Coefficient	t-statistic
Δp_{up}	Amount of price increase	-.30	7.1
Δp_{down}	Amount of price decrease	-.42	6.0
major-kill	Dummy variable for major fish kill	-1.94	4.2
minor-kill	Dummy variable for minor fish kill	-1.25	2.8
brochure	Dummy variable for brochure included	-.58	1.2
brochure & insert	Dummy variable for information insert include	.82	2.0
inspection	Dummy variable for inspection program in place	1.31	2.8
price for inspection	Amount of price increase due to seafood program	-.27	3.0
Interactions: Δp_{up}	* *income*	.0001	2.4
	**NC*	-.01	0.4
	**other-fish*	.02	0.6
Δp_{down}	* *income*	-.001	1.2
	**NC*	.05	1.0
	**other-fish*	-.04	0.8

major-kill	* *income*	-.0006	0.1
	**NC*	.31	1.2
	**other-fish*	.64	1.9
minor-kill	* *income*	-.005	0.8
	**NC*	-.03	0.1
	**other-fish*	.39	1.2
brochure	* *income*	.01	1.7
	**NC*	.30	1.2
	**other-fish*	-.14	0.4
brochure & insert	* *income*	-.005	1.0
	**NC*	-.61	0.2
	**other-fish*	-.25	0.8
inspection	* *income*	-.001	0.3
	**NC*	-.27	1.0
	**other-fish*	-.28	0.9
price of inspection	* *income*	.0006	0.6
	**NC*	.09	1.5
	**other-fish*	.03	0.5
Sigma(u)		2.14	190.4
Sigma(v)		.086	.09
censored		-x	

TABLE 5

CONSUMER SURPLUS

Total Consumer Surplus and
Consumer Surplus Due to a Fish Kill Under Different Scenarios
(Average per person/per meal)

Total consumer surplus:	**Basic Model:**	**General Model:**
Using price up coefficient	$11.24	$8.16
Using price down coefficient	$7.06	$5.80

Change in consumer surplus due a fish kill	**Major Fish Kill**		**Minor Fish Kill**	
Scenario	*Basic Model:*	*General Model:*	*Basic Model:*	*General Model:*
No information	-$4.17	-$2.70	-$4.34	-$2.95
Brochure	-$4.38	-$2.32	-$4.54	-$2.62
Brochure/counter	-$4.20	-$2.98	-$4.37	-$3.21
SIP	-$0.60	-$1.07	-$0.92	-$1.42
SIP + $1 price up	-$1.37	-$1.24	-$1.65	-$1.76

APPENDIX

<u>Text of Brochure</u>

What You Should Know About Pfiesteria

This booklet provides information about some issues related to Pfiesteria. This booklet and our telephone interview with you will consider these issues because they are important to the economy of the Mid-Atlantic Region. Please carefully consider the information in this booklet before our telephone interview. You may also like to have it nearby during our telephone interview.

What is Pfiesteria?

Pfiesteria (fis-teer-ee-ah) is a potentially toxic organism that has been associated with fish kills in coastal waters from Delaware to North Carolina. A fish kill is a situation in which many fish -- more than a few dozen -- die within hours or days.

Discovered in 1988, Pfiesteria has a 24 stage life-cycle. A few of these stages can produce toxins that affect fish. Pfiesteria is microscopic algae that is a natural part of the environment.

How does Pfiesteria affect fish?

Pfiesteria usually is in its non-toxic form, feeding on algae and bacteria in coastal rivers. Scientists believe that Pfiesteria only becomes toxic in the presence of a large number of fish. Pfiesteria cells then change form and stun the fish with a powerful toxin. The toxins are believed to cause lesions or sores.

Pfiesteria is NOT an infection like bacteria or viruses. Fish are NOT killed by an infection of Pfiesteria. Fish are killed by the toxins Pfiesteria releases, or by other infections once the Pfiesteria toxins have caused sores to develop. Fish may also die from Pfiesteria toxins without developing sores.

How long do toxic Pfiesteria outbreaks last?

