WILLINGNESS-TO-PAY FOR RED TIDE MITIGATION, CONTROL AND PREVENTION STRATEGIES: A CASE STUDY OF FLORIDA COASTAL RESIDENTS

By

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Harmful algal blooms (HABS) are natural events with ecological and economic consequences worldwide. In Florida, *Karenia brevis* is the algae species that has accounted for nearly all HABs. *Karenia brevis* produces potent neurotoxins that can kill fish and marine mammals and become airborne and affect the respiratory system of humans. The fact that such blooms, referred to locally as “red tides”, can affect humans is potentially disastrous to a state like Florida that is heavily dependent on coastal tourism. A variety of strategies for addressing HABS have been implemented around the world, and these strategies can be broken down into three main categories: prevention, control and mitigation. Some strategies are likely to face severe opposition, so to determine the potential acceptance of alternative red tide strategies in Florida, mail and online surveys were sent to households in coastal counties. The questionnaire uses a polytomous choice contingent valuation framework to estimate the willingness to pay for three hypothetical strategies: a fertilizer tax to improve general water quality (prevention strategy that is uncertain for red tides), a trust fund donation for a beach conditions reporting service (mitigation strategy designed to change behavior), and a property tax to fund pilot control programs (biological or chemical). For each strategy both binary and ordered logit models were

estimated. Results can be used to help summarize public opinion, inform policy makers, and evaluate specific programs intended to address the potentially harmful effects of red tide events in Florida.

CHAPTER 1
INTRODUCTION

Harmful Algal Blooms (HABs)

In most marine and fresh-water environments, microscopic, plant-like organisms occur naturally in the surface layer of the water. These organisms, which are referred to as phytoplankton or microalgae, form the base of the food chain upon which nearly all other marine organisms depend. An algal bloom occurs when there is an increase in concentration of phytoplankton to the extent that it dominates the local planktonic community. This can occur for several reasons. Most often, an increase in the nutrients the algae feed on, or some environmental condition like a change in water temperature or patterns in water circulation, are the cause of the population explosion. These are naturally occurring events, however, many scientists agree that human activity can exacerbate the severity of bloom events.

Many algal blooms are relatively benign in their effects; however, depending on the species of algae involved, some blooms can have considerable negative impacts on the affected area. The extent of the impacts can vary depending on a number of factors, including the length and size of the bloom. Larger blooms have been known to last for more than a year and stretch along several miles of coastline. Harmful algal blooms (HABs) occur when algal blooms produce toxic or otherwise harmful effects on humans, fish and marine mammals, and the surrounding ecosystem. Some species of algae that are responsible for HABs release powerful toxins in to the water and air. These toxins can paralyze fish and marine mammals, causing them to drown. They can also cause toxicity poisoning in humans that eat shellfish caught in affected waters. One common neurotoxin that can be found in contaminated shellfish is domoic acid, which can cause amnesic shellfish poisoning in humans. Extreme cases, though rare, can lead to coma or death. Some HABs release toxins not only into the water, but into the air as well.

Airborne toxins are responsible for causing or exacerbating respiratory ailments in humans, depending on the severity of the bloom. They can also cause coughing, scratchy throats, burning eyes, and skin irritation. Even blooms that do not release toxins have the potential to cause massive fish kills by depleting the dissolved oxygen in the water.

The negative impacts of HABs not only affect the environment and human health but also affect local economies (Jin et al. 2008). One case study estimated the negative economic impacts of HABs in the United States at $82 million annually (Hoagland and Scatasta 2006). This study found that the commercial fishing industry has been especially hard hit, with annual losses estimated at $38 million. The tourism and recreation industry losses were estimated at $4 million per year, mainly due to beach closures during HAB events. These researchers also estimated the annual health-related costs of HABs to be $37 million per year. In addition, it is very costly to manage and control bloom populations. Approximately $3 million per year has been spent on coastal monitoring and management

Nearly all HABs in Florida are caused by the species *Karenia brevis*. Generally, this algae turns the affected waters a reddish hue, thus earning the colloquial nickname “Red Tide”. *Karenia brevis* releases a potent neurotoxin into the water that kills fish and, in severe cases, dolphins and manatees as well. It also releases airborne toxins that make it difficult to breathe which, depending on the severity of the bloom and other environmental conditions (e.g., wind direction and speed), makes it virtually impossible for residents and tourists to participate in marine-based activities (e.g., beach going, diving, and fishing). Florida red tide also can also result in the closure of shellfish harvesting areas due to the release of toxins that make shellfish dangerous to consume (Fleming et al. 2009). Florida red tide occurs nearly every summer along the Gulf Coast and causes millions of dollars in damage and lost revenue (Morgan et al. 2010; Morgan et al. 2009; Larkin and Adams 2007; Backer 2009).

In the summer of 1971 the Tampa Bay area experienced a particularly bad red tide event, which prompted the first study of the wide-ranging economic effects of red tide on Florida's coastal communities. It was estimated that the 1971 red tide caused $20 million in lost revenue in both the commercial/recreational fishing and tourism industries in seven coastal counties alone. In addition to this lost revenue, these counties incurred thousands of dollars in clean-up costs from removing dead fish and debris from the coastline. The study forecasted that a red tide event of similar magnitude in the future could cause up to 40% more in economic damage (Habas and Gilbert 1974). In a 2007 study, it was found that beach attendance during a red tide event decreased by 13.5%, or 50,000 visitors, in the two counties under study (Larkin and Adams 2007). In addition, a study in 2006 found that hospital admissions of patients with respiratory illnesses increased significantly during a red tide, adding to the burden of local health care facilities (Kirkpatrick et al. 2006).

Clearly, HABs are costly in environmental, health and economic terms. Fortunately, scientists have developed, and continue to research, a variety of methods for managing bloom events. HAB management practices can be divided into three general categories: mitigation, control and prevention strategies. It is important to understand the difference in these strategies. Mitigation strategies focus on minimizing the effects of a bloom on humans, the environment and the economy *after* the bloom has already occurred. This can include, but is not limited to, monitoring coastal conditions and disseminating that information to the public. Mitigation strategies are proven to be effective, but they do not take any direct action against a bloom population.

Control strategies focus on managing a bloom after the bloom has occurred by reducing the duration and extent of the bloom. They attempt to "treat" or stop the bloom by using biological or chemical controls. Biological controls mainly involve using a predator species that will feed on the algae, or one that will complete for the same nutrients the algae is feeding on. A chemical control involves applying a natural material that attaches to the algae and removes it from surface waters. Control practices have been effective in small-scale lab testing, but have not been tried in a large-scale application in the United States.

Finally, prevention strategies differ from the previous two strategies in that they attempt to address the problem of algal blooms *before* they occur. They aim to reduce the frequency and the severity of future bloom events and, thus, are long-term HAB management strategies. Most focus on reducing human activity that increases the amount of nutrients in coastal waters. Prevention strategies are still largely untested for HABs; and, since blooms are natural events whose causes are still relatively unknown, it is unclear whether or not these strategies would be effective.

Problem Statement and Study Objective

Though HABs occur worldwide, this study focuses on HABs occurring along the Florida coast. In Florida, the most common HAB is known as a red tide, and is caused by the species *Karenia brevis.* In a state like Florida, where the economy is heavily dependent on the commercial fishing and tourism industries, a red tide can be a potentially catastrophic environmental and economic event (Larkin and Adams 2007). A variety of HAB management practices have been implemented around the world and in the state and much important research is still being done into these, and new, strategies. However, it would be folly for researchers and administrators to assume that all strategies will be equally acceptable to the public. Since it is Florida residents who will ultimately be paying for any management practice implemented in the state, it is important to understand what type of strategy is most appealing to them (Morgan et al. 2008). This type of information will allow researchers to focus their time and money on a strategy that is likely to be accepted by the public. In addition, if the public is particularly adverse to a method that scientists believe to be the most effective means of managing bloom populations, administrators may be able to change their opinion through education and dissemination of information.

The goal of this study is to determine public preferences for three alternative red tide mitigation, control and prevention strategies. This accomplished by administering a survey to residents in coastal counties where red tides are a common occurrence.

For the main purposes of this study, the survey is used to gather data on the public's concern for, experience with, and knowledge of red tides. Data is also gathered on residents' familiarity with and use of red tide information supplied by alternative agencies, organizations and media outlets. To evaluate these responses, residents were also asked about their fertilizer use, beach use and dependence on coastal water quality, in addition to socio-demographic characteristics. The survey also uses a stated preference methodology to evaluate the three types of strategies. In particular, three willingness-to-pay (WTP) scenarios were presented in random order for evaluation: a fertilizer tax to improve general water quality (prevention strategy that is uncertain for red tides), a trust fund donation for a beach conditions reporting service (mitigation strategy designed to change behavior), and a property tax to fund pilot control programs (biological or chemical). Respondents were first asked whether or not they would be willing to pay a specific amount and then asked how sure they were of the response and allowed to provide an alternate amount they would be willing to pay. This sequential and multiple response format allowed for the use of either dichotomous choice or ordered preference models, which are standard for analysis of this type of stated preference data. In addition to providing WTP estimates, the results of this study will be used to help summarize public opinion, inform policy makers, and evaluate specific programs intended to address the potentially harmful effects of red tide events in Florida.

Stated Preference Methodology

The Contingent Valuation Method (CVM)

Most environmental goods and services, water quality or environmental preservation, are not traded in markets. Therefore their economic value cannot be revealed through market prices. The only option for assigning monetary values to them is to rely on non-market valuation methods. The contingent valuation method (CVM) is a type of non-market valuation technique that is commonly used for measuring the public's willingness to pay for some non-market good or service. It is a valuable tool for performing cost-benefit analysis of environmental projects, such as ecosystem restoration projects.

The CVM is referred to as a "stated preference" technique, because it asks people to directly state their values or preferences, rather than inferring values from actual choices as "revealed preference" methods do (Carson et al. 1997). These stated preferences are discovered through the implementation of carefully designed and administered sample surveys. In these surveys a description of the good or service in question is provided, after which some hypothetical scenario in which the institutional mechanism that will provide or finance the good is introduced. The willingness to pay (WTP) is then elicited through a question taking on one of two basic formats: an open-ended question asking the respondent what is the maximum amount they would be willing to pay for the good/service in question or a dichotomous or discrete choice format in which the respondent is presented with a price (or cost) for the good/service in question and is then asked whether they would be willing to pay that amount (i.e., a yes, no or don't know response).

In 1993, in wake of the Exxon-Valdez oil spill, a panel of economists convened with the support of the National Oceanic Atmospheric Administration (NOAA) to evaluate the validity of using the CVM method to estimate non-market values for environmental goods or services. This panel created a list of guidelines that should be followed to ensure that WTP estimates from a CVM study are accurate (i.e., unbiased). The NOAA panel suggests that, for example, a closed-ended, discrete choice format should be used for several reasons: it is more realistic in that individuals typically make decisions faced with fixed prices; it provides less of an incentive to engage in strategic behavior; and it provides a more clear-cut decision rule as it is analogous to a referendum (i.e., if 50% or more of respondents answer "yes" then the program has the support of the population).

Another key component of a CVM study is referred to as the "payment vehicle", which is the institutional mechanism that will provide and finance the non-market good. The payment vehicle should be familiar, credible and feasible. With many CVM studies the payment vehicle of choice is some form of taxation. The respondent is generally asked if they would be willing to vote for a referendum (i.e., a closed-ended response format) that would implement the tax in order to generate funds to provide or conserve the environmental good or service in question. However, the payment vehicle can also take the form of an increase in the price (or cost) of a related market good, or the respondent can be asked if they would be willing to donate a specific amount to a trust fund or non-governmental group (NGO).

Several approaches have recently been developed that incorporate uncertainty into CVM studies. This is important because people are being asked to evaluate something for the first time; there is likely to be some uncertainty, since they may be unfamiliar about how to evaluate this new good. For example, an approach was employed by Li and Mattsson (1996) that used a two-step method. They first used a traditional dichotomous choice WTP question, but then included a follow-up question that required the respondent perform a "post-decisional" rating of the certainty of their response to the WTP question. This certainty rating was incorporated into the empirical model that was used to estimate the WTP for the sample respondents. The result reduced both the mean WTP and the variance of the estimated WTP; as such this method provides a more conservative estimate of willingness to pay. Conservative estimates of WTP are preferred since they are needed to ensure that a proposed program will produce benefits that exceed costs.

Probability Model and Evaluation

Using a dichotomous choice model evaluation format, as recommended by the NOAA panel (i.e., asking for a yes or no response to a proposed program, at a given price or cost to the respondent, which would help to provide a non-market good), allows for modeling the choice as follows:

$$\Pr(Y = 1|x_i) = \Phi(\beta' X) \tag{1}$$

where Pr is a probability, $Y = 1$ corresponds to respondents that were WTP the price specified for that particular strategy ($Y = 0$ if they were not) and Φ is the logistic cumulative density function that captures all the factors believed to be correlated with the probability of being WTP. In particular, β is a vector of the independent variable coefficient estimates and X is a vector of the independent variables believed to explain the probability of being WTP. In order to account for the uncertainty in their responses and obtain a more conservative estimate of WTP, different models can be estimated if respondents are asked about how sure they were about their decision, particularly for "yes" responses. Assuming respondents were allowed to qualify their "yes" response by asking them if they were unsure, somewhat sure or very sure, the following three models can be specified to capture a range of WTP estimates:

Model 1: $\Pr\,(\mathrm{Y} = 1(\text{"Yes" regardless of sureity})|X_i = \Phi(\beta' X)$ (2)

Model 2: $\Pr\,(\mathrm{Y} = 1(\text{"Yes", but only if "somewhat sure" or "very sure"})|X_i = \Phi(\beta' X)$ (3)

Model 3: $\Pr\,(\mathrm{Y} = 1(\text{"Yes", but only if "very sure"})|X_i = \Phi(\beta' X)$ (4)

The models vary the level of commitment to the alternative red tide strategies as measured by the certainty of their "yes" response; model 1 uses the most inclusive definition of a "yes" response while the "yes" definition for model 3 is the least inclusive.

The use of three binary models allows for the calculation of three mean WTP estimates (e.g., Welsh and Poe 1998). The benefit of this approach is the ability to calculate WTP estimates for different measures of commitment and to see if the variables explaining WTP change as the definition of WTP changes. The WTP was first determined using the "grand constant" approach:

$$Mean\ WTP = \frac{-\bar{X}\beta'}{\beta_0} \quad (5)$$

where $\bar{X}$ is a row vector for the sample means of the independent variables (1 is used for the constant term), β' is a column vector of the coefficient estimates for each of the independent variables, and β0 is the coefficient estimate for the price variable. The advantage of this approach is that it can be used to evaluate WTP estimates for different subgroups of respondents. The disadvantage is that this approach does not produce a reliable estimate of statistical significance (Loomis and Gonzales-Caban 1998).

The second WTP was then estimated using the Delta method. With this method, a simple binary logit model is estimated with the constant as the only explanatory factor in the model. A Wald test is then conducted on the WTP estimate. The Delta method has as its advantage the ability to produce a WTP estimate that can be statistically tested for difference with zero and that it provides an estimate of the variance that can be used to generate a 95% confidence interval around the result (Dumas et al. 2007).

Finally, the third WTP was estimated using the Turnbull Lower Bound method, which is a non-parametric approach. To calculate the WTP using the Turnbull method, you only need information on the responses at each price (or "bid level", as it is commonly known) used in the WTP scenario. For bids numbered j=1,…,k, Fj = Nj/(Tj) is calculated, where Nj is the number of "no" responses and Tj is the number of total responses. The values of Fj to Fj+1 are compared to verify that Fj < Fj+1. If Fj is not less than Fj+1 then the Nj and Nj+1 need to be pooled together, as well as Tj and Tj+1, to ensure that there is a monotonically increasing CDF. Once increasing Fjs are calculated, Fk+1 is set equal to one and F0 is set equal to zero. Then fj+1 = Fj+1-FJ is calculated for each price level. These numbers represent the probability that WTP falls between price j and price j+1. These probabilities are multiplied by the lower price level (j) which provides a WTP at each price level and, when summed, provides the expected value (or lower bound) of WTP, ELB(WTP). The corresponding variance of the lower bound is calculated as:

$$V\left(E_{LB}(WTP)\right) = \sum_{j=1}^{k} \frac{F_j\left(1-F_j\right)}{T_j}\left(t_j - t_{j-1}\right)^2 \qquad (6)$$

While alternative WTP estimates can be obtained from redefining the definition of a "yes" response, an ordered response format can be used to estimate the probability of a respondent selecting each of four possible responses: "no", "yes-but not very sure", "yes-and somewhat sure", or "yes-and very sure". The benefit of this model with respect to contingent valuation studies is that it was adopted in response to concerns related to the use of the dichotomous choice framework for non-market valuation, which was outlined in the Report of the NOAA Panel on Contingent Valuation. The multiple response question format, and in particular one that included an option for not supporting the proposal in general, can be useful for cases where there are a sufficient number of responses in each category (enough for the model to estimate distinct effects of each explanatory variable for each price level). For an ordered response model, assume that:

$$y = \beta' X + u \tag{7}$$

where X is a vector of explanatory variables, β is a vector of associated parameters and u is a logistic random variable with mean zero and unknown scale parameter. Also assume that:

$$Y_i = 0 \; if \; y \leq \mu_0 \tag{8}$$

$$Y_i = 1 \; if \; \mu_0 \leq y \leq \mu_1$$

$$Y_i = 2 \; if \; \mu_1 \leq y \leq \mu_2$$

$$Y_i = J \; if \; \mu_{J-1} \leq y$$

where the μ_J are threshold parameters differentiating each response level and μ_0 is normalized to zero so that J-2 threshold parameters are estimated. Using this arrangement, the probability of observing the different ordered outcomes for each i are then calculated using a logit model:

$$\Pr(Y_i \leq J) = \frac{e^{\mu_J - \beta' X}}{1 + e^{\mu_J - \beta' X}} \tag{9}$$

As the sign and magnitude of the estimated coefficients for an ordered response model are not directly interpretable, the marginal effects are generally used to discuss the impacts of the explanatory variables on the probability of observing the different outcomes. For a discrete explanatory variable x_i, the marginal effects are estimated by taking the difference between estimated probabilities when the discrete explanatory variable x_i takes the value of 0 and 1 holding all other variables constant, usually at their means, and are calculated using the equation:

$$\frac{\Delta \Pr\,(Y_i = j)}{\Delta x_i} = \Pr(Y_i = j | x_i = 1) - \Pr(Y_i = j | x_i = 0) \quad (10)$$

Application to Red Tide Strategies

In this study a dichotomous choice (DC) model was first used to estimate the initial “yes” or “no” binary response for each WTP scenario (Model 1). A separate model was run for each type of management strategy. For the mail survey, the response data for the dependent variable was obtained directly and the price they were asked to consider was included as an independent variable in the model. For the internet survey, a comparable model could use the zero values as “no” and all positive values as a “yes” response. The remaining independent variables included traditional demographics (e.g., age, education, ethnicity, income, length of Florida residency, and how many months the respondent resides in Florida per year), location (i.e., region of residence, number of miles from the coastline that the residence is located), level of concern with red tide, level of dependence on local water quality, and the order in which the particular scenario in question appears in the survey. In addition, each model included one or more distinct variables to capture strategic bias that is based on whether the respondent will be affected by the proposed strategy (e.g., if they maintain a lawn, are familiar with the beach reporting system in the Southwest region, or if they paid property taxes in Florida last year).

In the mail survey, respondents were asked about their level of uncertainty if they responded “yes” to the WTP question. This information was used to recode the answers to the WTP questions in order to determine a more accurate (i.e., conservative) estimate. Then, a model was run for each scenario in which only “yes” responses that were followed by a “very sure” certainty assessment of their response were coded as “yes” (Model 3). The second model

(Model 2) used only “yes” responses that were followed by “somewhat sure” or “very sure”, thus changing the “unsure” yes responses to “no”. This protocol was similar to a study by Vossler et al., in which the respondents from a survey asking if they would vote for a referendum that would implement a tax on home values were able to answer “yes”, “no” or “undecided”, and the “undecided” responses were re-coded as “no” responses (Vossler et al 2003).

The models were estimated using LIMDEP 8.0. The models were compared to one another (within each strategy type) using various statistics on model fit (i.e., chi-squared statistics, pseudo R2 statistics, and percent correctly predicted), as well the number of statistically significant variables and the stability of the signs on those variables.

In both the mail and the internet surveys the responses to the WTP scenarios can be modeled using an ordered response framework. In the mail survey this was possible by using the level of certainty responses to order the yes responses (0 for no responses, 1 for “not sure” yes responses, 2 for “somewhat sure” yes responses and 3 for “very sure” yes responses). Similarly, in the internet survey the “yes” responses could be replaced by a linear ranking to capture WTP higher values, or the value could be estimated using a generalized least squares methodology The ordered models can also be estimated using LIMDEP. In addition, WTP estimates can be defined and compared to the estimates from the discrete models. Lastly, these models generate marginal values for each ordered level being modeled. This information can be used to determine how each explanatory variable affects the probability of a coastal resident being not WTP or very sure of their WTP.

Data Collection

In order to determine consumers’ willingness-to-pay for different red tide management practices, 14,400 mail surveys were sent to residents in three different coastal regions in Florida where red tide is a common occurrence. The number of surveys sent to each region was determined based upon the population from the most recent census. A total of 1,674 surveys were sent to the northwest region, which included the following four counties: Gulf, Franklin, Bay and Okaloosa. Along the Gulf of Mexico in the southwest region, 6,624 surveys were sent to residents in the following four counties: Manatee, Sarasota, Charlotte and Lee. Finally, in the northeast region, 6,102 surveys were sent to residents in St. Johns, Flagler, Volusia and Brevard counties. To address order bias, 18 versions of the questionnaire were developed (which is discussed further below) such that 800 questionnaires of each version were sent. The questionnaires were color-coded based on region because the pretest of 100 revealed that the majority failed to provide their zip code. Since regional differences are hypothesized, the color-coding was added to the survey implementation protocol.

The internet survey was administered through Expedite Media Group (EMG), which had a total of 692,431 email addresses of residents located throughout the 12 county study region. EMG maintains email addresses for marketing purposes but organizations also use the agency to send newsletters and press releases in addition to solicitations or advertisements. EMG designed the invitation and sent a total of three messages (i.e.,, 'campaigns'). Respondents were allowed to 'opt out' of responding or receiving additional notices.

The questionnaire was organized into four sections. The first section of the survey (titled "Awareness, Experience, Knowledge and Concern) begins with a series of questions designed to gauge the respondent's knowledge of red tide, their level of concern with the issue, and their experience with it. Respondents were also asked a series of true or false questions regarding the causes and effects of red tide to determine their level of knowledge of the phenomenon. They were then asked about their level of concern for red tide events and their main reason why in a follow up question.

The second section of the survey, on “Information”, asked their opinion on nine issues related to scientific research on red tide. Respondents were then asked about how frequently they seek out information on red tide. These questions were designed to evaluate the awareness of and frequency of use of existing red tide information sources for the community in order to determine if any improvements could be made in the dissemination of information. Lastly, this section asked about the level of dependency on coast water quality.

The third section included the evaluation of three different “Red Tide Strategies”: mitigation, control and prevention. In the mail survey, each scenario (i.e.,, red tide strategy) has three different versions based on price: one with a low price level, one with a medium price level, and one with a high price. In addition, the scenarios had to be randomized with respect to order resulting in eighteen versions of the questionnaire. If a respondent received a survey with high price levels this meant that for every scenario the price level presented was high. For example, one version of the survey presented the prevention strategy first, second and third, all with low price levels. In this way order bias controlled for. Respondents were also instructed to respond to each scenario independently of the others, that is, they were asked to evaluate each as if they were the only option available. For each scenario, the respondents were presented with background information describing the type of management strategy, its risks and its benefits. In addition, a behavioral or experience question specific to each scenario was asked before each willingness-to-pay question was introduced to better assess strategic bias. After the willingness-to-pay section, they were asked which of the three scenarios they preferred most, if any. Each of these scenarios are discussed in turn.

To represent a “prevention” strategy, a state-wide retail tax on all fertilizer sales was proposed. It was explained that the tax on fertilizer was chosen in order to discourage its use in coastal areas where runoff into coastal waters could provide the increased nutrients needed for an algal bloom to occur, spread or intensify. It was also explained that regardless of its impact on future red tide events, it is believed that this scenario would ultimately help to improve the overall quality of coastal waters. The respondents were presented with the following willingness-to-pay scenario:

> Potential Prevention Strategy: Establish a state-wide retail tax on fertilizer that would encourage a reduction in fertilizer use and raise funds to pay for continual monitoring of coastal water quality, and research to determine water quality improvements. If no measurable improvements were found within three years, the law would be automatically repealed.

Depending on which price level the respondent received, they were asked if they would be willing to vote for a 5%, 10% or 15% tax on fertilizer sales. Additionally, the respondent was asked if such a fertilizer tax would affect them more due to personal fertilizer use, with the expectation that this information would be a determining variable in the willingness-to-pay for this strategy.

A real-time beach quality monitoring system was chosen to represent a "mitigation" strategy since it involves monitoring coastal conditions and broadcasting this information to the public, and such a system already exists in some coastal areas. It was stressed to respondents that this type of strategy would accrue benefits regardless of red tide conditions in the area because the reporting system also monitors tidal conditions, weather conditions and a whole suite of additional coastal information. The following scenario was presented:

> Potential Mitigation Strategy: Establish a Beach Conditions Reporting Service Trust Fund to support the training of observers, initial equipment expenditures and maintenance of an electronic reporting system. It is anticipated that one-time donations to this fund would be sufficient to establish and support this program over the next three years. Only people who donate would able to access the system.

Again, depending on the randomized price level, the respondent was asked if they would be willing to pay a one-time donation of $5, $15 or $25 for access to the reporting service for three years. Since this system has been launched at some beaches in the Southeast region, respondents were asked if they were familiar with the existing system. Some pre-test respondents from the Southeast region were familiar and, therefore, not willing to pay since it is available for free. This is important information for our study since funding for the current system is not guaranteed but there is a potential for it to be expanded state-wide.

Finally, for a "control" strategy, a three-year property tax to fund pilot red tide control methods was proposed. Respondents were told that control programs have been widely successful on a small-scale level and have been used in different countries, however research on a larger scale in the U.S. is still needed. Part of the funds raised would go towards pilot testing for ecological impacts from large-scale applications. The scenario was worded as follows:

> Potential Control Strategy: Establish a 3-year tax on the assessed value of all taxable property to fund red tide control programs, including pilot testing. If no measurable improvements were found within three years, the law would be automatically repealed.

Depending on price level, it was asked if respondents would be willing to vote for a three-year tax of $5, $10 or $15 per $100,000 of assessed value of all taxable property at the county level, for the funding of a local red tide control program. It was also asked if the respondent paid property taxes in Florida last year, as this could affect their response.

In addition, each WTP scenario had follow up questions regarding the certainty of the respondents answer. Respondents that answered "no" were asked if there was any amount they would be willing to support using in an open-ended format. Respondents that answered yes were asked to indicate whether they were very sure, somewhat sure or unsure of their response. In addition, those that answered "very sure" were asked to provide (as an open-ended response) the maximum amount they would be willing to pay would be.

The online questionnaire differed in the treatment of the WTP question. The internet survey asked for their *maximum* willingness to pay for each scenario and they were provided with five response choices (i.e.,, a closed-ended format). Three of the choices were the three levels used in the mail survey, which had been based on the incidence of pre-test responses to the highest price category. The other two choices were the bound values: zero (i.e.,, "I don't support this strategy") and a "more than" category to capture the maximum WTP above the highest price level of the three values presented.

The final section of the questionnaire asked a series of questions to allow the models to control for various socio-demographic characteristics. The "Demographics" information sought in the survey included the length of residency in Florida, location in the state (including distance to the nearest coast), and the age, education, ethnicity and household income of the respondent. Internet respondents were also provided a space to enter feedback regarding the content of the survey.

Organization of Thesis

In the following chapters the responses from the surveys, as well as the empirical results and WTP estimates will be discussed in depth. In Chapter 2 the responses from the mail surveys will be summarized individually, in order of their appearance in the survey. At the end of the chapter are several tables and figures that summarize these results in a clear and concise fashion. Also, the cover letter and questionnaire, as they appeared to the respondents, are shown in Appendix A. The final section of Chapter 2 will compare the responses from the mail survey to those from the internet survey. Chapter 3 is an in depth discussion of the empirical results from the estimation of the models detailed above. This chapter includes tables that define and describe the independent and dependent variables, as well as a series of tables that summarize the estimated coefficients and marginal effects for each type of model. The nine binary models are discussed first, followed by a discussion of the three ordered models. The estimated WTP values are also addressed in this section, as well as the non-parametric calculations of WTP (i.e., the Turnbull WTP). Finally, Chapter 4 is a conclusion and discussion of results, implications, limitations and future steps of the study.

CHAPTER 2
SUMMARY OF SURVEY RESPONSES

In order to determine consumers' public preferences for different red tide management practices, 14,400 mail surveys were sent to residents in three different coastal regions in Florida where red tide is a common occurrence. Out of those, 1,454 were returned, giving a response rate of 10.1%. This response rate is considered to be conservative since the surveys were sent by bulk mail to reduce costs, which mean that undeliverable questionnaires were not returned. The results from the mail survey are summarized in detail in this section. Each question is addressed individually and in order of appearance in the survey. The verbatim question, as it appeared in the survey, is also presented. The cover letter and questionnaire are shown in Appendix A. The final section of the chapter compares the responses to the mail and internet versions of the questionnaire. Since only 115 completed surveys were obtained from the internet version, responses are not discussed in detail here.

Awareness, Experience, Knowledge and Concern

The survey begins with a series of questions designed to gauge the respondent's knowledge of red tide, their level of concern with the issue, and their experience with it.

Question 1: Are You Aware of the Coastal Condition Known as Red Tide?

A total of 93.5% of respondents answered "yes" to this question, indicating that they were aware of red tide, while only 6.5% responded "no" (N = 1,431). Respondents who answered no were asked to skip directly to the demographic section of the survey, as the survey was intended to target those residents who had at the very least a passing knowledge of red tide. All subsequent questions, summarized below, were directed to those respondents who answered "yes".

Question 2: What Has Been Your Experience with Red Tide Events in Florida?

For this question respondents were asked to respond “yes” or “no” to a series of seven statements regarding their personal experience with red tide (Table 2-1). A significant portion of respondents (82.0%) reported having experienced the smell of dead fish at the beach at some point in the past, as well as having seen dead animals on the shore (73.9%). In contrast, very few respondents indicated that they had changed a hotel or restaurant reservation (6.2% and 19.2%, respectively).

Question 3: Do You Believe Each Statement Is True or False with Respect to Florida Red Tides?

In question three respondents were asked a series of true or false questions regarding the causes and effects of red tide in order to determine their level of knowledge of red tide. Respondents were able to answer “true”, “false” or “don’t know”. Of note are the second and third statements regarding the safety of seafood consumption during a red tide event. The majority of respondents either answered the statement incorrectly or indicated they did not know the correct answer (Table 2-2). Respondents were also largely unaware if “red drift” was another name for red tide (77.1%) and if red tides are the same worldwide (65.1%). However, most respondents answered correctly when asked if red tide conditions vary greatly within a small area (92%) and if people with asthma are more likely to experience health effects from red tide (78%). Many of these statements are directly comparable to those asked to 1,000 residents of Manatee and Sarasota counties in 2000 (Larkin and Adams 2007).

Question 4: How Concerned Are You, If at All, about Florida Red Tide Events?

The fourth question was designed to gauge the respondents’ concern about red tide. They were asked to choose between “I’m generally not concerned” and “I’m somewhat or very concerned” (Figure 2-1). Respondents were then asked for the reasoning for their answer in a follow up question. Out of the 1,302 respondents who answered this question 23.6% indicated that they were generally unconcerned about red tides in Florida, while the remaining 76.4% indicated that they were at least somewhat, if not very, concerned about the issue.

Those that responded “no” to the initial question were asked the follow-up question about their primary reason (Table 2-3). Of the 307 respondents who indicated they were not concerned in the initial question, 287 went on to answer the follow-up question. The response rates for each answer are listed in the table below, but the majority of respondents indicated that they were unconcerned because red tides are a natural occurrence (44.6%).

The respondents that answered yes to the initial question were also asked a similar question regarding the reasoning behind their response. Of the 995 respondents who answered yes to the initial question, 858 went on to complete the follow-up question. These respondents indicated that they were concerned mainly due to red tides’ effects on human health (31.9%).

Information

Next, a series of questions regarding information sources for red tide were presented. These questions were designed to determine the information seeking behaviors of respondents as well as to evaluate the quality of existing red tide information sources for the community in order to determine if any improvements could be made in the dissemination of information.

Question 5: Do You Agree or Disagree with Each Statement Concerning Scientific Research on Red Tides in Florida?

This question presented respondents with a series of statements that were designed to determine their feelings towards scientific research on red tide. Respondents were asked to answer based on a one through five Likert scale, where one was defined as “strongly disagree”, three was “don’t know” and five was “strongly agree”. The average Likert scale rating for each statement is provided, along with the percent of respondents who chose a rating of “5” in Table

2-4. The first four statements asked respondents to comment on the quality of research on red tide and the quality of monitoring and prediction systems. The average ratings for these for questions ranged from 3.00 to 3.86, indicating that respondents were largely unaware or unconcerned about the issue. The next three questions asked respondents to comment on how important they felt it was that research be done on the different effects that red tide has on human health, on people in general, and on marine animals. The statement regarding human health received the highest average Likert rating (4.54), indicating that people strongly agreed that learning about how red tide affects human health is important. The average ratings for the statements on red tide effects on people and marine animals were 4.46 and 4.47, respectively. In the final statement respondents were asked whether they thought that determining the costs and benefits of different red tide strategies is important. The average Likert rating for this statement was 4.29 indicating that respondents agreed that this issue was important.

Question 6: How Frequently Do You Seek Information about Florida Red Tides?

Question number six aimed to determine the frequency with which respondents search for information about red tide in general (Figure 2-2). Overall, nearly three quarters of respondents actively seek out information. In terms of frequency, the majority of respondents (43.1%) responded that they only look for information when a red tide affects near shore waters. Another 2.1% indicated that they only look for information when something new is reported about Florida red tides and 7.6% indicated that they look for information about Florida red tides on a regular basis to see what is new. Finally, only 23.1% responded that they never look for information about red tide events (N=1,330).

Question 7: How Familiar Are You with Red Tide Information Available from Each Agency?

Respondents were asked about their familiarity with eight different sources of information on red tides in Florida. They were able to choose whether they were "not at all", "somewhat" or "very" familiar (Table 2-5). The agencies in question were the Florida Fish & Wildlife Institute (FWRI), major universities in the state of Florida, Mote Marine Lab, the Sierra Club, Solutions to Avoiding Red Tide (START), Florida Red Tide Coalition (FRTC), Florida Red Tide Alliance FRTA) and the Beach Conditions Reporting System (BCRS)™. The majority of respondents indicated that they were not at all familiar with any of the organizations listed. The source with the highest percentage of respondents who were very familiar or somewhat familiar with it was the BCRS (15.2% and 39.7%, respectively). Mote Marine Lab closely followed the BCRS with 13.5%. The organization that respondents were the least familiar with was START (91.1% indicated that they were not at all familiar). Following closely behind START were FRTA with 90.8%, the Sierra Club with 89.6% and FRTC with 88.9%. These results, however, are likely regional in nature since not all organizations operate equally in every area of the state.

Question 8: How Frequently Do You Get Florida Red Tide Information from Each Source?

In this question respondents were asked to indicate how often they search for information regarding red tide from seven common sources. Respondents were asked to choose "never", "sometimes" or "often" (Table 2-6). The information source most commonly used by respondents to find information on red tide was the television (33.0% "often" and 55.7% "sometimes"). Also very popular were the local newspapers, with 28.7% "often" responses and 53.7% "sometimes" responses. The least common informational source was public forums, with 90.2% "never" responses, followed by printed brochures/pamphlets (78.7% "never" responses).

Question 9: How Dependent Are You on Coastal Water Quality and Quantity?

This question was meant to determine respondents' level of dependence on coastal water quality. Of the 1,338 respondents who answered the question, 6.9% were not at all dependent (Figure 2-3). 52.6% of respondents were somewhat dependent, and the remaining 40.5% were very dependent.

Red Tide Strategies

Following the information section was a series of three contingent valuation (i.e., WTP) questions for the purpose of evaluating public preference for the different types of management practices. There was a scenario for each type: mitigation, control and prevention. For each scenario, the respondents were presented with background information describing the type of management strategy, its risks and its benefits. In addition, a behavioral or experience question specific to each scenario was asked before each willingness-to-pay question was introduced. Finally, after the willingness-to-pay section, they were asked which of the three scenarios (if any) they approved of the most. Since there were three different price levels for each scenario, the price levels are denoted as "X" in the descriptions that follow. In addition, the order in which the scenarios appear within this summary is not indicative as to the order in which they appeared within the actual surveys (in reality, the order of appearance was randomized among surveys). The three scenarios are summarized in Table 2-7 but the questionnaire contains the exact questions and the background information provided on each (Appendix A).

Question 10: Do You Use Plant Fertilizers in Florida?

This program relies on funds generated from those who buy fertilizer, so those individuals might be less likely to support the program since it will cost them more. Conversely, those that don't use might be more likely to support the program indicating a strategic bias in their response since they would not have to pay. In stated preference questionnaires it is critical to remind the respondent of how the proposed program might affect them financially, so this question is needed to account for their use of fertilizers. After prefacing the question with this information, 54.9% indicated that the used plant fertilizers (N = 1,321).

Question 10A: Would You Vote for an X% Tax on All Fertilizer Sales?

Sixty percent of respondents who answered the question indicated that they would be willing to vote for the scenario described above, while 40% indicated that they would not be willing to vote in support of this program (N=1,326). The percentage of "yes" and "no" responses broken down by price level are provided in Table 2-8.

Question 10B: If So, How Sure Are You of This Decision?

Those that answered yes were then asked how sure they were of that decision using a closed-form, three level format for the response. Of the 795 respondents who answered yes, 789 went on to answer this question. Of those, 8.1% were unsure, 45.6% were somewhat sure and 46.3% were very sure (Figure 2-4). Those that responded that they were "very sure" were given the opportunity to provide a maximum percentage that they would be willing to pay. However, a very large number of respondents were confused by this question, thinking that they were being asked to provide their level of certainty in percentage form. Due to this misinterpretation by at least some respondents there were a high number of 100% values, which skewed the responses too much to be useful to this study. Therefore the average maximum WTP amount is not discussed or summarized. The same is true for the corresponding questions for each type of strategy.

Question 10C: If Not, Is There Any% That You Would Vote for?

Those respondents who answered no to the initial questions about their willingness to pay were asked if there was any amount at all that they might be willing to pay, and if so how much. This question was needed in case a respondents was asked to respond to an amount that they could not afford so amounts lower than the maximum (i.e., 10%) were expected. A total of 515 of the 531 respondents who answered no to the original question went on to answer this question. Of those, 83.3% responded that there was no amount that they would be willing to pay but 16.7% responded that there was, indeed, an amount they would be willing to pay, and the average of those amounts was 3.89%.

Question 11: Are You Aware of the Beach Conditions Reporting System for the Gulf Coast of Florida^{tm}?

Of the 1,334 respondents who chose to answer the question, 74.1% were unfamiliar with the system, while 25.9% had at least heard of it. This is another question where the responses are most likely regional in nature, since this system only operates in southwest Florida.

Question 11A: Would You Pay a One-Time Donation Of $X into This Trust Fund?

For this scenario, respondents would be donating to the trust fund for access to the proposed system for three years. The majority of respondents (64%) who answered the question indicated that they would not be willing to make a one-time donation to a beach conditions reporting service trust fund as described above. Thirty-six percent indicated that they would be willing to donate (N=1,320). The percentage of “yes” and “no” responses are reported by price level in Table 2-8.

Question 11B: If So, How Sure Are You of This Decision?

As with the previous two scenarios, those that answered yes were asked how sure they were of that decision. Of the 475 respondents who answered yes, 474 went on to answer this. Of those, 11.6% were unsure, 49.6% were somewhat sure and 38.8% were very sure of their stated willingness to pay (Figure 2-5).

Question 11C: If Not, Is There Any Amount That You Would Pay?

Those respondents who answered no to the initial question were asked if there was any amount at all that they might be willing to pay, and if so how much. A total 806 of the 875 respondents who answered no to the original question went on to answer this question. Of those, 88.8% responded that there was no amount that they would be willing to pay but 11.2% responded that there was an amount they would be willing to pay. The average of those open-ended responses from those respondents who were very sure of their willingness to pay was $6.91, which was less than the maximum proposed donation of $25.

Question 12: Approximately How Many Days Do You Spend at the Beach Each Year?

The average days spent at the beach per year among respondents was 48.9 days per year with a standard deviation of 87.4 days. The minimum number of days spent at the beach was 0 days and the maximum number of days was 365 days.

Question 13: Did You Pay Property Taxes in Florida in 2009?

Out of the 1,344 respondents who answered the question, 87.4% indicated that they paid property taxes in Florida in 2009.

Question 13A: Would You Vote For a 3-Year County Property Tax to Fund Control Programs?

Approximately 49% of respondents who answered the question indicated that they would be willing to vote for a 3-yeat property tax fo fund local control programs, while 50.7% indicated that they would not be willing (N=1,343). The percentage of responses by price level are shown in Table 2-8.

Question 13B: If So, How Sure Are You of This Decision?

As with the previous scenarios, those that answered yes were asked how sure they were of that decision. Of the 662 respondents who answered yes, 652 went on to answer this follow-up. Of those, 11.0% were unsure, 54.6% were somewhat sure and 34.4% were very sure of their stated WTP for a control program (Figure 2-6).

Question 13C: If Not, Is There Any Amount That You Would Pay?

Those respondents who answered no to the initial questions were asked if there was any amount at all that they might be willing to pay, and if so how much. A total of 653 of the 681 respondents who answered no to the original question went on to answer this question. Of those, 85.2% responded that there was no amount that they would be willing to pay but 14.9% responded that there was, indeed, an amount they would be willing to pay. The average of those amounts was $4.69 per $100,000 of assessed taxable property value, which was less than the maximum of 415 proposed in the question.

Question 14: In General, Which Type of Control Most Appeals to You?

Over half (56.2%) of respondents indicated that they would prefer biological controls (e.g., introducing a predator species or a species that completes for food with the algae), while 20.7% preferred chemical controls (e.g., introducing a substance that would alter the composition of the algae or absorb the algae) and the remaining 23.1% preferred neither.

Question 15: Which Program Would You Prefer If The State of Florida Only Had Funds for One?

The final question of the survey asked respondents which of the three scenarios, if any, they would prefer if the state of Florida only had funds to implement one. Of the three proposed programs the prevention program had the most support with 43.1% of respondents indicating that they favored that strategy (Figure 2-7). Twenty percent favored the control strategy and 16.6% favored the mitigation strategy. Finally, 20.4% indicated that they would prefer that no strategy be implemented and funds used for some other purpose (N=1,311).