Toxic outbreaks of Pfiesteria are typically very short, no more than a few hours. After an outbreak, Pfiesteria cells change back into non-toxic forms very quickly, and the Pfiesteria toxins in the water go away within a few hours. However, Pfiesteria-associated fish sores or fish kills may continue for days or even weeks.

Is Pfiesteria the only cause of fish sores and fish kills?

Pfiesteria is only one cause of fish kills. Other causes include a lack of dissolved oxygen in the water, changes in water salinity or temperature, sewage or chemical spills, red or brown tides, infections, and other environmental changes.

In addition, there are many possible causes for fish sores other than Pfiesteria. These include physical injury in nets or traps, bites by other fish or birds, poor water quality, and viruses or bacteria.

Where has Pfiesteria been found?

Pfiesteria has been found in coastal waters from Delaware Bay to North Carolina. It has not been found in freshwater lakes, streams, or other inland waters.

Pfiesteria has been associated with major fish kills at many sites along the North Carolina coast, particularly the New, Neuse and Tar-Pamlico Rivers. Pfiesteria has been associated with fish kills in the Chicamacomico and Manokin Rivers and King's Creek in Maryland, and the lower Pocomoke River in Maryland and Virginia. Pfiesteria has been associated with fish sores in Maryland, Virginia, and North Carolina.

What causes toxic Pfiesteria outbreaks?

Scientists generally agree that a large number of fish can make Pfiesteria become toxic. However, other factors may contribute to toxic Pfiesteria outbreaks. Pollutants are thought to help Pfiesteria grow by stimulating the growth of algae that Pfiesteria feeds on. Excess nutrients such as nitrogen and phosphorus are common pollutants in coastal waters. The main sources of nutrient pollution in coastal areas are sewage treatment plants, septic tanks, runoff from cities, suburbs and farms, and air pollutants that settle on the land and water.

Can Pfiesteria cause human health problems?

Any human health problems associated with Pfiesteria are from its release of toxins into coastal waters. Preliminary evidence suggests that exposure to waters where toxic forms of Pfiesteria are active may cause memory loss, confusion, and a variety of other symptoms including respiratory, skin, and gastrointestinal problems. It has been shown that similar human health effects can be caused by exposure to Pfiesteria toxins in laboratories.

Pfiesteria is not a virus, fungus, or bacteria. It is not contagious or infectious, and cannot be "caught" like a cold or flu. There is no evidence that Pfiesteria-associated illnesses are associated with eating finfish or shellfish.

Is Pfiesteria related to red and brown tides?

A few species of algae can become harmful to marine life and to people under certain conditions. Scientists call such events "harmful algal blooms." Brown tides, toxic Pfiesteria outbreaks, and some kinds of red tides are all types of harmful algal blooms.

Who should I contact to report fish sores or fish kills?

A few fish with sores or even a few dead fish are not cause for alarm. However, if you notice a lot of fish -- more than a few dozen -- that are dead or dying, have sores, or showing other signs of disease, please contact your state's Pfiesteria hotlines:

Delaware	1-800-523-3336
Maryland	1-888-584-3110
North Carolina	1-888-823-6915
Virginia	1-888-238-6154

Text of Insert

Is it safe to eat seafood?

YES. In general, it IS safe to eat seafood.

There has never been a case of illness from eating finfish or shellfish exposed to Pfiesteria. There is no evidence of Pfiesteria-contaminated finfish or shellfish on the market. There is no evidence that illnesses related to Pfiesteria are associated with eating finfish or shellfish.

The following common-sense precautions are recommended:

- Obey public health advisories.
- Do not harvest or consume fish or shellfish from areas that are closed by the state.
- Do not handle or consume finfish or shellfish that you have caught that are already dead or dying; that have sores, or other signs of disease.

Is it safe to swim and boat in coastal waters?

YES. In general, swimming, boating, and other recreational activities in coastal waters ARE generally safe. The following common-sense precautions are recommended:

Obey public health advisories. Do not go into or near the water in areas that are closed by the state.