Demographics

Question 16: How Long Have You Resided in Florida?

The average length of Florida residency among respondents was 24.2 years (N=1,445), but responses ranged from 0 to 82 years. The standard deviation was 16.87 years.

Question 17: How Many Months out of the Year Do You Reside in Florida?

The majority of respondents reside in Florida for the entire year (93.4%). The average of the months of residency in Florida each year was 11.7 months, with a standard deviation of 1.2 months (N=1,439). Figure 2-8 displays a frequency distribution for months residing in Florida.

Question 18: What Is the ZIP Code of Your Residence in Florida?

The ZIP code information was first used to determine the distribution of responses in the study area. The overall response rate for each region is provided in the Table 2-8, as well as the proportion of the total responses represented by the region. To review, the northeast region was comprised of St. Johns, Flagler, Volusia and Brevard counties. The southwest region included Manatee, Sarasota, Charlotte and Lee counties. Finally, the northwest region encompassed Gulf, Franklin, Bay and Okaloosa counties. At 10.7%, the response rate for the southwest region was slightly better than the 10.4% overall response rate, however, the response rates for the northeast and northwest regions (9.9% and 8.4%, respectively) were slightly under the overall response rate. Of the total 1,454 responses, the southwest region made up the highest percentage of responses at 48.9%. The northeast region made up 41.7%, and the northwest region brought up the rear at only 9.6%. While these distributions may seem disproportionate, they are roughly equivalent to the proportion of surveys mailed out to each area (which was based on population).

Question 19: How Many Miles by Car Do You Live from the Coast?

The average distance of respondents' residences to the nearest coastline was 8.7 miles with a standard deviation of 10.9 miles. The reported minimum distance of residency to the coastline was 0 miles and the maximum distance was 200 miles. Finally, 43.2% of respondents lived within five miles of the coast (N=1,428).

Question 20: In What Year Were You Born?

The information gathered in this question was converted from year born into the age of the respondent. The average age was 59.9 years with a standard deviation of 14.4 years. The minimum age was 18 years and the maximum was 96 years. Finally, 50.2% of respondents were over the age of sixty (N = 1,426).

Question 21: What Is the Highest Level of Education That You Have Completed?

The majority of respondents had a college degree or higher (Figure 2-9). Thirty-two percent of respondents held a bachelor's degree, while 25% held a professional or graduate degree. Only 11% held a high school degree or less.

Question 22: Which of the Following Describe Your Race or Ethnicity?

To describe their ethnicity respondents were allowed to choose from more than one category. The majority of respondents (92.4%) considered themselves to be Caucasian. Nearly two percent (1.9%) considered themselves to be African American and another 3.0% indicated that they were of Hispanic descent. Finally, 2.7% indicated that they were of some other race or ethnicity (N = 1,433).

Question 23: Which Category Includes Your Household's Annual Income before Taxes?

The majority of respondents' (56.3%) reported an annual income level fell between $30,000 and $90,000 (Figure 2-10). Approximately 17% made less than $30,000 a year, and around 7% earned over $150,000 per year.

Comparison of Mail and Internet Responses

To supplement the mail surveys, an additional 692,431 email invitations for an internet version of the survey were sent out to residents in the same 12 counties. The two surveys were very similar, only treating the format of the WTP questions in a slightly different manner (due to complications with the online format). Due to this, the WTP from the mail and internet surveys must be estimated separately in slightly different ways. The rest of the surveys can be compared directly. Since there were only 115 responses from the internet survey were returned, they are not summarized fully on their own. They are, however, compared below to the responses from the mail survey, for questions of particular interest. Appendix B shows difference in WTP questions in online survey, while Appendix C provides verbatim responses to open-ended final question asking for comments about survey. The open-ended responses are not included due to the tremendous number of comments; however they are available from the author upon request.

Table 2-10 compares the percentage of respondents who have experienced the effects of red tide. The percentage of yes responses is provided. It appears that the respondents from the internet survey have slightly more personal experience with red tide. Of those respondents, 86% indicated they had noticed red tide conditions in the water, as compared to 74% from the mail survey. Similarly, 93% indicated that they had experienced the odor of decaying fish as compared to 82% from the mail survey. In fact, there was a higher percentage of internet respondents answering "yes" for every indicator of level of experience.

The responses from the true/false questions are compared in Table 2-11. Again, the respondents from the internet survey seemed to have more knowledge about the causes and effects of red tide. For each question a higher percentage of those respondents answered correctly. For example, 54% of internet respondents were aware that seafood bought in stores or restaurants is safe to consume, as compared to only 44% of mail respondents. Of note, too, is that 50% of internet respondents were aware that reddish-brown water does not always indicate that humans will experience respiratory problems, while only 32% of mail survey respondents were aware of this.

In Table 2-12 the primary reasons why a respondent was concerned or unconcerned about red tide is compared between the two surveys. First, of note is that 81% of internet respondents reported being concerned about red tide, compared to 76% of mail respondents. While, the reasons for being concerned about red tide do not differ greatly, the reasons for being not concerned were slightly dissimilar. The In the internet survey 73% of respondents indicated that they were unconcerned about red tide because it is a natural occurrence, while only 44% of mail respondents felt that way. In addition, only 4% of internet respondents were unconcerned because red tide had not affected them, as compared to 29% for the mail respondents. This is consistent with the responses from question two, which indicated that internet respondents had more personal experience with red tide than mail respondents.

Table 2-13 compares the percentages that agree with statements about scientific research on red tides in Florida. These responses were remarkably similar across both surveys. Table 2-14 is a comparison of the familiarity of respondents with various agencies that supply red tide information. These, too, are very similar, though respondents from the internet survey were slightly more familiar with each of the agencies. Of note is Mote Marine Lab, with whom 47%

of internet respondents were at least somewhat familiar with as compared to only 37% of mail respondents. In addition, 21% of internet respondents were familiar with the Sierra Club, while only 10% of mail respondents were. Finally, 42% of internet respondents were familiar with red tide research from the universities in Florida while only 30% of mail respondents reported a familiarity. Table 2-15 compares the percentage of respondents that obtain information about red tide from several different informational sources. Like the last two questions, the responses from the internet and mail surveys were for the most part similar to one another. A notable difference was the response rate for internet sites, where 58% percent of internet respondents used this informational source sometimes or often, while only 34% of mail respondents did the same.

The percentage of respondents who were willing to pay for each strategy is broken down by price level in Table 2-16. For each strategy type there were more respondents from the mail survey who were not willing to pay than from the internet survey (40% versus 36% for prevention, 64% versus 46% for mitigation, and 51% versus 44% for control). The responses for the rest of the price levels did not differ a great deal. For the prevention strategy, 33% of internet respondents were willing to pay the lowest price level (1%), as compared with 22% of mail respondents. Another notable difference was that 19% of internet respondents were willing to pay the highest price level for the mitigation strategy ($25), while only 9% of mail respondents were willing to do the same.

A comparison of the responses from the strategy specific questions can be found in Table 2-17. The percentage of respondents who use fertilizer, the number of days spent at the beach and the percentage of respondents who paid property taxes were not notably different. In addition, respondents from both surveys preferred biological controls to chemical controls or no controls at all. Overall preference for the strategies was similar: respondents from both surveys preferred prevention strategies the most, followed by control, no strategy at all and finally, mitigation. Finally, more respondents from the internet survey were aware of the BCRS (31%) than respondents from the mail survey (26%).

Geographic characteristics and tenure in Florida are summarized in Table 2-18. There were more responses from the northeast region in the mail survey (41%, versus 25% from the internet), while there were more responses from the southwest region in the internet survey (68%, versus 49% from the mail survey). The responses from the northwest region were similar for both. Length of residency in Florida seemed to be distributed similarly in both surveys, though the internet survey had more respondents who had resided for over 20 years than the mail survey (65% versus 50%). The majority of respondents for both the internet and mail surveys resided in Florida for more than 9 months out of the year (96% and 95%, respectively). Finally, for both surveys the majority of respondents lived within 20 miles of the coast (96% for the internet survey and 95% for the mail survey). Table 2-19 summarizes the remaining demographic characteristics. The internet respondents did not differ in age (an average of 60 years for both). They also did not differ greatly in ethnicity (95% Caucasian for the internet survey versus 92% for the mail survey). Respondents from the internet survey were very slightly more educated, with 33% having a graduate or professional degree as compared with 25% of mail survey respondents. Finally, internet respondents were somewhat wealthier than mail respondents. Only 6% of internet respondents were in the lowest income bracket as compared to 17% of mail respondents, and 16% were in the highest income bracket as compared to 7% of mail respondents.

Finally, Figures 2-11 and 2-12 compare frequency at which respondents search for information and the dependence on coastal water quality, respectively. The information seeking behaviors reported by respondents from the internet survey and respondents from the mail survey are almost identical. However, a larger percentage of internet respondents reported being highly dependent on coastal water quality than did the mail respondents (57% versus 40%).

Table 2-1. Respondents' experience with red tide events in Florida

Alternative possible effects of a red tide on humans	Yes	No	N
I have noticed red tide conditions in the water	74.3%	25.7%	1,325
I have seen dead animals on shore during a red tide	73.9%	26.1%	1,326
I have experienced the odor of decaying fish at the beach	82.0%	18.0%	1,327
I have (or a member of my family has) experienced burning eyes, scratchy throat, or coughing that could have been from a red tide	69.1%	30.9%	1,336
I have changed plans to visit a beach because of a red tide	63.7%	36.3%	1,327
I have changed hotel reservations because of a red tide event	6.2%	93.8%	1,302
I have changed a restaurant reservation because of a red tide event	19.2%	80.8%	1,317

Table 2-2. True or false statements about red tide events in Florida

Statements about red tide	True	False	Don't Know	Correct Answer	N
Red tide conditions can vary greatly from one area to another (within a few miles) due to winds and currents	92.0%	1.0%	7.0%	True	1,347
Seafood bought in stores or restaurants is safe to eat during red tides	44.3%	16.4%	39.3%	True	1,342
Recreationally caught shrimp and crab are safe to eat during a red tide	12.8%	37.1%	50.1%	True	1,337
Recreationally caught finfish are unsafe to eat during a red tide	32.3%	14.8%	52.9%	False	1,342
Recreationally caught oysters are unsafe to eat during a red tide	43.1%	9.1%	47.8%	True	1,342
People with asthma are more likely to notice the effects of red tide	78.0%	1.3%	20.6%	True	1,343
"Red drift" is just another name for red tide	16.8%	6.1%	77.1%	False	1,334
Reddish-brown water indicates that humans will experience respiratory problems	17.7%	32.4%	49.9%	False	1,344
The algae that causes red tides is always present in the Gulf of Mexico	44.9%	7.8%	47.3%	True	1,345
Red tides are the same all over the world	9.1%	25.8%	65.1%	False	1,344

Table 2-3. Primary reason for whether respondent was concerned or not about red tides

Primary reason	Distribution of responses
For generally being not concerned:	
Red tides have not affected me	28.9%
Red tides are unpredictable so being concerned serves no purpose	9.8%
Scientists are working on the issue	5.9%
Red tides are a natural occurrence	44.6%
Other	10.8%
Total (N = 287)	100.0%
For being somewhat or very concerned:	
Red tides cause economic losses	9.8%
Red tides prevent fishing, beach-going, and other marine activities.	24.1%
Red tides affect human health	31.9%
Red tides indicate poor water quality	11.5%
Other	22.6%
Total (N = 858)	100.0%

Table 2-4. Level of agreement about scientific research on red tides in Florida

Statements about scientific research	N	Average Rating	% Rated as “5”
Scientific research on red tides in Florida has generated a lot of knowledge	1,346	3.36	9.1%
Scientific research on red tides in Florida has generated practical applications	1,343	3.00	2.3%
Results from the scientific research on Florida red tides is confusing	1,344	3.20	6.2%
Better monitoring and prediction systems are needed for red tides in Florida	1,345	3.86	26.7%
Learning about how Florida red tides affect marine animals is important	1,346	4.46	56.2%
Learning about how Florida red tides affect human health is important	1,346	4.54	64.6%
Learning about how people are affected by Florida red tides is important	1,345	4.47	58.9%
Learning about how we can control or prevent Florida red tides is important	1,344	4.41	59.6%
Determining the costs and benefits of different red tide strategies is important	1,345	4.29	48.6%

Notes: The rating scale is a five-point Likert format were 1 was defined as “strongly disagree”, 3 as “don’t know” and 5 as “strongly agree”.

Table 2-5. Familiarity of respondents with various agencies that supply red tide information in Florida

Agency or Organization	N	Not at all	Somewhat	Very
FWRI (Fish & Wildlife Research Institute)	1,344	65.4%	29.2%	5.4%
Universities	1,336	70.5%	25.8%	3.6%
Mote Marine Lab	1,342	63.4%	23.0%	13.5%
Sierra Club	1,337	89.6%	9.2%	1.2%
START (Solutions to Avoid Red Tide)	1,337	91.1%	7.0%	1.9%
Florida Red Tide Coalition	1,339	88.9%	9.9%	1.2%
Florida Red Tide Alliance	1,338	90.8%	8.2%	1.0%
Beach Conditions Reporting Systems	1,340	45.1%	39.7%	15.2%

Table 2-6. Frequency of obtaining information by alternative sources

Information delivery mechanism	N	Never	Sometimes	Often
Television	1,358	11.3%	55.7%	33.0%
Radio	1,347	43.7%	46.1%	10.2%
Local newspapers	1,353	18.0%	53.3%	28.7%
Internet websites	1,341	65.7%	27.4%	6.9%
Public forums, meetings or workshops	1,344	90.2%	9.0%	0.8%
Printed brochures or pamphlets	1,347	78.7%	20.3%	1.0%
Friends or family	1,347	33.1%	52.1%	14.8%

Table 2-7. Description of willingness-to-pay scenarios

Description of strategy	Payment vehicle	Bid levels (X)
Prevention:		
Establish a state-wide retail tax on fertilizer that would encourage a reduction in fertilizer use and raise funds to pay for continual monitoring of coastal water quality, and research to determine water quality improvements. If no measurable improvements were found within three years, the law would be automatically repealed.	Fertilizer tax	1% 5%, 10%
Mitigation:		
Establish a Beach Conditions Reporting Service Trust Fund to support the training of observers, initial equipment expenditures and maintenance of an electronic reporting system. It is anticipated that one-time donations to this fund would be sufficient to establish and support this program over the next three years. Only people who donate would able to access the system.	One-time trust fund donation	$5, $15, $25
Control:		
Establish a 3-year tax on the assessed value of all private property to fund red tide control programs, including pilot testing. If no measurable improvements were found within three years, the law would be automatically repealed.	Property tax	$5, $10, $15

Table 2-8. Percentage of willingness-to-pay responses, by price level

Price level	N	# Yes	%Yes	# No	% No
Prevention:					
High (10%)	457	251	54.9%	206	45.1%
Med (5%)	415	246	59.3%	169	40.7%
Low (1%)	454	298	65.6%	156	34.4%
Total	1,326	795		531	
Mitigation:					
High ($25)	452	115	25.4%	337	74.6%
Med ($15)	413	141	31.4%	272	65.9%
Low ($5)	455	219	48.1%	236	51.9%
Total	1,320	475		845	
Control:					
High ($15)	464	206	44.4%	258	55.6%
Med ($10)	418	181	43.3%	237	56.7%
Low ($5)	461	275	59.7%	186	40.3%
Total	1,343	662		681	

Table 2-9. Responses by region

Region	N	Distribution of responses	Response rate
Northeast region	607	41.7%	9.9%
Southwest region	707	48.9%	10.7%
Northwest region	140	9.6%	8.4%
Total	1,454	100.0%	

Table 2-10. Percentage of respondents that have experienced effects of a red tide event by survey

Potential experience with red tides	Internet (N=111-115)	Mail (N=1,302-1,336)
I have noticed red tide conditions in the water	86%	74%
I have seen dead animals on the shore during a red tide	88%	74%
I have experienced the odor of decaying fish on the beach	93%	82%
I have (or a member of my family has) experienced burning eyes, scratchy throat, or coughing that could have been from a red tide	85%	69%
I have changed plans to visit a beach because of a red tide event	74%	64%
I have changed a hotel reservation because of a red tide event	7%	6%
I have changed a restaurant reservation because of a red tide event	37%	19%

Table 2-11. Comparison of responses regarding red tide knowledge

		Internet (N = 112-115)		Mail (N = 1,337-1,347)	
	Correct Answer	Correct	Don't Know	Correct	Don't Know
Red tide conditions can vary greatly from one area to another (within a few miles) due to winds and currents	True	97%	3%	92%	7%
Seafood bought in stores or restaurants is safe to eat during red tides	True	54%	30%	44%	39%
Recreationally caught shrimp and crab are safe to eat during a red tide	True	18%	46%	13%	50%
Recreationally caught finfish are unsafe to eat during a red tide	False	26%	41%	15%	53%
Recreationally caught oysters are unsafe to eat during a red tide	True	45%	25%	43%	48%
People with asthma are more likely to notice the effects of red tide	True	86%	14%	78%	21%
"Red drift" is just another name for red tide	False	7%	77%	6%	77%
Reddish-brown water indicates that humans will experience respiratory problems	False	50%	38%	32%	50%
The algae that causes red tides is always present in the Gulf of Mexico	True	61%	36%	45%	46%
Red tides are the same all over the world	False	33%	55%	26%	65%

Table 2-12. Primary reason for whether respondent was concerned or not about red tides by survey

Primary reason	Internet (N=114)	Mail (N=1,145)
For generally being not concerned:		
Red tides have not affected me	4%	29%
Red tides are unpredictable so being concerned serves no purpose	9%	10%
Scientists are working on the issue	9%	6%
Red tides are a natural occurrence	73%	44%
Other	5%	11%
Total	100%	100%
For being somewhat or very concerned:		
Red tides cause economic losses	9%	10%
Red tides prevent fishing, beach-going, and other marine activities.	25%	24%
Red tides affect human health	40%	32%
Red tides indicate poor water quality	18%	11%
Other	8%	23%
Total	100%	100%

Note: 81% of internet respondents reported being “somewhat or very concerned” about red tide events in Florida compared with 76% from the mail survey.

Table 2-13. Comparing the percentage that “agree” with statements about scientific research on red tides in Florida between mail and internet respondents

Statements about scientific research	Internet (N=109 to 110)	Mail (N=1,343 to 1,436)
Scientific research on red tides in Florida has generated a lot of knowledge	47%	46%
Scientific research on red tides in Florida has generated practical applications	21%	20%
Results from the scientific research on Florida red tides is confusing	46%	33%
Better monitoring and prediction systems are needed for red tides in Florida	75%	69%
Learning about how Florida red tides affect marine animals is important	94%	94%
Learning about how Florida red tides affect human health is important	98%	94%
Learning about how people are affected by Florida red tides is important	96%	93%
Learning about how we can control or prevent Florida red tides is important	91%	88%
Determining the costs and benefits of different red tide strategies is important	89%	88%

Notes: The mail survey responses were obtained on a 5-point Likert scale where 4 was “agree” and 5 was “strongly agree”; these responses are combined to derive the percentages in this table.

Table 2-14. Comparison of the familiarity of respondents with various agencies that supply red tide information in Florida by survey

Agency or Organization	Internet (N = 107-110)	Mail (N = 1,342-1,344)
FWRI (Fish & Wildlife Research Institute)	37%	35%
Universities	42%	30%
Mote Marine Lab	47%	37%
Sierra Club	21%	10%
START (Solutions to Avoid Red Tide)	15%	9%
Florida Red Tide Coalition	16%	11%
Florida Red Tide Alliance	12%	9%
Beach Conditions Reporting Systems	56%	55%

Note: Familiarity is defined to include those that indicated they were “somewhat” or “very familiar” with the agencies as opposed to “not at all” familiar.

Table 2-15. Comparing the percentage of respondents that respondents obtain information by alternative source and survey

Information delivery mechanism	Internet (N = 106-109)	Mail (N = 1,341-1,358)
Television	92%	89%
Radio	64%	56%
Local newspapers	81%	82%
Internet websites	58%	34%
Public forums, meetings or workshops	18%	10%
Printed brochures or pamphlets	26%	21%
Friends or family	75%	67%

Note: Respondents were considered to obtain information if they sought it out either "sometimes" or "often".

Table 2-16. Comparison of willingness-to-pay scenarios by survey

Strategy	Payment vehicle	Internet (maximum WTP?)	Mail (WTP X? yes or no)
Prevention	Fertilizer tax	0%, 1%, 5%, 10%,or more than 10%	1%, 5%, or 10%
Mitigation	One-time trust fund donation (3 years access)	\$0, \$5, \$15, \$25, or more than \$25	\$5, \$15, or \$25
Control	3-year property tax	\$0, \$5, \$10, \$15, or more than \$15	\$5, \$10, or \$15

Notes: Zero values for the internet survey are equivalent to not being WTP in the first stage of questioning in the mail survey. The three levels identified are equivalent between surveys. For comparison the highest two categories in the internet survey can be consolidated.

Table 2-17. Comparison of WTP responses by bid level and survey

Strategy and bid level	Internet	Mail
Prevention:	(N=109)	(N=1,326)
Not willing to pay (WTP = 0%)	36%	40%
Willing to pay level 1 (WTP = 1%)	33%	22%
Willing to pay level 2 (WTP = 5%)	18%	19%
Willing to pay at least level 3 (WTP ≥ 10%)	13%	19%
Mitigation:	(N=103)	(N=1,320)
Not willing to pay (WTP = \$0)	46%	64%
Willing to pay level 1 (WTP = \$5)	18%	16%
Willing to pay level 2 (WTP = \$15)	17%	11%
Willing to pay at least level 3 (WTP ≥ \$25)	19%	9%
Control:	(N=108)	(N=1,343)
Not willing to pay (WTP = \$0)	44%	51%
Willing to pay level 1 (WTP = \$5)	19%	20%
Willing to pay level 2 (WTP = \$10)	19%	13%
Willing to pay at least level 3 (WTP ≥ \$15)	16%	16%

Table 2-18. Comparison of responses related to WTP questions by survey

Strategy and related question	Internet	Mail
Prevention:	(N=110)	(N=1,321)
Respondent uses fertilizers (%)	47%	55%
Mitigation:	(N=108)	(N=1,334)
Respondent is aware of the BCRS (%)	31%	26%
Respondent's annual days spent at beach	(N=109)	(N=1,087)
No beach use (0 days)	4%	11%
1-7 days per year	29%	24%
8-14 days per year	22%	13%
15-21 days per year	10%	13%
≥ 22 days per year	35%	39%
Control:	(N=110)	(N=1,334)
Respondent paid property taxes in Florida last year (%)	92%	87%
Respondents preference for type of control:	(N=106)	(N=1,297)
Biological	60%	56%
Chemical	18%	21%
Neither	22%	23%
Overall preference for red tide strategy:	(N=109)	(N=1,311)
Prevention	42%	43%
Mitigation	17%	17%
Control	19%	20%
None of them	21%	20%

Table 2-19. Comparison of respondent geographic characteristics and tenure in Florida by survey

Characteristic	Internet	Mail
Region:	(N=110)	(N=1,454)
East/North central region	25%	41%
Southwest region	68%	49%
Northwest region	6%	10%
Length of residency in Florida (years):	(N=109)	(N=1,445)
Less than one year	0%	1%
1-5 years	2%	10%
6-10 years	10%	17%
11-20 years	23%	22%
21-30 years	30%	19%
More than 30 years	35%	31%
Length of residency in Florida (months/year):	(N=109)	(N=1,439)
Less than one month	0%	<1%
1-3 months	1%	<1%
4-6 months	1%	2%
7-9 months	2%	2%
More than 9 months	96%	95%
Distance to coast (miles by car):		
0 miles (live on the water)	0%	<1%
1-5 miles	1%	<1%
6-10 miles	1%	2%
11-20 miles	2%	2%
More than 20 miles	96%	95%

Table 2-20. Comparison of age, education, income and race by survey

Characteristic	Internet	Mail
Average age of respondent (years; N=96, 1,426)	60 (10 s.d.)	60 (14 s.d.)
Highest level of education completed:	(N=110)	(N=1,431)
Some elementary or high school	1%	2%
High school graduate or GED	4%	9%
Technical/vocational	2%	6%
Some college	29%	26%
College graduate	32%	32%
Graduate/professional degree	33%	25%
Race or ethnicity (check all that apply):	(N=110)	(N=1,433)
White/Caucasian (% yes)	95%	92%
African American/Black (% yes)	0%	2%
Asian (% yes)	0%	0%
Native Hawaiian/Pacific Islander (% yes)	0%	0%
American Indian/Alaskan Native (% yes)	< 1%	2%
Hispanic/Latino (% yes)	2%	3%
Other (% yes)	2%	3%
Annual household income before taxes ($/year):	(N=98)	(N=1,322)
Less than $30,000	6%	17%
$30,000-$60,000	23%	32%
$60,001-$90,000	26%	25%
$90,001-$120,000	23%	14%
$120,001-$150,000	5%	6%
More than $150,000	16%	7%

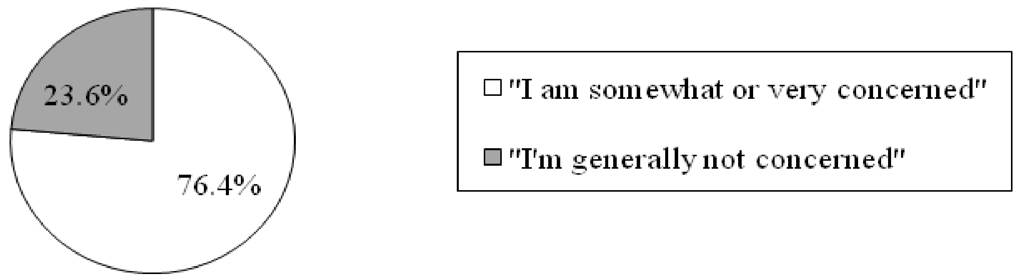

Figure 2-1. Concern over red tide events in Florida (N = 1,302)

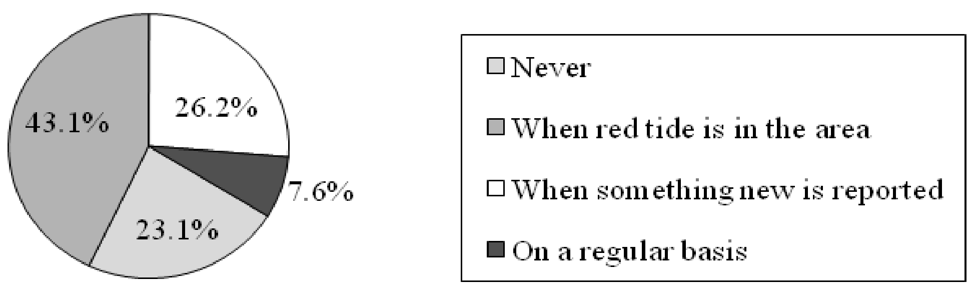

Figure 2-2. How frequently respondents seek information about red tides (N = 1,330)

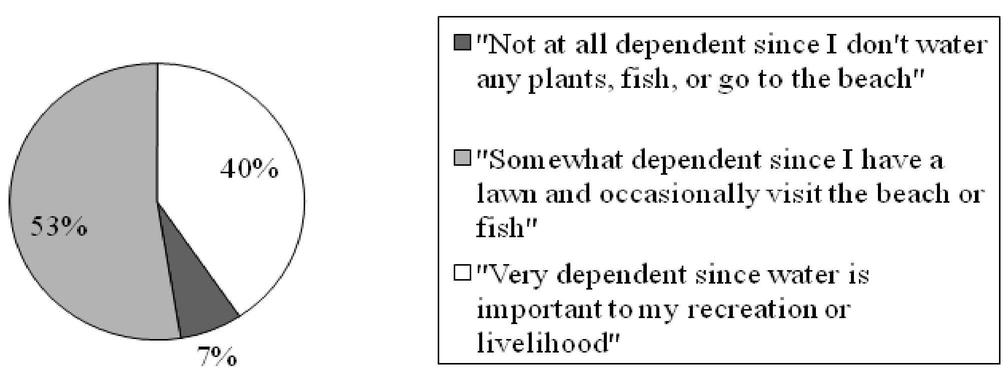

Figure 2-3. Dependence on coastal water quality (N = 1,338)

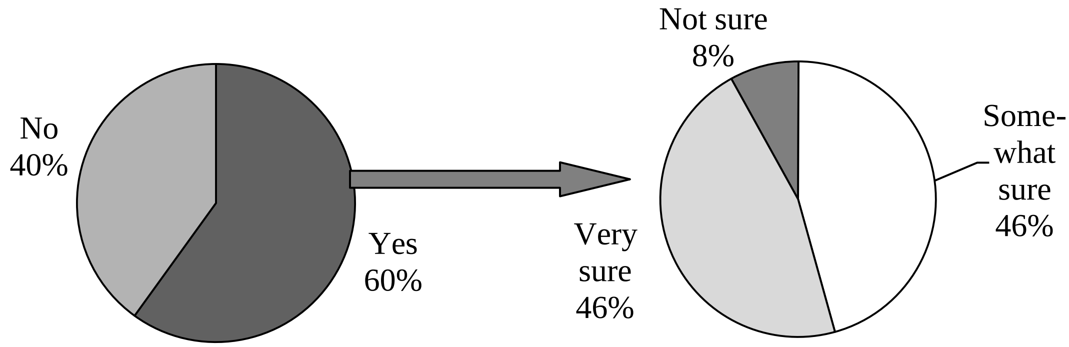

Figure 2-4. Share of respondents willing to pay a fertilizer tax (N = 1,326) and how sure they are of that decision (N = 789).

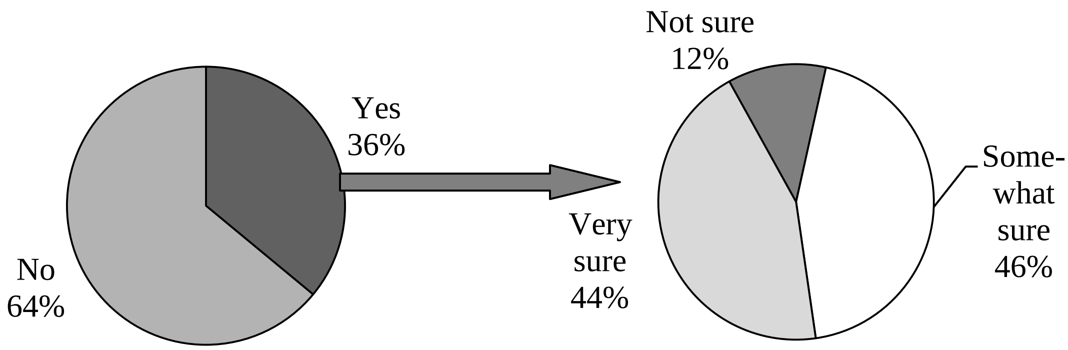

Figure 2-5. Share of respondents willing to donate to a trust fund (N = 1,320) and how sure they are of that decision (N = 474).

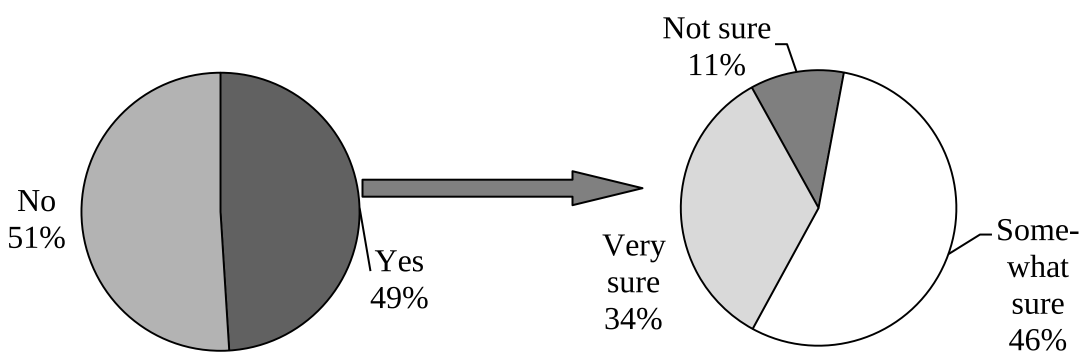

Figure 2-6. Share of respondents willing to vote for a property tax (N = 1,343) and how sure they are of that decision (N = 653).

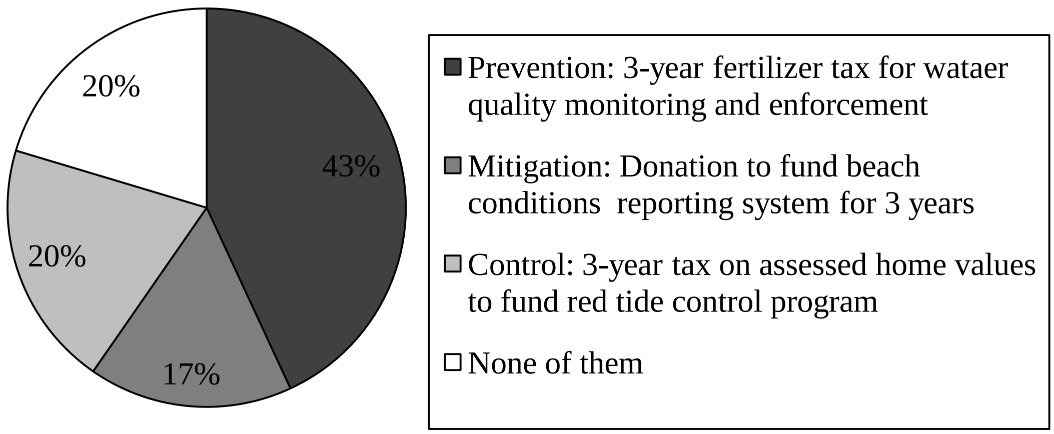

Figure 2-7. Respondents preferred strategy (N = 1,311)

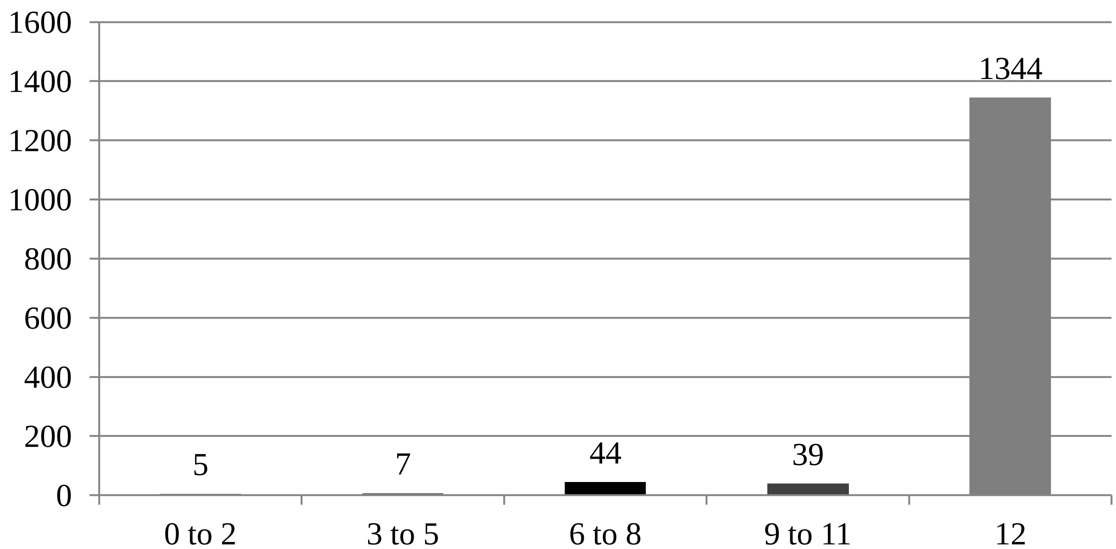

Figure 2-8. Frequency of Months Residing in Florida (N=1,439)

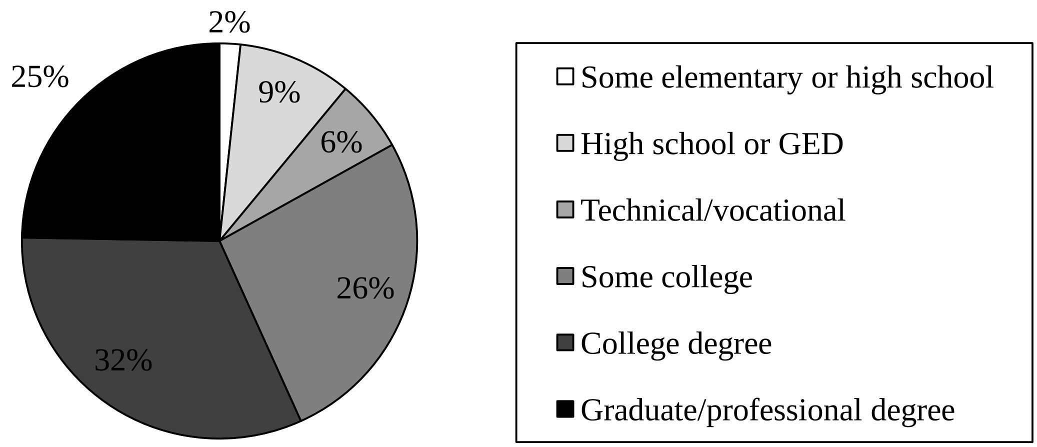

Figure 2-9. Distribution of highest level of formal education among respondents (N = 1,431)

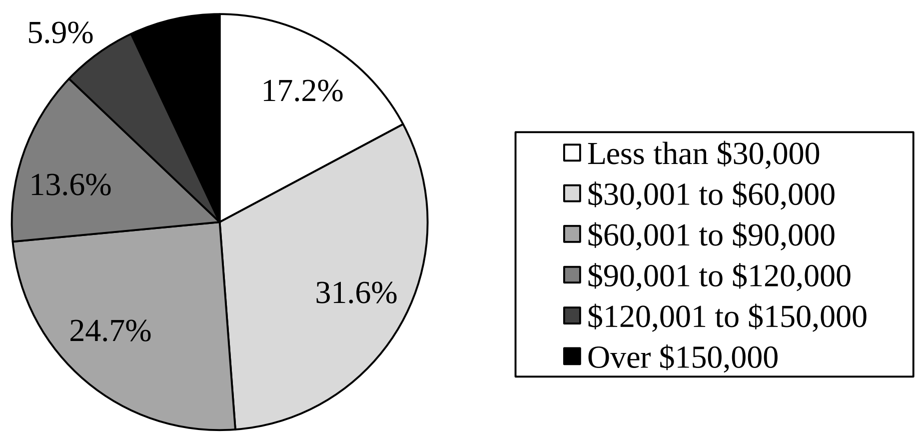

Figure 2-10. Distribution of household income of respondents (N = 1,322)

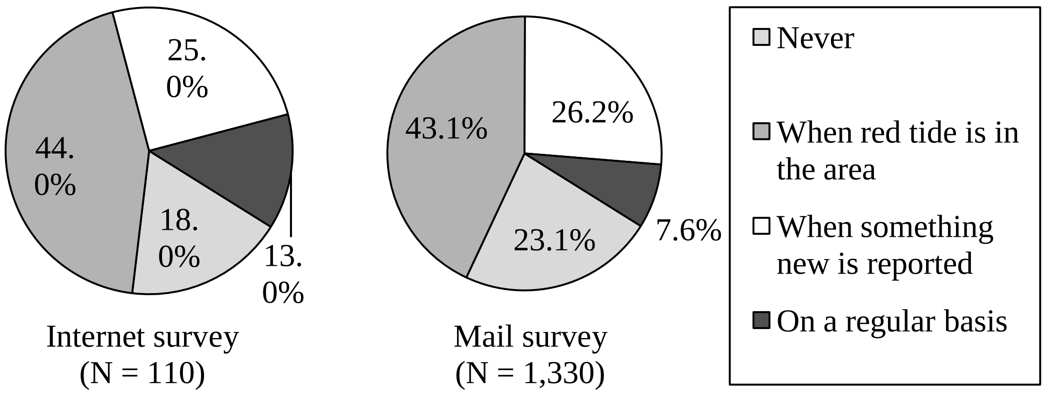

Figure 2-11. Comparison of frequency that respondents seek information about red tides by survey format

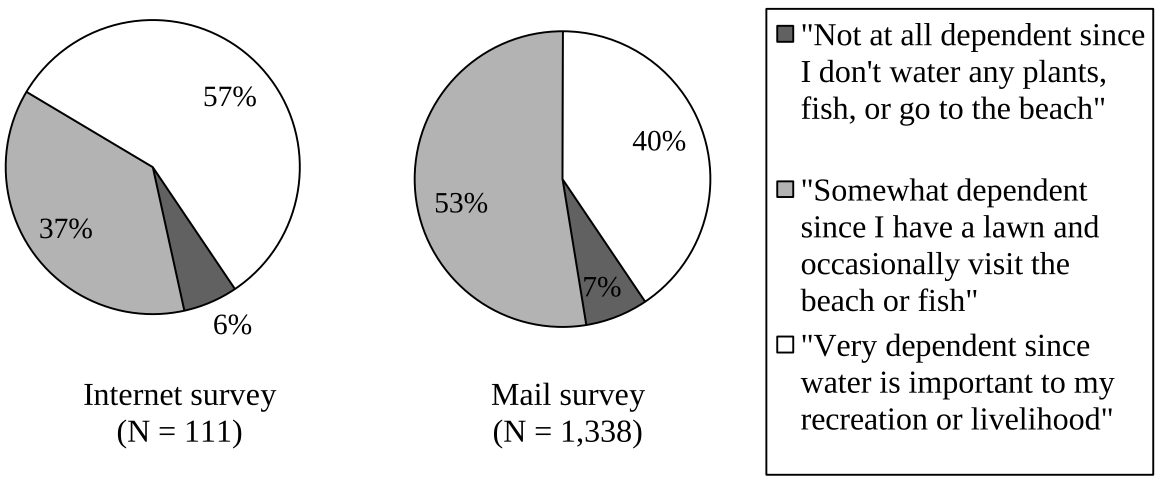

Figure 2-12. Comparison of dependence on coastal water quality by survey

CHAPTER 3
RESULTS OF EMPIRICAL MODELS

Overview

All models were estimated in LIMDEP 8.0 using maximum likelihood estimation (MLE). As discussed in Chapter 1, models were run for each management strategy (i.e. prevention, control and mitigation) separately. There were a total of four models run for each strategy. These included three binary logit models in which the definition of a "yes" response was altered based on the respondents' level of certainty of their response, as well as one ordered model that captured four levels: zero for those not willing to pay the price they were asked to evaluate through three to capture increasing levels of certainty of the "yes" responses (i.e., 1 for "not sure" yes responses, 2 for "somewhat sure" yes responses and 3 for "very sure" yes responses). This research analysis plan led to twelve models being estimated in total. A description of the dependent and independent variables used in these models (including definitions and statistics) can be found in Tables 3-1 and 3-2, respectively.

The next section will focus primarily on a comparison of the three binary models for each management strategy based on model statistics and the signs and statistical significance of the explanatory variables. The alternative estimates of willingness to pay (WTP) will also be discussed for each model. The third section will cover the results of the ordered models, including the marginal values and comparable WTP estimates. The fourth section will include a brief discussion and summary of the non-parametric estimates of WTP (i.e. the Turnbull approach). The final section of chapter 3 includes a summary and discussion of the empirical results.