If you notice significant numbers of fish that are dead or that have sores, avoid contact with the fish and water, and report the incident to your state's environment or natural resource agency.

If you have health problems after being exposed to fish, water, or air at the site of a fish kill or suspected toxic Pfiesteria outbreak, contact your physician and your state or local public health agency right away.

What is being done about Pfiesteria?

State and federal agencies are working closely with local governments and academic institutions to address the problems posed by Pfiesteria. Federal agencies involved in the effort include the:

U.S. Environmental Protection Agency
National Oceanic and Atmospheric Administration
Centers for Disease Control and Prevention
National Institute of Environmental Health Sciences
Food and Drug Administration
U.S. Geological Survey, and
U.S. Department of Agriculture.

Together with state departments of health and natural resources, these agencies are working to:

- manage the risk of human health effects by monitoring and rapid response through river closures and public health advisories
- direct funding and technical expertise to Pfiesteria-related research and monitoring
- make current and accurate information widely available to the public, and
- understand and address the causes of Pfiesteria outbreaks.

Text Describing Fish Kills

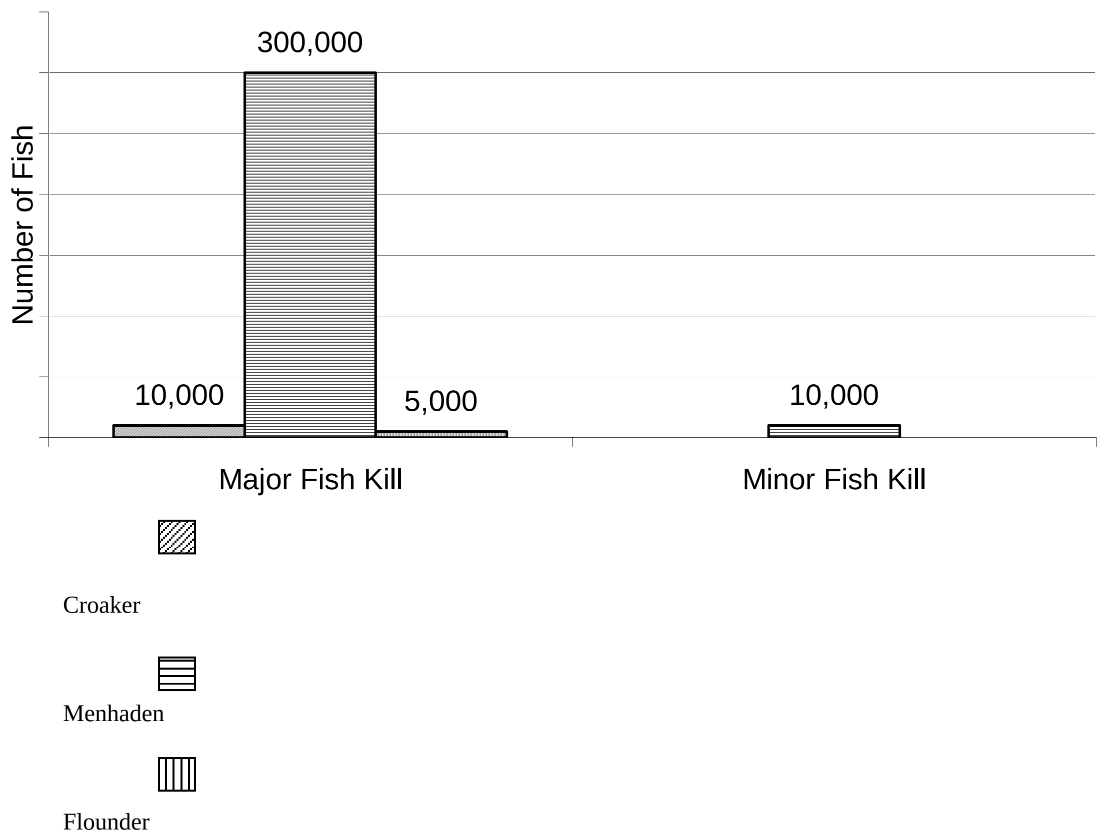
Pfiesteria Associated Fish Kills in the Mid-Atlantic Region

The following describes what some people consider to be typical Pfiesteria associated fish kills in the Mid-Atantic Region

Major Pfiesteria associated fish kills typically involve hundreds of thousands of fish over large areas of river surface. Most of the fish in these kills are menhaden. However edible species such as croaker and flounder may also be found. Lesions appear on more than 50% of the menhaden.