Comparison of Binary Models

For each management strategy, three binary logit models were run in which the definition of a "yes" response was changed based on the respondents' level of certainty regarding their response. All three estimated models are shown in a single table for each strategy (Tables 3-3, 3-4 and 3-5) and the corresponding estimated marginal values are similarly shown in a tables for each strategy (Tables 3-6, 3-7, and 3-8). To review, the first model used the data in its raw format, where a yes response was considered a true "yes" regardless of whether the respondent indicated that they were "not sure", "somewhat sure" or "very sure" of the price (cost) proposed to them. Throughout this discussion this model will be referred to as Model 1. In the second model the "yes" responses remained "yes" if the respondent indicated that they were 'very sure" or "somewhat sure" and were re-coded as "no" if the respondent indicated that they were "not sure" or answered "no". This model will be referred to as Model 2. Finally, in the last binary model only the "very sure" yes responses remained "yes", while the "somewhat sure" and "not sure" yeses were re-coded as "no" responses. This model will be referred to as Model 3. The models for each management strategy are discussed separately below.

Binary Logit Models for the Prevention Strategy

The empirical results for the prevention binary logit models are shown in Table 3-3, including the coefficients and their corresponding p-values, as well as model performance results and WTP estimates. In addition, the marginal effects are summarized in Table 3-6, though they are not discussed here. There were 1,016 useable observations for estimating the prevention models once all missing observations were thrown out.

There are several different indicators of whether the estimated models are good in the sense that they adequately explain the responses; even though the goal of this study was not to create a model for prediction (i.e., maximize the explanatory power of each model), it is important to have a set of explanatory variables that are justified by economic theory and that do have explanatory power.

First, a likelihood ratio test is used to test the significance of each estimated model. This test compares the log-likelihood value for the "restricted" and "unrestricted" models. The restricted model assumes all model coefficients, except the intercept, equal zero. The unrestricted model is the model as specified with the explanatory variables that are hypothesized to have a correlation with the dependent variable (i.e., whether respondents indicated they were willing-to-pay to support the proposed program). LIMDEP automatically computes both log-likelihood values and the resulting likelihood ratio statistic, which is the absolute value of two times the difference in the log-likelihood values. If this statistic is greater than the 5% critical value of the Chi-square distribution with 18 degrees of freedom (i.e., the number of omitted variables in the constrained model), which is 28.87, then the null hypothesis of the restricted model is rejected in favor of the unrestricted model. As a result, we use the unrestricted model results reported in Table 3-3 for each model.

A second method of examining model fit in general is the proportion of the variance in the dependent variable that is explained by the variance in the independent variables using the R^2 statistic, but is no equivalent measure in logistic regression. However, there are several "pseudo" R^2 statistics that can be used. LIMDEP computes the McFadden R^2 statistic, which is calculated using the restricted and unrestricted log-likelihoods of the data. Because pseudo R^2 statistics are generally much lower than the traditional R^2, the McFadden R^2 for models 1, 2 and 3 (0.217, 0.196, and 0.142, respectively) are expected and are considered to explain an adequate amount of the variation in the dependent variables.

A third method for discussing model fit is the percent of responses that were correctly predicted by the estimated models. The percents correctly predicted among the three models varied only slightly from model to model (73.9% for Model 1, 72.2% for Model 2 and 72.5% for Model 3). Taking into consideration all of the different measures for model "success", it is clear that though the models' predictive power decreased slightly as the models became less inclusive (i.e. from Model 1 to Model 3), all three models were of adequate fit and superior to constant only specifications. In addition, the signs of the coefficients of the significant variables in all three models were consistent across all three models indicating a robust specification.

Seven of the total eighteen explanatory variables were significant determinants of WTP for Model 1 at the 10% level or lower (i.e., $p < 0.10$). Since the magnitude of the coefficients is not directly interpretable in logistic regression, the sign of the coefficients will be discussed. As one would expect, the variable for price level (P_Price) was significant and negative, indicating that an increase in price would decrease the probability of a WTP greater than zero. The only other significant variable that was negative was length of Florida residency (Q16). Level of concern for red tide (Q4), information seeking behavior (Q6A) and preference for the prevention strategy (Pref_P) all increased the probability of a WTP greater than zero. The dummy variables for region (DV_EST and DV_SW) were also significant and positive, indicating that being in either the southwest coast region or the northeast coast region increased the probability of WTP other than zero more-so than being in the base region (the northwest region).

For Model 2 seven out of the eighteen variables were statistically significant at the 10% level or lower. As with Model 1, the variable for price level was a significant determinant of WTP. Price level was negative for Model 2, also, indicating that an increase in this variable would decrease the probability of a WTP greater than zero. However, length of Florida residency was not a significant determinant of WTP for Model 2. Again, level of concern for red tide, information seeking behavior, preference for the prevention strategy and the dummy variables for region were all statistically significant and positive. In addition, dependence on coastal water quality and quantity was significant and positive for Model 2, indicating that an increase in this variable will increase the probability of a WTP greater than zero.

Model 3 had the most significant variables of the three models, nine in total. The significant variables also differed for this model as compared with the first two. As with Model 1 and Model 2, price was significant and negative, as well as the length of Florida residency. The level of concern for red tide, information seeking behavior and preference for the prevention were, again, all significant and positive; however, the regional dummy variables were not significant for Model 3, which means that region is not a factor in explaining those that were very sure of their willingness to pay for the proposed prevention strategy. Unlike the previous two models, age was a significant determinant for Model 3, having a negative impact on WTP. Older respondents were less likely to be very sure of their willingness to pay for the proposed prevention strategy. Also unlike the previous models, education level (Q21A) and ethnicity (Q22) were significant for Model 3. These variables were positive, indicating that a higher education level would increase the probability of being very sure of their WTP a 1% to 10% fertilizer tax, as would being of Caucasian ethnicity.

The average willingness to pay associated with each model was estimated using two methods: the "grand constant" (GC) method and the Delta method. The grand constant was calculated using all estimate parameters, regardless of their statistical significance (Dumas et al. 2007). WTP estimates for the prevention models are included in Table 3-4. For Model 1, the estimated WTP (i.e., average fertilizer tax that would be supported by residents of coastal counties) calculated using the GC method was 10.3% while the WTP calculated using the Delta method was higher, at 16.3%. For Model 2 the estimated WTPs were 5.2% and 11.2% for the GC method and Delta method, respectively. Finally, for Model 3 the GC method estimated WTP was -14.0% while the Delta method estimated WTP was -19.4%. Of the three WTPs calculated using the Delta method, however, none were statistically significant. Note that negative WTP estimates are not uncommon when logit models are estimated using linear variables so redefining the variables and using a probit distribution would likely solve this problem; however, given that we have several models and several methods of calculating WTP, and the negative estimates are only associated with the model attempting to explain those that were very sure of their response, these approaches are not investigated here.

Binary Logit Models for the Control Strategy

The empirical results for the binary logit models of the WTP for the proposed control strategy are shown in Table 3-4, and the corresponding marginal effects are summarized in Table 3-7. There were 975 observations used in the estimation of the control models. As with the prevention models, the likelihood ratio test for all three control models indicate that the unrestricted models (with all the explanatory variables) perform better than the restricted models. The McFadden R^2 for control models 1, 2 and 3 were 0.21, 0.22, and 0.14, respectively, indicating that the model explaining only the very sure responses does not explain as much of the variation in the dependent variables as the first two models. There was slightly more variation in the percents correctly predicted among the three models than for the prevention models (i.e., 70.6% for Model 1, 71.3% for Model 2 and 80.5% for Model 3), with the very sure model being able to best predict the responses. Taking into consideration all of the different measures for model “success”, again all three models were of adequate fit and superior to constant only specifications.

The control models had significantly more statistically significant variables than the prevention models. The signs of the coefficients of the all the significant variables in all three models were consistent. The explanatory variables that were significant determinants of WTP across all three models were the price level (C_Price), the strategy specific dummy variable for whether or not the preferred control strategy was “neither” (C5N), the dummy variable for the northeast region (DV_EST), whether or not control was the preferred strategy (Pref_C), the length of Florida residency (Q16), the level of concern for red tide issues (Q4), information seeking behavior (Q6A) and dependence on coastal water quality and quantity (Q9A). The variables that increased the probability of a WTP greater than zero across all models were the dummy variable for the northeast region, whether or not control was the preferred strategy, the level of concern for red tide issues, the frequency at which respondents look for red tide information and dependence on coastal water quality and quantity. Those that decreased the probability of a WTP greater than zero across all models were the price level, the dummy variable for whether or not the preferred control strategy was “neither” and the length of Florida residency. These variables were statistically significant determinants of WTP with the same signs no matter how inclusive the definition of a yes was.

There were several more explanatory variables that were the significant for both Models 1 and 2, but not for Model 3. These included the variable indicating whether control came first in the order of appearance of the strategy types (CFST), which is an indication of order bias, the dummy variable for the southwest coast region (DV_SW), education level (Q21A), income level (Q23A), and the variable for the true/false “score” that indicating their level of knowledge (Q3). The variables that increased the probability of a WTP greater than zero were the control first variable, the dummy variable for the southwest region and education level. Those that had the opposite effect were income level and the variable for the true/false “score”, meaning that they decreased the probability of a WTP a 3-year property tax surcharge of $5 to $15 per $100,000 of assessed value.

There was only one variable that was significant in Model 2 only. That variable was ethnicity (Q22), and it had the effect of increasing the probability of a WTP greater than zero. The only significant variable that was specific to Model 3 was the number of months a year residing in Florida (Q17). The estimated coefficient for this variable was negative, indicating that an increase in months decreased the probability of a WTP greater than zero. In total, there were fifteen out of twenty variables that were statistically significant in at least one of the models.

WTP estimates for the control models are reported in Table 3-5. For Model 1, the estimated WTP calculated using the GC method was $0.70 while the WTP calculated using the Delta method was much higher, at $10.17. For Model 2 the estimated WTPs were -$3.43 and $7.01 for the GC method and Delta method, respectively. Finally, for Model 3 the GC method estimated WTP was -$28.79 while the Delta method estimated WTP was -$16.99. Again, none of the WTPs calculated using the Delta method were found to be statistically significant.

Binary Logit Models for the Mitigation Strategy

The empirical results for the binary logit models for the proposed mitigation strategy are shown in Table 3-5, while the corresponding marginal effects are summarized in Table 3-8. The mitigation models were estimated using 836 observations. As with the prevention and control models, the likelihood ratio test statistic (i.e., the chi-squared value) for all three mitigation models indicate that they are preferable to the constant-only (restricted) model. The McFadden R^2 for mitigation models 1, 2 and 3 were nearly identical at 0.12, 0.12, and 0.13, respectively. They, too, are considered to explain an adequate amount of the variation in the dependent variables for these types of models. There was more variation in the percents correctly predicted among the three models than in the control models (69.9% for Model 1, 72.0% for Model 2 and 85.0% for Model 3), although the pattern was the same with Model 3 being a better predictor of the choices. Taking into consideration all of the different measures for model "success" all three models were of adequate fit and superior to constant only specifications, though slightly worse than the previous two models given the lower McFadden R^2 and higher variation within the percent correctly predicted.

Like the prevention models, the mitigation models had, in total, far fewer statistically significant variables than the control models. Again, the signs of the significant variables were consistent across models. The explanatory variables that were significant determinants of WTP across all three models were the price level (M_Price), the strategy specific variable for number of days spent at the beach (M5), whether or not mitigation was the preferred strategy (Pref_M) and the level of concern for red tide issues (Q4). The variables that increased the probability of a WTP greater than zero across all models were number of beach days, whether or not mitigation was the preferred strategy and the level of concern for red tide issues. The only significant variable that decreased the probability of a WTP greater than zero was the price level.

The strategy-specific variable indicating awareness of the Beach Conditions Reporting System for the Gulf Coast of Florida™ (BCRS) was a significant determinant of WTP for both Model 1 and Model 2. The estimated coefficient for this variable was positive for both models, indicating that awareness of the BCRS increased the probability of a WTP greater than zero. Also significant and positive for both Models 1 and 2 was the information seeking behavior variable (Q6A), indicating that as the frequency at which information on red tide is searched for increases, so does the probability of a WTP greater than zero. For Models 1 and 3, but not

Model 2, dependence on coastal water quality and quantity (Q9A) was statistically significant. This variable was positive for both models indicating that an increase in dependence on coastal water quality increases the probability of a WTP greater than zero. While the dummy variable for the northeast region was significant across all models, the dummy variable for the southwest region (DV_SW) was only significant for Models 2 and 3. Like the northeast variable, the estimated coefficients on this variable for both models were positive indicating that being in the southwest region increased the probability of a WTP greater than zero more-so than being in the base region (northwest). Finally, education level was a significant determinant in Model 2 only and had a positive effect on WTP. In total, nine out of twenty explanatory variables were significant determinants for at least one mitigation model.

WTP estimates for the mitigation models are also reported in Table 3-5. For Model 1, the estimated WTP calculated using the GC method was -$11.70 while the WTP calculated using the Delta method was higher and positive, at $2.98. For Model 2 the WTPs were -$28.02 and -$0.12 for the GC method and Delta method, respectively. Finally, for Model 3 the GC method estimated WTP was -$32.09 while the Delta method estimated WTP was -$16.37. For comparison, the values that respondents were asked to evaluate ranged from $5 to $25. As with the prevention and control models, none of the Delta method WTPs were statistically significant.

Summary of Binary Logit Models

While all models were determined to be of adequate fit and predictive power, the models for prevention and control were slightly better than those for mitigation. For prevention models, the predictive power of the models decreased as the level of inclusivity decreased (i.e. as the definition of a “yes” response became more stringent). For the control models there is no clear relationship between inclusivity and predictive power, as the both the R^2 and the percent correctly predicted increased from Model 1 to Model 2 but then decreased from Model 2 to

Model 3. The same can be said of the mitigation models, as the R^2 increased from Model 1 to Model 2 and decreased from Model 2 to Model 3 and the percent correctly predicted increased across models.

For all models (across all management strategies) price level (P_Price, C_Price and M_Price), strategy preference (Pref_P, Pref_C, and Pref_M) and level of concern regarding red tide issues (Q4) were significant and of the same sign (negative for price, positive for strategy preference and concern). These results are all intuitive. In addition, the frequency at which information on red tide is searched for (Q6A) was significant and positive across all models with the exception of mitigation Model 3. The signs of all the models (within the management strategies) were consistent and, though marginals were not discussed, the signs of the estimated coefficients and the marginals were consistent with each other as well.

Though the WTPs for the prevention models decreased as the definition of a yes variable became stricter (which would be expected), they were not adequately similar between the different calculation methods (i.e., the grand constant method and the Delta method). In addition, the WTPs calculated using the Delta method were not statistically significant so there is little confidence that the WTP estimates are indeed accurate. The same issue arises with the control models and the mitigation models. All in all, it is determined that while the binary logit models are accurate enough in determining how the independent variables affect the WTP they do not produce adequate estimates of WTP.

Ordered Models

In addition to the three binary models run for each strategy type an ordered model was also run for each strategy. For these models the different ordered levels zero through three were created based on the certainty levels of the "yes" responses (i.e., 0 for "no" responses, 1 for "not sure" yes responses, 2 for "somewhat sure" yes responses and 3 for "very sure" yes responses).

In a sense, the ordered models capture the certainty information that is implied by estimating the separate binary logit models.

Ordered Logit Model for Prevention Strategy

Parameter estimates for the ordered model of responses to the proposed prevention strategy (i.e., a fertilizer tax) are found in table 3-9. There were 1,004 observations used in the estimation of the ordered model. The likelihood ratio test as indicated by the chi-squared statistic for the model indicated that the model, as specified, is superior to the restricted (constant only) model. In addition, the McFadden R^2 was 0.12, indicating that an adequate amount of the variation in the dependent variables can be explained by the independent variables in the model.

All threshold parameters (µ1 and µ2) were statistically significant indicating that the response categories (i.e., 0 for no responses, 1 for "not sure" yes responses, 2 for "somewhat sure" yes responses and 3 for "very sure" yes responses) are indeed ordered. For the prevention ordered model, ten out of eighteen explanatory variables were significant determinants of WTP. Of the strategy-specific variables, the price-level (P_Price) and the strategy preference (Pref_P) were the only variables that had a significant effect on WTP. Other significant variables included the regional dummy variables (DV_EST and DV_SW), age, length of residency in Florida (Q16), income level (Q23A), level of concern (Q4), information seeking behavior (Q6A), and dependence on coastal water quality (Q9A). Estimated WTP was calculated using the Delta method and is also summarized in Table 3-9. The estimated WTP for the prevention ordered model was 16.9% (per bag of fertilizer purchased) and was statistically significant at the 1% level.

As the sign and magnitude of the estimated coefficients for an ordered response model are not directly interpretable it is more productive to discuss the direction and extent of the impact of each variable using the marginal effects. The marginal effects from the prevention ordered model are summarized in Table 3-10. These effects were computed at the means of the covariates. Since the ordered response model best explains the impacts of the explanatory variables at the extremes of the ordered levels, only the marginal effects of y=0 and y=3 will be discussed here (Genio et al. 2007).

For the prevention strategy, a higher price level reduced the probability of being very willing to pay by 1 percentage point. Conversely, a higher price-level increased the probability of being not willing to pay at all also by 1 percentage point. Residing in the northeast region and residing in the southwest region both increased the probability of being very willing to pay by 14 and 11 percentage points, respectively. Those variables decreased the probability of not being willing to pay at all by 16 and 13 percentage points, respectively. The probability of being very willing to pay was increased by 32 percentage points when prevention was the preferred strategy, while the probability of not being willing to pay at all was decreased by 36 percentage points when the preferred strategy was prevention. Individuals who were concerned with red tide issues in Florida were about 11 percentage points more likely to be very willing to pay and 16 percentage points less likely to be completely unwilling to pay. As the frequency with which individuals seek out information on red tide increases one category, the probability of being very willing to pay increases by 7 percentage points. Conversely, as the frequency with which individuals seek out information on red tide increases one category the probability of being not willing to pay at all decreases by 9 percentage points. In the same way, as an individual’s dependence on water quality increased by one category, they were 7 percentage points more likely to be very willing to pay. As an individual’s dependence on water quality increased by one category they were also 9 percentage points less likely to be completely unwilling to pay. As for demographic characteristics, as average age and the average length of residency in Florida increased each by one year the probability of being very willing to pay went down by 0.1 and 0.2 percentage points, respectively. As average age and the average length of residency in Florida increased each by one year the probability of being not willing to pay at all went up by 0.2 percentage points for both. Individuals of Caucasian ethnicity increased their probability of being very willing to pay by 7 percentage points. However, ethnicity did not significantly affect the probability of being not willing to pay at all. Finally, as income level increased by one category the probability of being very willing to pay decreased by 0.1 percentage points while the probability of being not willing to pay at all increased by 0.01 percentage points.

Ordered Logit Model for Control Strategy

Parameter estimates for the ordered model for the proposed control strategy (i.e., biological or chemical) are also found in Table 3-9. There were 975 observations used in the estimation of the ordered model. The likelihood ratio test for the model indicated that it is better than the constant-only model. In addition, the McFadden R^2 was 0.13, indicating that an adequate amount of the variation in the dependent variables can be explained by the independent variables in the model.

All threshold parameters (µ1 and µ2) were statistically significant indicating that the response categories (i.e., 0 for "no" responses, 1 for "not sure" yes responses, 2 for "somewhat sure" yes responses and 3 for "very sure" yes responses) are indeed ordered. More variables were significant for the control ordered model, fourteen out of twenty explanatory variables. Of the strategy-specific variables, the price-level (C_Price), the dummy variable for whether the favored control strategy was "neither" (C5N), whether control was first in the order presentation of strategies (CFST) and the strategy preference (Pref_C) were the variables that had a significant effect on WTP. Other significant variables included the region dummy variables (DV_EST and DV_SW), length of residency in Florida (Q16), months of the year residing in

Florida (Q17), ethnicity, income level (Q23A), number of true/false question answered correctly in the survey (Q3), level of concern (Q4), information seeking behavior (Q6A), and dependence on coastal water quality (Q9A). Estimated WTP was calculated using the Delta method and is also summarized in Table 3-9. The estimated WTP for the control ordered model was $10.11 and was statistically significant at the 1% level

Again, signs and magnitudes of the impacts on WTP of the significant individual explanatory variables will be discussed using the marginal effects of those variables. The marginal effects from the ordered logit model for the control strategy are summarized in Table 3-11. As with prevention, only the marginal effects on being not willing to pay at all (y=0) and on being very willing to pay (y=3) will be discussed.

For the ordered model for the control strategy, increasing price to the next highest level decreased the probability of being very willing to pay by 0.8 percentage points, while increasing the price to the next highest level increased the probability of being not willing to pay at all by 2 percentage points.

Individuals that indicated that they would prefer "neither" as their preferred method of control decreased their probability of being very willing to pay by 12 percentage points. Preferring "neither" for the different methods of control strategies had the highest positive effect on being not willing to pay at all, increasing the probability by 33 percentage points, as would be expected. When control was the preferred strategy the probability of being very willing to pay was increased by 19 percentage points. Conversely, when control was the preferred strategy, the probability of being not willing to pay at all decreased by 32 percentage points. The last strategy-specific variable that had a significant effect was whether control came first in the order of presentation of scenarios. When control was presented as the first strategy for the respondent to evaluate, the probability of being very willing to pay increased by 3 percentage points, while the probability of being not willing to pay at all increased by 8 percentage points (which indicates and controls for the degree of order bias).

Residing in the northeast region and residing in the southwest region both increased the probability of being very willing to pay, by 8 and 5 percentage points, respectively. Residing in those areas decreased the probability of being not willing to pay at all by 18 and 12 percentage points, respectively. The number of true/false questions answered correctly in the survey also had a significant effect. Increasing the number of questions answered correctly by one question actually decreased the probability of being very willing to pay by 0.6 percentage points, while increasing the number of questions answered correctly by one question increased the probability of being not willing to pay at all by 2 percentage points. Individuals who indicated that they were concerned with issues about red tide were 7 percentage points more likely to be very willing to pay. Being concerned with red tide issues also decreased the probability of being not willing to pay by 18 percentage points. As the frequency with which individuals seek out information on red tide increased by one category, the probability of being very willing to pay increased by 3 percentage points. Conversely, as the frequency with which individuals seek out information on red tide increases one category the probability of being not willing to pay at all decreases by 8 percentage points.

As an individual's dependence on water quality increased by one category, they were 6 percentage points more likely to be very willing to pay. As an individual's dependence on water quality increased by one category they were also 13 percentage points less likely to be completely unwilling to pay.

Of the demographic characteristics, as the average length of residency in Florida increased by one year the probability of being very willing to pay decreased by 0.1 percentage points while the probability of being not willing to pay at all increased by 0.3 percentage points. As education level increased by one category, the probability of being very willing to pay increased by 0.7 percentage points and the probability of being completely unwilling to pay was decreased by 2 percentage points. Finally, individuals of Caucasian ethnicity were 5 percentage points more likely to be very willing to pay. Those who were of Caucasian ethnicity were also 15 percentage points less likely to be not willing to pay at all.

Ordered Logit Model for Mitigation Strategy

Parameter estimates for the ordered model for the mitigation strategy (i.e., Beach Conditions Reporting Service) are also found in Table 3-9. There were 836 observations used in the estimation of this ordered model. The likelihood ratio test for the model indicated that it is superior to the restricted model. In addition, the McFadden R^2 was 0.09, and though it is lower than would be hoped for, it still indicates that at least some of the variation in the dependent variables is explained by the independent variables in the model.

All threshold parameters (μ1 and μ2) were statistically significant indicating that the response categories (i.e. 0 for "no" responses, 1 for "not sure" yes responses, 2 for "somewhat sure" yes responses and 3 for "very sure" yes responses) are indeed ordered. Only eight out of twenty explanatory variables were significant determinants of WTP for the mitigation strategy. Of the strategy-specific variables, the price-level (M_Price), awareness of the Beach Conditions Reporting System for the Gulf Coast of Florida™ (BCRS) (M1), number of days spent on the beach (M5) and the strategy preference (Pref_M) had a significant effect on WTP. Other significant variables included the southwest region dummy variable (DV_SW), education level (Q21A), level of concern (Q4) and information seeking behavior (Q6A). Estimated WTP was calculated using the Delta method and is also summarized in Table 3-9. The estimated WTP for the mitigation ordered model was $3.16 and was statistically significant at the 1% level. For comparison, respondents evaluated prices that ranged from $5 to $25 for a 3-year subscription to this proposed beach condition information system.

Again, signs and magnitudes of the impacts on WTP of the significant individual explanatory variables will be discussed using the marginal effects of those variables. The marginal effects from the ordered logit model for the proposed mitigation strategy are summarized in Table 3-12. As with prevention and control models, only the marginal effects on being not willing to pay at all (y=0) and on being very willing to pay (y=3) will be discussed.

As price level increased to the next highest level the probability of being very willing to pay was raised by 0.6 percentage points. However, as price level increased the probability of being not willing to pay at all was decreased by 1 percentage point. Individuals who were aware of the BCRS in the Gulf Coast area of Florida were 4 percentage points more likely to be very willing to pay. Those same individuals were also 8 percentage points less likely to be not willing to pay at all. As the average number of beach days among individuals increased by one day, the probability of being very willing to pay was increased by 0.1 percentage points. As the average number of beach days increased by one, the probability of being not willing to pay at all decreased by 0.1 percentage points. The last strategy-specific variable that was significant was the strategy preference. When mitigation was the preferred strategy the probability of being very willing to pay went up by 8 percentage points. Conversely, when mitigation was the preferred strategy the probability of being not willing to pay at all went down by 16 percentage points.

Only one region dummy variable had a significant effect, and that was the dummy variable for the southwest region. Residing the southwest region increased the probability of being very willing to pay by 5 percentage points, while it decreased the probability of not being willing to pay at all by 11 percent; this larger impact is expected since this service is already available free to the public in this region. Individuals that were concerned with issues regarding red tide were 9 percentage points more likely to be very willing to pay and were 22 percentage points less likely to be not willing to pay at all. As the frequency with which individuals seek out information on red tide increases one category, the probability of being very willing to pay increases by 4 percentage points. Conversely, as the frequency with which individuals seek out information on red tide increases one category the probability of being not willing to pay at all decreases by 8 percentage points.

Finally, the only demographic characteristic that was significant was education level. As education level increased by one category the probability of being very willing to pay increased by 8 percentage points and the probability of being not willing to pay at all decreased by 2 percentage points.

Summary of the Ordered Logit Models

All three ordered models were of significant fit and predictive power. The likelihood ratio test results (i.e., chi-squared values) indicate that the models perform better than constant only specifications. In addition, the parameter estimates for each model ($\mu 1$ and $\mu 2$) were statistically significant. This result indicates that there is indeed an ordered effect among the response categories zero through three. For each model the signs and statistically significant variables were consistent between the parameter estimates and the marginal effects. The control model had the most explanatory variables that were significant determinants of WTP. The willingness to pay for each model calculated using the Delta was statistically significant for all three models, meaning one can be confident that they are an accurate estimate of WTP. Due to the better model fit, the significant threshold parameters, the higher number of significant variables, and the significant estimated willingness the ordered models for prevention, control and mitigation are considered to be superior to the corresponding binary logit models, and is why the impacts of the significant variables are discussed in more detail for those models.

Non-Parametric Estimates of Willingness to Pay

In addition to using the "grand constant" and Delta approaches to estimate mean WTP, a non-parametric approach known as the Turnbull lower bound mean approach was also used. The Turnbull method constructs an interval estimate for the willingness-to-pay based on the fraction of "no" responses at each price level. A range of prices is constructed using the various price levels for each management strategy. The Turnbull WTP is calculated by multiplying the lower bound of each price interval by the fraction of the sample estimated to be in that interval and summing the results. This process results in a conservative estimate of WTP. The necessary components for the process, as well as the WTP estimates, are summarized in Table 3-14. The lower bound WTP for the prevention strategy was calculated to be 5.77%. The WTP calculated for the control strategy was $8.96, and the WTP for the mitigation strategy was calculated to be $8.36.

Summary of Empirical Results

The natural question resulting from the information above is which model, out of the four for each strategy, is superior. There are a number of determinants that can be used to judge the issue. One criterion that could be used is the set of statistics on model fit. For the binary models the model fit statistics gradually got worse as the models became less inclusive (i.e., from Model 1 to Model 3), with the exception of the models for the proposed control strategy. In addition, the model fit statistics were worse for the ordered models for each strategy, though only very slightly. However, despite this, the statistics indicate that each model is still better than a constant only specification of the models. Therefore this criterion alone is not enough to determine which model is best. Another criterion that could be applied to determine which model is superior is the number of significant explanatory variables that the model produces. For each strategy, the ordered models had the highest amount of statistically significant determinants. Finally, the estimated WTPs can be compared and used to determine the best model. The WTP estimates for the binary models receive a mixed review. The discrepancies between the WTPs using the grand constant method and those using the Delta method are too large for one to be entirely comfortable with. In addition, the WTPs for prevention Model 3, control Model 3 and mitigation models 2 and 3 are all negative. Finally, none of the WTPs using the Delta method from any of the models are statistically significant, meaning that very little confidence can be placed in those values. On the other hand, for all three ordered models, the estimated WTP using the Delta method were all positive and significant at the 1% level. Therefore, though the three binary models and the ordered models may be comparable in their ability to determine which characteristics of an individual are significant determinants of willingness to pay, the ultimate goal of this study is to produce an accurate and reasonable estimate of willingness to pay. Thus, with this objective in mind, it can be said that the ordered logit models for the proposed prevention, control and mitigation strategies are superior to their respective binary logit models.

Using the corresponding marginal values from the ordered models, it can be determined which explanatory variables were significant determinants of WTP. Though the models for each strategy type had a set of strategy specific explanatory variables, the rest of the independent variables were the same. For each model, price was significant and negative. Also significant for each model, but increasing the probability of support for the programs, were the level of concern about red tides, information seeking behavior about red tides, dependence on water quality and strategy preference variables. All of these results are intuitive. Obviously, as prices increase there will be less individuals who are willing to pay for a given management strategy. It can also be surmised that individuals who are concerned with red tide and those whose livelihoods depend on water quality would be more likely to be willing to pay than those who are not. In the same way, if an individual searches for red tide information more frequently it could be an indication that they are more concerned about the issues, making them more likely to be willing to pay. Finally, if the strategy in question is an individual's favorite strategy out of all three, it makes intuitive sense that they would be more likely to be willing to pay for that strategy. Although they are intuitive, the models are important in that they provide statistical evidence of support and (more importantly) they control for these known factors in the WTP estimates. Surprisingly, the strategy-specific variables that indicated whether a respondent would be more economically impacted by the proposed strategy, because they buy fertilizer (P1) or because they own taxable property in Florida (C1) were not statistically significant. It would make sense that using fertilizer or owning property would reduce the probability of being willing to pay, however, this apparently is not the case.

Table 3-1. Description of dependent variables for the WTP models

Variable	N	Mean	Std Dev	Min	Max
Prevention:					
PWTP (1 if yes “very sure”, “somewhat sure” or “not sure”, 0 if “no”)	1,326	0.60	0.49	0.00	1.00
PWTPA (1 if yes “very sure” or “somewhat sure”, 0 else)	1,326			0.00	1.00
PWTPB (1 if yes “very sure”, 0 else)	1,326			0.00	1.00
P_Ordered (0 if “no”, 1 if “not sure”, 2 if “somewhat sure”, 3 if “very sure”)	1,326			0.00	3.00
Control:					
CWTP (1 if yes “very sure”, “somewhat sure” or “not sure”, 0 if “no”)	1,343	0.49	0.50	0.00	1.00
CWTPA (1 if yes “very sure” or “somewhat sure”, 0 else)	1,343			0.00	1.00
CWTPB (1 if yes “very sure”, 0 else)	1,343			0.00	1.00
C_Ordered (0 if “no”, 1 if “not sure”, 2 if “somewhat sure”, 3 if “very sure”)	1,343			0.00	3.00
Mitigation:					
MWTP (1 if yes “very sure”, “somewhat sure” or “not sure”, 0 if “no”)	1,320	0.36	0.48	0.00	1.00
MWTPA (1 if yes “very sure” or “somewhat sure”, 0 else)	1,320			0.00	1.00
MWTPB (1 if yes “very sure”, 0 else)	1,320			0.00	1.00
M_Ordered (0 if “no”, 1 if “not sure”, 2 if “somewhat sure”, 3 if “very sure”)	1,320			0.00	3.00

Table 3-2. Description of independent variables for the WTP models

Variable	N	Mean	Std Dev	Min	Max
P_Price (1%, 5%, or 10% tax on all fertilizer sales)	1,454	5.33	3.73	1.00	10.00
C_Price ($5, $10, or $15 ad-valorem fee on all taxable property)	1,454	9.99	4.14	5.00	15.00
M_Price ($5, $15 or $25 donation to trust fund)	1,454	14.9	8.28	5.00	25.00
P1 (1 if uses fertilizer, 0 else)	1,321	0.55	0.49	0.00	1.00
M1 (1 if heard of BCRS, 0 else)	1,334	0.25	0.44	0.00	1.00
M5 (number of days spent at beach)	1,088	48.9	87.4	0.00	365.00
C1 (1 if pays property tax in FL, 0 else)	1,344	0.87	0.33	0.00	1.00
C5N (1 if “neither” was preferred control strategy, 0 else)	1,301	0.23	0.42	0.00	1.00
Pref_P (1 if prevention was preferred strategy, 0 else)	1,311	0.43	0.50	0.00	1.00
Pref_C (1 if control was preferred strategy, 0 else)	1,311	0.20	0.40	0.00	1.00
Pref_M (1 if mitigation was preferred strategy, 0 else)	1,311	0.17	0.37	0.00	1.00
PFST (1 if prevention was ordered first, 0 else)	1,454	0.35	0.48	0.00	1.00
CFST (1 if control was ordered first, 0 else)	1,454	0.33	0.47	0.00	1.00
MFST (1 if mitigation was ordered first, 0 else)	1,454	0.32	0.47	0.00	1.00
Q2 (level of experience with red tide, 1 through 7)	1,452	3.55	2.07	0.00	7.00
Q3 (number of true/false questions answered correctly, 1 through 10)	1,454	3.64	2.11	0.00	10.00
Q4 (1 if concerned with red tide issues, 0 else)	1,302	0.76	0.42	0.00	1.00
Q6A (1 if never, 2 if sometimes, 3 if frequently)	1,330	1.85	0.53	1.00	3.00
Q9A (1 if very dependent on coastal water quality, 0 else)	1,338	0.41	0.49	0.00	1.00
Q16 (number of years residing in FL)	1,445	24.15	16.87	0.00	82.00
Q17 (number of months per year residing in FL)	1,439	11.73	1.21	0.00	12.00
Q19 (miles of residence to coast)	1,428	8.67	10.91	0.00	200.00
AGE (age of respondent in years)	1,426	59.92	14.38	18.00	96.00
Q21A (education level)	1,430	4.52	1.28	1.00	6.00
Q22 (1 if Caucasian, 0 else)	1,433	0.94	0.24	0.00	1.00
Q23A (income level)	1,322	2.80	1.40	1.00	6.00
DV_EST (1 if from east coast region, 0 else)	1,454	0.42	0.49	0.00	1.00
DV_SW (1 if from southwest coast region, 0 else)	1,454	0.48	0.50	0.00	1.00

Table 3-3. Estimated binary logit models for the proposed prevention strategy

		Model 1		Model 2		Model 3	
Variable	Mean	β	Pr > z	β	Pr > z	β	Pr > z
Constant	1.00	-2.143	0.072	-3.297	0.005	-4.059	0.001
P_Price	5.36	-0.070	0.001	-0.074	0.000	-0.057	0.006
P1	0.56	0.052	0.747	0.108	0.483	0.181	0.255
PFST	0.36	-0.163	0.310	-0.192	0.213	0.128	0.418
DV_EST	0.39	1.078	0.000	1.024	0.000	0.215	0.444
DV_SW	0.51	0.844	0.001	0.720	0.005	0.314	0.257
AGE	59.92	-0.005	0.398	-0.008	0.162	-0.013	0.026
Pref_P	0.44	2.162	0.000	1.816	0.000	1.329	0.000
Q16	24.07	-0.010	0.042	-0.005	0.261	-0.009	0.079
Q17	11.77	-0.001	0.989	0.055	0.403	0.004	0.951
Q19	8.54	-0.004	0.557	-0.008	0.249	0.002	0.798
Q2	3.81	0.010	0.828	0.003	0.948	0.017	0.719
Q21A	15.4	0.031	0.453	0.038	0.332	0.068	0.098
Q22	0.95	0.377	0.294	0.369	0.292	0.719	0.083
Q23A	73.23	-0.002	0.214	-0.003	0.140	-0.003	0.163
Q3	4.01	0.012	0.771	0.016	0.693	-0.009	0.834
Q4	0.76	0.739	0.000	0.906	0.000	0.665	0.003
Q6A	1.87	0.354	0.032	0.505	0.002	0.489	0.005
Q9A	0.41	0.222	0.179	0.273	0.084	0.568	0.000
Model Statistics:							
N		1,016		1,016		1,016	
Log Likelihood		-525.97		-557.706		-525.007	
McFadden R^2		0.217		0.196		0.142	
Chi-Squared		291.33	0.000	272.010	0.000	174.201	0.000
Correct Pred. (%)		73.92		72.146		72.539	
WTP (Delta)		16.35%	0.992	11.15%	0.919	-14.02%	0.919
WTP (Grand Constant)		10.28%		5.17%		-19.38%	

Table 3-4. Estimated binary logit models for the proposed control strategy

Variable	Mean	Model 1 β	Model 1 Pr > z	Model 2 β	Model 2 Pr > z	Model 3 β	Model 3 Pr > z
Constant		-2.607	0.032	-2.343	0.055	-2.697	0.055
C_Price	10.000	-0.074	0.000	-0.082	0.000	-0.066	0.003
C1	0.876	-0.120	0.621	-0.163	0.506	-0.003	0.993
C5N	0.221	-1.405	0.000	-1.478	0.000	-1.320	0.000
CFST	0.308	0.418	0.010	0.412	0.011	0.120	0.535
DV_EST	0.381	0.729	0.006	0.711	0.009	0.578	0.100
DV_SW	0.509	0.565	0.030	0.490	0.066	0.317	0.360
AGE	58.136	0.008	0.185	0.003	0.633	-0.006	0.404
Pref_C	0.206	1.856	0.000	1.704	0.000	0.982	0.000
Q16	23.811	-0.013	0.008	-0.010	0.036	-0.009	0.129
Q17	11.760	-0.017	0.791	-0.032	0.640	-0.108	0.129
Q19	8.684	0.003	0.602	0.005	0.457	0.004	0.599
Q2	3.818	0.035	0.439	0.025	0.594	0.035	0.544
Q21A	15.393	0.068	0.089	0.064	0.119	0.060	0.219
Q22	0.952	0.528	0.155	0.816	0.040	0.563	0.280
Q23A	73.185	-0.004	0.056	-0.004	0.041	-0.002	0.306
Q3	4.028	-0.086	0.034	-0.060	0.149	-0.003	0.949
Q4	0.762	0.605	0.002	0.895	0.000	0.907	0.004
Q6A	1.863	0.199	0.036	0.297	0.075	0.298	0.146
Q9A	0.417	0.330	0.018	0.527	0.001	0.684	0.000
Model Statistics:							
N		975		975		975	
Log Likelihood		-534.064		-525.190		-391.625	
McFadden R^2		0.210		0.218		0.138	
Chi-Squared		283.483	0.000	292.374	0.000	125.267	0.000
Correct Pred. (%)		70.560		71.282		83.487	
WTP (Delta)		$10.17	0.901	$7.01	0.897	-$16.99	0.879
WTP (Grand Constant)		$0.70		-$3.43		-$28.79	

Table 3-5. Estimated binary logit models for the proposed mitigation strategy

		Model 1		Model 2		Model 3	
Variable	Mean	β	Pr > z	β	Pr > z	β	Pr > z
Constant		-2.257	0.077	-1.748	0.176	-2.051	0.190
M_Price	-0.912	-0.062	0.000	-0.062	0.000	-0.065	0.000
M1	0.077	0.309	0.092	0.433	0.020	0.368	0.122
M5	0.135	0.003	0.005	0.002	0.029	0.003	0.015
MFST	0.017	0.051	0.760	0.157	0.362	-0.102	0.653
DV_EST	0.005	0.014	0.960	0.421	0.160	0.466	0.256
DV_SW	0.130	0.260	0.350	0.573	0.054	0.651	0.111
AGE	0.227	0.004	0.523	0.001	0.934	0.002	0.835
Pref_M	0.125	0.737	0.000	0.582	0.006	0.740	0.004
Q16	-0.072	-0.003	0.551	-0.001	0.785	0.008	0.212
Q17	-0.641	-0.054	0.445	-0.113	0.130	-0.125	0.132
Q19	0.091	0.010	0.136	0.000	0.991	-0.018	0.149
Q2	0.204	0.054	0.276	0.065	0.214	-0.011	0.872
Q21A	0.907	0.059	0.156	0.084	0.052	0.051	0.351
Q22	-0.316	-0.330	0.401	-0.573	0.149	-0.629	0.216
Q23A	0.054	0.001	0.716	-0.001	0.714	-0.001	0.590
Q3	-0.067	-0.017	0.697	-0.038	0.401	-0.028	0.630
Q4	0.795	1.058	0.000	1.133	0.000	1.378	0.000
Q6A	0.402	0.185	0.073	0.307	0.104	0.150	0.532
Q9A	0.373	0.159	0.299	0.097	0.593	0.434	0.064
Model Statistics:							
N		836		836		836	
Log Likelihood		-476.351		-457.211		-303.529	
McFadden R^2		0.122		0.120		0.125	
Chi-Squared		132.770	0.000	125.213	0.000	86.859	0.000
Correct Pred. (%)		69.856		72.010		84.994	
WTP (Delta)		$2.98	0.915	-$0.12	0.989	-$16.37	0.863
WTP (Grand Constant)		-$11.70		-$28.20		-$32.09	

Table 3-6. Estimated marginal values for the binary logit models of the prevention strategy