Minor Pfiesteria associated fish kills typically involve less than ten thousand fish over small areas of river surface. All of the fish in these kills tend to be menhaden. Lesions appear on more than 50% of the menhaden.

For example, this chart illustrates typical major and minor fish kills



Text Describing Seafood Inspection Program

Seafood Inspection Program of the U.S. Department of Commerce

The U.S. Department of Commerce (USDC), National Oceanic and Atmospheric Administration (NOAA) offers a voluntary inspection service to seafood producers and processors (under the authority of the Agricultural Marketing Act of 1946). The Voluntary Seafood Inspection Program offers a variety of professional inspection services that assure compliance with all applicable food regulations.

USDC Seafood Inspection Program services are provided for a fee. As of October 1, 1999, the basic hourly fee for a full-time in-house plant inspector was $49.30. Services provided by the USDC seafood inspectors are designed to meet the needs of the individual producers. Generally, the inspector serves as:

- Sanitation advisor: oversees corrections of sanitary practices at the facility
- Quality control monitor: observes production to assure a wholesome end product
- Official certifier: sample and evaluates final product for U.S. Grade A certification

Products inspected and certified under the USDC Seafood Inspection Program that meet all of the requirements and criteria specified have the U.S. Grade A seal of approval.

The U.S. Grade A mark signifies that a product meets the highest level of quality established in the applicable U.S. grade standard and has been processed under the USDC Voluntary Seafood Inspection Program in a sanitarily approved facility.

A Proposed Mandatory Inspection Program

Only a small number of seafood producers participate in the voluntary seafood inspection program. The main reason is that some businesses think the voluntary seafood inspection program will result in higher prices. It has been proposed that the voluntary seafood inspection program become mandatory.

Seafood producers would be required to pay the fee for a USDC seafood inspector. With the Mandatory Seafood Inspection Program you could be sure that all the seafood you ate had the Grade A seal of approval.

Text Describing Hypothetical Fish Kill: Minor Kill (in NC)

A Hypothetical Situation

Please consider the following hypothetical situation. This press release is based on fish kills that have actually happened in the past. But remember, the fish kill that is described did not actually take place. Look on the back of this page for the location of the hypothetical fish kill. When we call you back, we'll talk about this hypothetical situation.

Press Release
September 2000

Last week, scientists responded to reports of dead fish on the lower Pocomoke River. Dead fish were observed over a large area of the main portion of the river between Shelltown and Fair Island. The kill was estimated to affect approximately 300,000 menhaden, 10,000 croaker and 5,000 flounder. Lesions were observed on over 75% of the menhaden. The fish had been dead for at least 24 hours. Other fish in the area were healthy, suggesting conditions that caused the kill had ceased.

Water samples were collected and sent to several laboratories for Pfiesteria analysis. All results to date indicate that Pfiesteria was involved in the fish kill. According to a university scientist, two samples showed concentrations of the organism at levels high enough to be lethal to fish under certain environmental conditions if the organisms are actively releasing toxins.

As a precaution, until the cause of the fish kill can be determined, it is recommended that you avoid direct body contact with the water in the fish kill area; including swimming, water skiing, personal watercraft operation, fishing, clamming, crabbing or other recreational water activities. If you fall into the water, change any wet clothing and wash with soap and clean water. Keep pets from affected areas. Avoid touching any sores or lesions on the dead or dying fish and do not eat dead or dying fish or fish with sores. If you experience any illness that you think could be related to the fish kill, contact your physician promptly.

State officials are working to monitor the situation and collect additional information as needed.

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