		Model 1		Model 2		Model 3	
Variable	Mean	β	Pr > z	β	Pr > z	β	Pr > z
Constant	1.00	-0.471	0.073	-0.795	0.005	-0.762	0.001
P_Price	5.36	-0.015	0.001	-0.018	0.000	-0.011	0.006
P1	0.56	0.011	0.747	0.026	0.483	0.034	0.252
PFST	0.36	-0.036	0.313	-0.047	0.214	0.024	0.422
DV_EST	0.39	0.224	0.000	0.236	0.000	0.041	0.449
DV_SW	0.51	0.184	0.009	0.172	0.004	0.059	0.256
AGE	59.92	-0.001	0.398	-0.002	0.162	-0.002	0.025
Pref_P	0.44	0.431	0.000	0.405	0.000	0.256	0.000
Q16	24.07	-0.002	0.042	-0.001	0.261	-0.002	0.078
Q17	11.77	-0.000	0.989	0.013	0.403	0.001	0.951
Q19	8.54	-0.001	0.557	-0.002	0.249	0.000	0.798
Q2	3.81	0.002	0.828	0.001	0.948	0.003	0.719
Q21A	15.4	0.007	0.453	0.009	0.332	0.013	0.098
Q22	0.95	0.087	0.313	0.091	0.298	0.113	0.032
Q23A	73.23	-0.001	0.214	-0.001	0.140	-0.001	0.163
Q3	4.01	0.003	0.771	0.004	0.693	-0.002	0.834
Q4	0.76	0.171	0.000	0.221	0.000	0.114	0.001
Q6A	1.87	0.078	0.032	0.122	0.002	0.092	0.004
Q9A	0.41	0.048	0.175	0.065	0.081	0.109	0.001

Table 3-7. Estimated marginal values for the binary logit models of the control strategy

		Model 1		Model 2		Model 3	
Variable	Mean	β	Pr > z	β	Pr > z	β	Pr > z
Constant		-0.439	0.141	-0.574	0.054	-0.304	0.054
C_Price	10.000	-0.019	0.000	-0.020	0.000	-0.007	0.003
C1	0.876	-0.038	0.530	-0.040	0.509	0.000	0.993
C5N	0.221	-0.324	0.000	-0.319	0.000	-0.115	0.000
CFST	0.308	0.107	0.007	0.102	0.011	0.014	0.541
DV_EST	0.381	0.184	0.004	0.174	0.008	0.069	0.119
DV_SW	0.509	0.142	0.026	0.120	0.063	0.036	0.360
AGE	58.136	0.002	0.212	0.001	0.633	-0.001	0.402
Pref_C	0.206	0.405	0.000	0.398	0.000	0.136	0.000
Q16	23.811	-0.003	0.013	-0.003	0.036	-0.001	0.128
Q17	11.760	-0.006	0.722	-0.008	0.640	-0.012	0.128
Q19	8.684	0.001	0.637	0.001	0.457	0.000	0.599
Q2	3.818	0.010	0.393	0.006	0.594	0.004	0.544
Q21A	15.393	0.014	0.166	0.016	0.119	0.007	0.219
Q22	0.952	0.123	0.163	0.182	0.018	0.052	0.182
Q23A	73.185	-0.001	0.072	-0.001	0.041	0.000	0.305
Q3	4.028	-0.022	0.028	-0.015	0.149	0.000	0.949
Q4	0.762	0.160	0.001	0.207	0.000	0.086	0.000
Q6A	1.863	0.059	0.149	0.073	0.075	0.034	0.145
Q9A	0.417	0.109	0.006	0.129	0.001	0.081	0.001

Table 3-8. Estimated marginal values for the binary logit models of the control strategy

		Model 1		Model 2		Model 3	
Variable	Mean	β	Pr > z	β	Pr > z	β	Pr > z
Constant		-0.481	0.085	-0.353	0.260	-0.199	0.187
M_Price	-0.912	-0.013	0.000	-0.013	0.000	-0.006	0.000
M1	0.077	0.071	0.093	0.091	0.025	0.038	0.149
M5	0.135	0.001	0.002	0.000	0.029	0.000	0.016
MFST	0.017	0.008	0.821	0.032	0.368	-0.010	0.648
DV_EST	0.005	0.005	0.940	0.087	0.166	0.047	0.278
DV_SW	0.130	0.064	0.296	0.115	0.052	0.064	0.115
AGE	0.227	0.001	0.684	0.000	0.934	0.000	0.835
Pref_M	0.125	0.170	0.001	0.126	0.009	0.087	0.015
Q16	-0.072	-0.001	0.582	0.000	0.785	0.001	0.211
Q17	-0.641	-0.015	0.362	-0.023	0.130	-0.012	0.133
Q19	0.091	0.002	0.135	0.000	0.991	-0.002	0.145
Q2	0.204	0.012	0.292	0.013	0.213	-0.001	0.872
Q21A	0.907	0.015	0.102	0.017	0.052	0.005	0.351
Q22	-0.316	-0.073	0.438	-0.127	0.179	-0.076	0.306
Q23A	0.054	0.000	0.778	0.000	0.714	0.000	0.590
Q3	-0.067	-0.004	0.643	-0.008	0.401	-0.003	0.630
Q4	0.795	0.210	0.000	0.198	0.000	0.105	0.000
Q6A	0.402	0.083	0.039	0.062	0.103	0.015	0.532
Q9A	0.373	0.014	0.711	0.020	0.594	0.044	0.073

Table 3-9. Estimated ordered logit models for the prevent, control, and mitigation strategies

	Prevention		Control		Mitigation	
Variable	β	Pr > z	β	Pr > z	β	Pr > z
Constant	-2.092	0.031	-1.192	0.252	-1.995	0.095
P_Price	-0.062	0.000	---	---	---	---
P1	0.065	0.613	---	---	---	---
PFST	-0.065	0.617	---	---	---	---
Pref_P	1.688	0.000	---	---	---	---
C_Price	---	---	-0.072	0.000	---	---
C1	---	---	-0.126	0.548	---	---
C5N	---	---	-1.454	0.000	---	---
CFST	---	---	0.306	0.028	---	---
Pref_C	---	---	1.356	0.000	---	---
M_Price	---	---	---	---	-0.063	0.000
M1	---	---	---	---	0.334	0.052
M5	---	---	---	---	0.003	0.002
MFST	---	---	---	---	0.046	0.775
Pref_M	---	---	---	---	0.686	0.000
DV_EST	0.745	0.001	0.727	0.003	0.280	0.301
DV_SW	0.599	0.007	0.500	0.036	0.484	0.071
AGE	-0.008	0.109	0.000	0.968	0.002	0.738
Q16	-0.009	0.019	1.356	0.000	0.000	0.990
Q17	0.003	0.951	-0.011	0.015	-0.088	0.201
Q19	-0.003	0.556	-0.074	0.204	0.003	0.523
Q2	0.015	0.695	0.005	0.444	0.053	0.268
Q21A	0.042	0.196	0.024	0.560	0.075	0.060
Q22	0.454	0.127	0.064	0.071	-0.433	0.238
Q23A	-0.003	0.074	0.620	0.067	0.000	0.943
Q3	0.012	0.728	-0.004	0.035	-0.031	0.460
Q4	0.692	0.000	-0.058	0.103	1.117	0.000
Q6A	0.388	0.005	0.721	0.000	0.363	0.039
Q9A	0.385	0.004	0.312	0.030	0.153	0.362
Mu(1)	0.316	0.000	0.522	0.000	0.202	0.000

Mu(2)	1.812	0.000	0.264	0.000	1.321	0.000
Model Statistics:						
N	1,004		975		836	
Log Likelihood	-1,100.791		-1,127.715		-752.155	
McFadden R^2	0.123		0.134		0.087	
Chi-Squared	305.341	0.000	302.864	0.000	144.240	0.000
WTP (Delta)	19.40%	0.000	$10.11	0.000	$3.16	0.140
Std. Err. (Delta)	3.73%		$1.05		$2.14	

Table 3-10. Estimated marginal values for the ordered logit models of the prevention strategy

	Y=0		Y=1		Y=2		Y=3	
Variable	β	Pr > z	β	Pr > z	β	Pr > z	β	Pr > z
P_Price	0.014	0.000	0.001	0.001	-0.004	0.001	-0.011	0.000
P1	-0.015	0.613	-0.001	0.611	0.004	0.616	0.012	0.612
PFST	0.015	0.618	0.001	0.611	-0.004	0.625	-0.012	0.615
DV_EST	-0.162	0.001	-0.015	0.002	0.036	0.001	0.141	0.001
DV_SW	-0.134	0.007	-0.010	0.007	0.036	0.011	0.108	0.007
AGE	0.002	0.109	0.000	0.117	0.000	0.119	-0.001	0.111
Pref_P	-0.355	0.000	-0.028	0.000	0.067	0.000	0.316	0.000
Q16	0.002	0.019	0.000	0.024	-0.001	0.028	-0.002	0.019
Q17	-0.001	0.951	0.000	0.951	0.000	0.951	0.001	0.951
Q19	0.001	0.556	0.000	0.557	0.000	0.558	-0.001	0.556
Q2	-0.003	0.695	0.000	0.695	0.001	0.695	0.003	0.695
Q21A	-0.010	0.196	-0.001	0.202	0.003	0.204	0.008	0.197
Q22	-0.108	0.141	-0.005	0.001	0.039	0.221	0.073	0.084
Q23A	0.001	0.074	0.000	0.082	0.000	0.085	-0.001	0.075
Q3	-0.003	0.728	0.000	0.728	0.001	0.728	0.002	0.728
Q4	-0.162	0.000	-0.008	0.000	0.056	0.001	0.114	0.000
Q6A	-0.087	0.005	-0.007	0.008	0.024	0.009	0.071	0.005
Q9A	-0.086	0.003	-0.007	0.008	0.022	0.004	0.071	0.005

Table 3-11. Estimated marginal values for the binary logit models of the control strategy

	Y=0		Y=1		Y=2		Y=3	
Variable	β	Pr > z	β	Pr > z	β	Pr > z	β	Pr > z
C_Price	0.018	0.000	0.000	0.043	-0.010	0.000	-0.008	0.000
C1	0.032	0.547	0.000	0.389	-0.017	0.540	-0.014	0.562
C5N	0.334	0.000	-0.021	0.000	-0.196	0.000	-0.117	0.000
CFST	-0.076	0.027	0.001	0.166	0.041	0.024	0.034	0.036
DV_EST	-0.180	0.002	0.002	0.289	0.095	0.001	0.083	0.005
DV_SW	-0.124	0.034	0.003	0.121	0.068	0.033	0.053	0.037
AGE	0.000	0.968	-0.000	0.968	-0.000	0.968	-0.000	0.968
Pref_C	-0.317	0.000	-0.009	0.013	0.132	0.000	0.193	0.000
Q16	0.003	0.015	-0.000	0.099	-0.001	0.015	-0.001	0.015
Q17	0.018	0.204	0.000	0.269	-0.010	0.205	-0.008	0.205
Q19	-0.001	0.444	0.000	0.469	0.001	0.444	0.000	0.444
Q2	-0.006	0.560	0.000	0.572	0.003	0.560	0.003	0.560
Q21A	-0.016	0.071	0.000	0.159	0.009	0.072	0.007	0.072
Q22	-0.150	0.052	0.008	0.229	0.089	0.063	0.053	0.021
Q23A	0.001	0.035	-0.000	0.127	-0.001	0.036	0.000	0.036
Q3	0.015	0.103	0.000	0.190	-0.008	0.104	-0.006	0.104
Q4	-0.176	0.000	0.008	0.016	0.102	0.000	0.067	0.000
Q6A	-0.078	0.030	0.002	0.119	0.043	0.030	0.033	0.031
Q9A	-0.130	0.000	0.002	0.105	0.070	0.000	0.058	0.000

Table 3-12. Estimated marginal values for the binary logit models of the mitigation strategy

	Y=0		Y=1		Y=2		Y=3	
Variable	β	Pr > z	β	Pr > z	β	Pr > z	β	Pr > z
M_Price	0.014	0.000	-0.001	0.000	-0.006	0.000	-0.006	0.000
M1	-0.075	0.058	0.005	0.036	0.034	0.051	0.036	0.070
M5	-0.001	0.002	0.000	0.003	0.000	0.002	0.000	0.002
MFST	-0.010	0.775	0.001	0.774	0.005	0.775	0.005	0.776
DV_EST	-0.062	0.305	0.005	0.285	0.028	0.299	0.029	0.315
DV_SW	-0.106	0.069	0.008	0.065	0.049	0.067	0.049	0.074
AGE	0.000	0.738	0.000	0.738	0.000	0.738	0.000	0.738
Pref_M	-0.159	0.001	0.009	0.000	0.068	0.000	0.082	0.002
Q16	0.000	0.990	-0.000	0.990	-0.000	0.990	-0.000	0.990
Q17	0.019	0.201	-0.001	0.202	-0.009	0.201	-0.009	0.203
Q19	-0.001	0.522	0.000	0.524	0.000	0.523	0.000	0.522
Q2	-0.012	0.268	0.001	0.270	0.005	0.268	0.005	0.268
Q21A	-0.016	0.060	0.001	0.063	0.008	0.060	0.008	0.061
Q22	0.100	0.259	-0.006	0.118	-0.044	0.223	-0.051	0.305
Q23A	0.000	0.943	-0.000	0.943	-0.000	0.943	-0.000	0.943
Q3	0.007	0.460	-0.001	0.461	-0.003	0.460	-0.003	0.461
Q4	-0.216	0.000	0.020	0.000	0.104	0.000	0.092	0.000
Q6A	-0.079	0.039	0.006	0.042	0.037	0.040	0.036	0.040
Q9A	-0.034	0.364	0.003	0.356	0.016	0.362	0.016	0.368

Table 3-13. Summary of estimated marginal values for the extreme levels from the ordered logit models for each strategy

Variable	Prevention		Control		Mitigation	
	$\beta_{y=0}$	$\beta_{y=3}$	$\beta_{y=0}$	$\beta_{y=3}$	$\beta_{y=0}$	$\beta_{y=3}$
P_Price	0.014*	-0.012*	---	---	---	---
P1	-0.015	0.012	---	---	---	---
PFST	0.019	-0.015	---	---	---	---
Pref_P	-0.352*	0.314*	---	---	---	---
C_Price	---	---	0.018*	-0.008*	---	---
C1	---	---	0.032	-0.014	---	---
C5N	---	---	0.334*	-0.117*	---	---
CFST	---	---	-0.076*	0.034*	---	---
Pref_C	---	---	-0.317*	0.193*	---	---
M_Price	---	---	---	---	0.014*	-0.006*
M1	---	---	---	---	-0.075*	0.036*
M5	---	---	---	---	-0.001*	0.000*
MFST	---	---	---	---	-0.010	0.005
Pref_M	---	---	---	---	-0.159*	0.082*
DV_EST	-0.163*	0.142*	-0.180*	0.083*	-0.062	0.029
DV_SW	-0.138*	0.111*	-0.124*	0.053*	-0.106*	0.049*
AGE	0.002*	-0.001*	0.000	-0.000	0.000	0.000
Q16	0.002*	-0.002*	0.003*	-0.001*	0.000	-0.000
Q17	-0.002	0.002	0.018	-0.008	0.019	-0.009
Q19	0.001	-0.001	-0.001	0.000	-0.001	0.000
Q2	-0.003	0.003	-0.006	0.003	-0.012	0.005
Q21A	-0.010	0.008	-0.016*	0.007*	-0.016*	0.008*
Q22	-0.123*	0.082*	-0.150*	0.053*	0.100	-0.051
Q23A	0.001*	-0.001*	0.001*	0.000*	0.000	-0.000
Q3	-0.002	0.002	0.015	-0.006	0.007	-0.003
Q4	-0.162*	0.114*	-0.176*	0.067*	-0.216*	0.092*
Q6A	-0.095*	0.077*	-0.078*	0.033*	-0.079*	0.036*
Q9A	-0.084*	0.070*	-0.130*	0.058*	-0.034	0.016

*Significant at the 10% level

Table 3-14. Turnbull estimates using Model 1 data

Group j	Fee	Fee Range	“no” obs. (N_j)	Total obs. (T_j)	CDF=F_j (N_j/T_j)	PDF=P_j (F_j-F_{j-1})	E_{LB}(WTP)
Prevention:							
0	1%	0-1%	156	454	0.344	0.344	0.00%
1	5%	1-5%	169	415	0.407	0.063	0.06%
2	10%	5-10%	206	457	0.451	0.044	0.22%
3	>10%				1.000	0.549	5.49%
Total			531	1,326		1.000	5.77%
Std. Err.							0.15%
Control:							
0	$5.00	$0-5	186	461	0.403	0.403	$0.00
1	$10.00	$5-10	237	418	N/A	N/A	N/A
2	$15.00	$10-15	258	464	N/A	N/A	N/A
3	>$15.00				1.000	0.597	$8.96
Total			681	1,343		1.000	$8.96
							$0.11
Mitigation:							
0	$5.00	$0-5	236	455	0.519	0.519	$0.00
1	$15.00	$5-15	272	413	0.659	0.140	$0.70
2	$25.00	$15-25	337	452	0.746	0.087	$1.31
3	>$25.00				1.000	0.254	$6.35
Total			845	1,320		1.000	$8.36
							$0.33

*Note: The standard error is the square root of the variance

CHAPTER 4
CONCLUSION AND DISCUSSION

Harmful algal blooms (HABS) are natural events with ecological and economic consequences worldwide. In Florida, *Karenia brevis* is the algae species that has accounted for nearly all of blooms. This algae species is unique in that the toxins produced during the bloom are a neurotoxin that can kill fish and marine mammals, as well as become airborne and affect the respiratory system of humans. Red tides are potentially disastrous to a state like Florida that is heavily dependent on coastal tourism and commercial fishing. The three most common types of strategies for dealing with red tide are control, mitigation and prevention strategies. Research is continually being done on all three types of management practices; however it is possible that some strategies may face opposition from the public. This study attempts to determine public preference for the three different types of management practices by conducting a mail survey of Florida residents in coastal areas where red tide is a frequent nuisance. The main findings from the study are summarized below:

- Most respondents were at least somewhat aware of the issue of red tide in Florida. Many indicated they had at least experienced red tide conditions in the water at some point in their lives. A considerable number of respondents revealed they were largely unaware if fish, shellfish and oysters were safe to consume during a red tide event. A significant percentage of those indicated they were, indeed, concerned about the issue. The majority of those who were concerned indicated they were concerned mostly because red tides negatively affect human health and also prevent beach and water activities. Despite their concern, most respondents were unfamiliar with the existing sources of red tide information, such as START, FWRI, FRTA and FRTC. They were also fairly unfamiliar with the status of research on red tide (i.e., effectiveness and results produced to date). For the prevention strategy, 60 percent of respondents indicated they were willing to pay the proposed tax. Of those, 46 percent were very sure of their response. Forty-nine percent of respondents indicated they would be willing to pay for the proposed control strategy, and of those, 34 percent indicated they were very sure of their decision. In addition, when asked what their preferred method of control was, the majority indicated they preferred biological controls to chemical controls (or neither). For the mitigation strategy 36 percent indicated they would be willing to pay the proposed donation. Of those respondents, 44 percent were very sure of their answer.

- Three binary models were run for each type of strategy (prevention, control and mitigation). All models were found to be of adequate fit and predictive power. For the prevention strategies, the model fit and predictive power decreased as the models became less inclusive of a definition of a success (i.e., a yes answer). The same can be said for the mitigation models. For the control strategy, the models actually improved from Model 1 to Model 2 and then declined from Model 2 to Model 3. The statistically significant variables, and their signs, were consistent between models. The variables that were significant across strategy types included price, strategy preference, level of concern and information seeking behaviors.

- In addition to the binary logit models, one ordered logit model was run for each strategy type. The ordered models were found to be superior to the binary models. These, too, were all found to be of adequate fit and predictive power. For the prevention, control and mitigation models the threshold parameters were all statistically significant, indicating the models were indeed ordered. The price level, age, length of Florida residency and income level were found to have a negative impact on WTP for the prevention strategy, while being in the southwest or northeast regions, being concerned about red tide, seeking information on red tide frequently and being dependent on local water quality all increased the probability of being WTP. For the control strategy a high price level, a longer length of residency, and a higher level of knowledge about red tide all decreased the likelihood of being WTP, while residing in the northeast or southwest region, being of Caucasian descent, being concerned about red tide, seeking information on red tide frequently and being dependent on local water quality all increased the probability of being WTP. Finally, for the mitigation strategy only higher price level reduced the probability of being WTP at a significant level. However, residing in the southwest region, spending more days at the beach, being familiar with the BCRS, being concerned about red tide and seeking information on red tide frequently all increased the likelihood of being WTP.

- Using the Delta method from the ordered logit model, the prevention strategy was found to have an estimated WTP of 19.4 percent per sale of fertilizer. The Turnbull lower bound calculation yielded a lower bound WTP of 5.77 percent. For control, the estimated WTP using the Delta method from the ordered model was $10.11, while the Turnbull lower bound WTP was $8.96. Finally, the Delta method estimated WTP for the mitigation strategy was $3.16, while the Turnbull lower bound WTP was $8.36. All of the estimated WTP using the Delta method were statistically significant at the 1% level, indicating that the estimates are accurate.

- A total of 115 complete responses were received from 692,432 residents in the 12-county study region that were invited to complete the survey online by email from Expedite Media Group. The low response rate (0.02%) is not a surprise since Expedite is a marketing service; recipients receive multiple solicitations each day. For this campaign, 10.2% viewed the message and 1.4% of those began the survey. This response is comparable to other surveys conducted through Expedite.

- The mail survey and internet respondents were similar with respect to many factors, for example the average age was identical (60 years), distance from their residence to the coast

(95% are more than 20 miles), race (92%-95% Caucasian), and residency during the year (95% spend more than 9 months per year in Florida); however, there were notable differences. The internet respondents had generally lived in Florida longer, are more highly educated and have higher incomes. The internet sample reported more experience with all seven of the potential negative effects of red tide (by one to 19 percentage points). The internet sample had a higher percentage of correct answers to all 10 questions regarding red tide knowledge (by one to 18 percentage points). The internet respondents were more familiar with the red tide information provided by Universities, Mote Marine Lab, and Sierra Club (by at least 10 percentage points). The internet respondents are more likely to obtain red tide information by internet (58% to 34% for mail survey respondents). The internet respondents reported being more dependent on coastal water quality or quantity than mail survey respondents (57% versus 40%, respectively, reported being "very dependent since water is important to my recreation or livelihood). The internet respondents were less willing to support any of the three red tide strategies, from four to 18-percentage points less for the prevention and mitigation strategies, respectively.

These findings have several potentially significant implications. First, from the answers to question three in the survey it is apparent that there is a lack of knowledge among the public regarding the causes and effects of red tide, especially with regard to the safety of seafood consumption. Although this lack of knowledge did not significantly impact willingness to pay, it is still a cause for concern and additional education and outreach efforts should made throughout the state. The WTP findings indicate that the public is most willing to pay for prevention programs, followed by control programs, with mitigation programs being the management strategy that they are least likely to pay for. The strategy that had the most support overall was prevention. This is at first slightly surprising, since it was emphasized in the survey that this strategy carried the most amount of uncertainty with regards to its effectiveness for dealing with red tide. However, other studies have shown that people are more likely to be willing to pay when humans are part of the cause of the environmental problem in question (Bulte et al. 2005). Since it was indicated that the prevention strategy was more directly related to human causes than the control or mitigation strategies, the high level of support for the prevention strategy could be expected. In addition, it was indicated to the respondents that the prevention strategy would improve overall water quality. It may be that respondents' concern for overall water quality is driving the high level of support, which suggests that red tide issues be included in general water quality programs. These findings should be taken into account as new programs are devised and introduced to the public.

Though a significant amount of confidence can be placed in the results found by this study, a few caveats should be mentioned. First, the WTP estimates for the mitigation strategy may be to low due to "unintentional misrepresentation" bias (Polome et al. 2006). This occurs when the respondent does not understand the provided description of the public good they are being asked to value. For the mitigation strategy many respondents indicated their confusion over whether the proposed program would be offered in their region. This may have resulted in more "no" responses than would have been given had the respondents understood the description of the strategy, resulting in WTP estimates that are too low. In addition, the WTP results may be low due to respondents' uncertainty that the programs would actually be implemented and executed efficiently (Polome et al. 2006). Many respondents, for all three strategy types, indicated doubt that the hypothetical programs could or would be implemented in the manner indicated in the description. For this reason there may be more "no" responses for each strategy type than if there was complete confidence that the strategy in question could be implemented easily and efficiently. These "no" responses would not reflect the respondents' feelings about the actual management practice, and would lower the estimated WTP for each strategy.

There are several steps that should be addressed in the future. First, it is apparent from the survey responses and the estimated coefficients from the binary and ordered models that there may possibly be regional differences among respondents' willingness to pay. Therefore, new models should be estimated based on the three regions included in the study. Additionally, in the survey respondents who answered “no” to each scenario were allowed to provide an amount that they would be willing to pay at. In essence, the respondents who indicated that they would be willing to pay at a different price level could be considered “yes” responses, just at a different price level. Using this information, new models could be run in which those “no” responses are recoded as “yes” responses, using the price that each respondent indicated as the new price level. In addition, the study sample population should be compared to the total population of Florida using current census data, to ensure that the sample population is representative of the total population. Finally, the estimated WTPs from this study should be extrapolated to the relevant population to calculate the total WTP that can be compared to the total costs of the proposed programs. Total WTP can be extrapolated using the formula:

$$EV_j = \sum_{i=NW,NE,SW} \widehat{WTP}_i * H_i * V_i$$

where EV_j is the economic value of proposed strategy *j* across the *i* study regions (NW=northwest, NE=northeast, SW=southwest), which is calculated by multiplying the estimated household-level willingness to pay estimate for each region, number of households in each region (*H*), and the total cost per household (*V*). Note that *V* will be zero for the mitigation strategy, it will equal the average fertilizer expenditures for the prevention strategy (e.g., average pounds used times retail cost per pound), and the median assessed value of private residences divided by $100,000 for the control strategy.

APPENDIX A
MAIL SURVEY COVER LETTER AND QUESTIONNAIRE

UF | UNIVERSITY of FLORIDA

Food and Resource Economics Department
PO Box 110240
Gainesville, FL 32611-0240 U.S.A
Telephone: (352) 392-1845

January 2010

Dear Florida Resident:

We need your help in assessing awareness of Florida red tide events and issues related to this topic. In order to better understand these issues, we've developed a questionnaire that seeks your level of concern for, knowledge about, and experience with red tide events in Florida. We also ask about where you get information on red tides and your preferences for strategies to address future red tides. This information will help education and outreach efforts and provide valuable information to the state as it decides how best to spend its limited resources.

Your household was randomly selected to participate in this survey by the Florida Survey Research Center at the University of Florida. We do not have the mailing list and are not linking addresses with responses since we are only interested in the response of the sample as a whole. Thus, by responding to this survey you cannot not be solicited by any of the agencies or groups mentioned in the survey. The questionnaire should take about 10 minutes to complete.

Since this survey is being conducted through the University of Florida, it has been approved by the Institutional Review Board (IRB). According to this approval we need to tell you that there are no direct benefits or risks to you for answering the questions. Participation is voluntary and you will not be compensated. Your identity will remain anonymous. You cannot be penalized for choosing not to answer certain questions. If you have any questions, please contact me directly at 1-352-846-2874. For questions about your rights as a research participant, please contact the IRB at 1-352-392-0433 (protocol# 2009-U-1087).

Thank you in advance for your time in helping us to better understand how Florida residents feel about red tide events in Florida.

Best regards,

Michael J. Scicchitano

Please answer today and mail using the self-addressed, postage paid envelope, ***even if you are unaware of "red tides"***

Michael J. Scicchitano, Ph.D.
Director, FSRC
mscicc@ufl.edu

Awareness, Experience, Knowledge, and Concern

1. **Are you aware of the coastal condition known as "red tide"?**

	Yes, I am aware of "red tides"		No, I am not aware of "red tides"

If "no", please go to Question 16 (last page).

2. **What has been your experience with red tide events in Florida?** Circle one for each.

I have noticed red tide conditions in the water	Yes	No
I have seen dead animals on the shore during a red tide	Yes	No
I have experienced the odor of decaying fish on the beach	Yes	No
I have (or a member of my family has) experienced burning eyes, scratchy throat, or coughing that could have been from a red tide	Yes	No
I have changed plans to visit a beach because of a red tide event	Yes	No
I have changed hotel reservations because of a red tide event	Yes	No
I have changed a restaurant reservation because of a red tide event	Yes	No

3. **Do you believe each statement is True (T) or False (F) with respect to red tides in Florida?** If you are unsure, please circle don't know (DK):

Red tide conditions can vary greatly from one area to another (within a few miles) due to winds and currents	T	F	DK
Seafood bought in stores or restaurants is safe to eat during red tides	T	F	DK
Recreationally caught shrimp and crab are safe to eat during a red tide	T	F	DK
Recreationally caught finfish are unsafe to eat during a red tide	T	F	DK
Recreationally caught oysters are unsafe to eat during a red tide	T	F	DK
People with asthma are more likely to notice the effects of red tide	T	F	DK
"Red drift" is just another name for a red tide	T	F	DK
Reddish-brown water indicates that humans will experience respiratory problems	T	F	DK
The algae that causes red tides is always present in the Gulf of Mexico	T	F	DK
Red tides are the same all over the world	T	F	DK

4. How concerned are you, if at all, about Florida red tide events?

	I'm generally not concerned

OR

	I'm somewhat or very concerned

4A. What is the <u>one</u> reason you are generally *not concerned* about red tide events in Florida?

	Red tides have not affected me
	Red tides are unpredictable so being concerned serves no purpose
	Scientists are working on the issue
	Red tides are a natural occurrence
	Other:

4B. What is the <u>one</u> reason you are at least somewhat concerned about red tide events in Florida?

	Red tides cause economic losses
	Red tides prevent fishing, beach going, and other marine activities
	Red tides affect human health
	Red tides indicate poor water quality
	Other:

Information

5. Do you agree or disagree with each of the following statements concerning scientific research on red tides in Florida? Please use the following 5-point rating scale:

1 = strongly disagree 2 = disagree 3 = don't know 4 = agree 5 = strongly agree

	Rating
Scientific research on red tides in Florida has generated a lot of knowledge	
Scientific research on red tides in Florida has generated practical applications	
Results from the scientific research on Florida red tides is confusing	
Better monitoring and prediction systems are needed for red tides in Florida	
Learning about how Florida red tides affect marine animals is important	
Learning about how Florida red tides affect human health is important	
Learning about how people are affected by Florida red tides is important	
Learning about how we can control or prevent Florida red tides is important	
Determining the costs and benefits of different red tide strategies is important	

6. **Which of the following statements best describes how frequently you seek information about Florida red tides?** Please check one.

	I never look for information about red tide events in Florida
	I only look for information when a red tide event affects near shore waters
	I only look for information when something new is reported about Florida red tides
	I look for information about Florida red tides on a regular basis to see what is new

7. **How familiar are you with red tide information available from each of the following agencies and organizations in Florida?**

Please circle one number for each.	**Not at all**	**Somewhat**	**Very**
FWRI (Fish & Wildlife Research Institute)	1	2	3
Universities	1	2	3
Mote Marine Lab	1	2	3
Sierra Club	1	2	3
START (Solutions to Avoid Red Tide)	1	2	3
Florida Red Tide Coalition	1	2	3
Florida Red Tide Alliance	1	2	3
Beach Conditions Reporting System	1	2	3

8. **How frequently do you get Florida red tide information from each source?**

Please circle one number for each.	**Never**	**Sometimes**	**Often**
Television	1	2	3
Radio	1	2	3
Local newspapers	1	2	3
Internet websites	1	2	3
Public forums, meetings, or workshops	1	2	3
Printed brochures or pamphlets	1	2	3
Friends or family	1	2	3

9. **How dependent are you on coastal water quality and quantity?** Check one.

	Not at all dependent since I don't water any plants, fish, or go to the beach
	Somewhat dependent since I have a lawn and occasionally visit the beach or fish
	Very dependent since water is important to my recreation or livelihood

Red Tide Strategies

We will describe three different types of red tide programs: **prevention**, **mitigation**, and **control**. We'd like for you to evaluate each independently. After the last program is described, we will ask you which you would prefer the most (if any).

PREVENTION:

Background: We know that plants - including algae - need nutrients to grow and that when excess nutrients drain from the land to the sea, these waters can become "enriched." Nutrients from land can be naturally occurring or can come from the human use of fertilizers for lawns and crops. We know that sometimes this enrichment can provide fuel for naturally occurring algae and lead to a bloom. Some blooms can be harmless and provide food for tiny animals. Others are called "harmful algal blooms" because they have toxins and can make animals sick or even kill them. Some harmful algal blooms, including Florida red tide, can be harmful to people. Reducing the amount of nutrients washing into the sea from land - whether Florida red tides are involved or not - would help improve some aspects of water quality.

Potential Prevention Strategy: Establish a state-wide retail tax on fertilizer that would encourage a reduction in fertilizer use and raise funds to pay for continual monitoring of coastal water quality, and research to determine water quality improvements. *If no measurable improvements were found within three years, the law would be automatically repealed.*

10. This program relies on funds raised from those that buy fertilizer. Would this program cost you more because you use plant fertilizers in Florida?

☐	Yes, I use fertilizers	☐	No, I don't use fertilizer

10.A. Would you vote for a 10% tax on all fertilizer sales to support this type of long-run prevention program?

☐	Yes, I would vote for it	☐	No, I would not vote for it

OR

10.B. How sure are you of this decision?

☐	Not sure
☐	Somewhat sure
☐	Very sure *If "Very sure", what is the most that you would vote for?* _____%

10.C. Is there any % you would vote for?

☐	Yes, I would vote for _______%
☐	No *If "No", why not?*

MITIGATION:

Background: Many factors determine when and where someone might visit a particular beach or coastal area in Florida, including unpredictable weather and environmental conditions. In the case of red tides, these conditions can vary within the hour and between nearby beaches. Providing accurate and timely information on a variety of coastal conditions would help the public decide when and where to visit. This service would maximize the enjoyment of the trip to the public and help stabilize tourism expenditures across the state. It would also mitigate, or minimize, the negative impacts of Florida's red tide on human health and coastal economies. Since this system includes a variety of beach related information, the benefits of this short-run mitigation strategy will accrue regardless of red tide conditions.

Potential Mitigation Strategy: Establish a Beach Conditions Reporting Service Trust Fund to support the training of observers, initial equipment expenditures and maintenance of an electronic reporting system. *It is anticipated that one-time donations to this fund would be sufficient to establish and support this program over the next three years. Only people who donate would able to access the system.*

11. Are you aware of the Beach Conditions Reporting System for the Gulf Coast of Florida™?

	Yes, I know of this system		No, I've never heard of it

11A. Would you pay a one-time donation of $25 into this trust fund for access to information provided by this service for the next three years?

	Yes, I would donate		No, I would not donate

OR

11B. How sure are you of this decision?

	Not sure
	Somewhat sure
	Very sure *If "Very sure", what is the most that you would pay? $ _____*

11C. Is there any amount you would pay?

	Yes, I would pay $ _______
	No *If "No", why not?*

12. Approximately how many days do you spend at the beach each year? _____ days

CONTROL:

Background: We know that red tides are caused by rapid growth in one species of algae. This growth can be stopped using biological or chemical controls. A biological control would involve releasing a predator species. A chemical control would involve spreading a natural material on the bloom to inactivate the toxin or remove it from surface waters. Both types of strategies have been used to successfully treat blooms throughout the world, but not in conditions identical to Florida; thus, pilot testing would be required to determine any ecological impacts. In summary, this scenario seeks to shorten a single bloom's occurrence within a specific area and is similar in nature to mosquito control efforts. Benefits include protecting beachside and marine recreation and coastal tourism.

Potential Control Strategy: Establish a 3-year tax on the assessed value of all private property to fund red tide control programs, including pilot testing. *If no measurable improvements were found within three years, the law would be automatically repealed.*

13. Did you pay property taxes in Florida last year?

☐	Yes, I paid this tax	☐	No, I didn't pay this tax

13A. Would you vote for a 3-year ad-valorem fee of $10 per $100,000 of the *assessed* value of all taxable property in your county to fund a local Red Tide Control program?

☐	Yes, I would vote for it	☐	No, I would not vote for it

OR

13B. How sure are you of this decision?

☐	Not sure
☐	Somewhat sure
☐	Very sure
	If "Very sure", what is the most that you would vote for? _____%

13C. Is there any % you would vote for?

☐	Yes, I would vote for _______%
☐	No
	If "No", why not?

14. In general, which type of control most appeals to you? Please select one:

☐	Biological	☐	Chemical	☐	Neither

15. **Of the three types of red tide programs you just evaluated, which would you prefer if the State of Florida only had funds for one?** Please check one.

	Prevention: 3-year fertilizer tax for water quality monitoring and enforcement
	Control: 3-year tax on assessed home values to fund red tide control programs
	Mitigation: Donation to fund beach conditions reporting program for 3 years
	None of them

Demographics

16. How long have you resided in Florida? (If less than 1 year, please enter "0") _____ years

17. How many months of the year do you reside in Florida? _____ months

18. What is the ZIP code of your residence in Florida? _ _ _ _ _

19. How many miles by car do you live from the coast? _____ miles

20. In what year were you born? 1 9 _ _

21. What is the highest level of education that you have completed?

	Some elementary or high school		Some college
	High school graduate/GED		College graduate
	Technical/Vocational		Graduate/Professional degree

22. Which of the following describe your race or ethnicity? Please mark all that apply.

	White/Caucasian		Native Hawaiian/Pacific Islander
	African American/Black		American Indian/Alaskan Native
	Asian		Hispanic/Latino
	Other		

23. Which category includes your household's annual income before taxes?

	Less than $30,000		$90,001 to $120,000
	$30,000 to $60,000		$120,001 to $150,000
	$60,001 to $90,000		More than $150,000

Thank you. Please mail in the postage-paid envelope <u>today</u>!

APPENDIX B

REVISED STATED PREFERENCE QUESTIONS FOR ONLINE QUESTIONNAIRE

Red Tide Strategies

We will describe three different types of red tide programs: **prevention**, **mitigation**, and **control**. We'd like for you to evaluate each independently. After the last program is described, we will ask you which you would prefer the most (if any).

Please select one of the three terms that includes the month you were born. You will be randomly choosing the order you will evaluate these three programs, which could affect your evaluation.

	January - April
	May - August
	September - December

PREVENTION:

Background: We know that plants - including algae - need nutrients to grow and that when excess nutrients drain from the land to the sea, these waters can become "enriched." Nutrients from land can be naturally occurring or can come from the human use of fertilizers for lawns and crops. We know that sometimes this enrichment can provide fuel for naturally occurring algae and lead to a bloom. Some blooms can be harmless and provide food for tiny animals. Others are called "harmful algal blooms" because they have toxins and can make animals sick or even kill them. Some harmful algal blooms, including Florida red tide, can be harmful to people. Reducing the amount of nutrients washing into the sea from land - whether Florida red tides are involved or not - would help improve some aspects of water quality.

Potential Prevention Strategy: Establish a state-wide retail tax on fertilizer that would encourage a reduction in fertilizer use and raise funds to pay for continual monitoring of coastal water quality, and research to determine water quality improvements. *If no measurable improvements were found within three years, the law would be automatically repealed.*

12. This program relies on funds raised from those that buy fertilizer. Would this program cost you more because you use plant fertilizers in Florida?

	Yes, I use fertilizers		No, I don't use fertilizer

10.A. What is the highest fertilizer sales tax that you would vote for to support this type of long-run prevention program?

0% I do not support this	1%	5%	10%	More than 10%

Please select the value that <u>best</u> represents the most you would be willing to vote for even.

<u>MITIGATION:</u>

Background: Many factors determine when and where someone might visit a particular beach or coastal area in Florida, including unpredictable weather and environmental conditions. In the case of red tides, these conditions can vary within the hour and between nearby beaches. Providing accurate and timely information on a variety of coastal conditions would help the public decide when and where to visit. This service would maximize the enjoyment of the trip to the public and help stabilize tourism expenditures across the state. It would also mitigate, or minimize, the negative impacts of Florida's red tide on human health and coastal economies. Since this system includes a variety of beach related information, the benefits of this short-run mitigation strategy will accrue regardless of red tide conditions.

Potential Mitigation Strategy: Establish a Beach Conditions Reporting Service Trust Fund to support the training of observers, initial equipment expenditures and maintenance of an electronic reporting system. *It is anticipated that one-time donations to this fund would be sufficient to establish and support this program over the next three years. Only people who donate would able to access the system.*

24. Are you aware of the Beach Conditions Reporting System for the Gulf Coast of Florida™?

	Yes, I know of this system		No, I've never heard of it

11A. What is the highest one-time donation that you would be willing to make to this trust fund for access to information provided by this service for the next three years?

$0 I do not support this	$5	$15	$25	More than $25

11.B. Approximately how many days do you spend at the beach each year? Please count partial days as full days.

Pull down [none, 1-7, 8-14, 15-21, more than 21].

CONTROL:

Background: We know that red tides are caused by rapid growth in one species of algae. This growth can be stopped using biological or chemical controls. A biological control would involve releasing a predator species. A chemical control would involve spreading a natural material on the bloom to inactivate the toxin or remove it from surface waters. Both types of strategies have been used to successfully treat blooms throughout the world, but not in conditions identical to Florida; thus, pilot testing would be required to determine any ecological impacts. In summary, this scenario seeks to shorten a single bloom's occurrence within a specific area and is similar in nature to mosquito control efforts. Benefits include protecting beachside and marine recreation and coastal tourism.

Potential Control Strategy: Establish a 3-year tax on the assessed value of all private property to fund red tide control programs, including pilot testing. *If no measurable improvements were found within three years, the law would be automatically repealed.*

25. Did you pay property taxes in Florida last year?

	Yes, I paid this tax		No, I didn't pay this tax

12.A. If a 3-year ad-valorem fee were on the next ballot, what is the highest fee that you vote for? The fee would apply to each $100,000 of the *assessed* value of all taxable property in your county and it would be used to fund a local Red Tide Control program in your region only.

$0 I do not support this	$5	$10	$15	More than $15

12.B. In general, which type of control most appeals to you?

	Biological		Chemical		Neither

26. Of the three types of red tide programs you just evaluated, which would you prefer if the State of Florida only had funds for one?

	Prevention: 3-year fertilizer tax for water quality monitoring and enforcement
	Control: 3-year tax on assessed home values to fund red tide control programs
	Mitigation: Donation to fund beach conditions reporting program for 3 years
	None of them

APPENDIX C
OPEN-ENDED COMMENTS FROM ONLINE RESPONDENTS (N = 47)

- Our state, which is already too dependent on tourism, cannot afford any ecological disasters be it red tide or oil drilling off shore.

- I am a recreational fisherman and sea turtle patroller and very concerned about the effects of red tide on my community.

- I am concerned that few people know much about red tide, even in our area where it severely impacts our economy and quality of life.

- Like the building code, establish types of fertilizer that can be sold in counties on the water. NO NEW TAX.

- Go back to areas of critical concern and let everyone keep their storm water runoff on their own property.

- None of the funding approaches that are mentioned are levied upon the tourists who frequently visit our area and occupy the resorts located on the beach. It is this group that tends to take advantage of our beaches.

- Add a 1 to 2% visitors or sales tax since they, and the hotels, rely very heavily on the water and beaches health and welfare.

- I don't know if fertilizer control is in the category of chemical or biological. I answered that I would prefer biological, if there should be some organism that prevents the algae from making the toxin. However, I also support fertilizer control. I am not so sure about the clay proposals, seems as if it might be a worse problem than the red tide.

- Regarding the proposed "pay to get warnings" system, for it to help me it would need to be very current. I go to the beach in the morning, before 10 am in warm weather. And conditions can change from day to day. I have looked up some info on the internet in the past and found that it applied to different beaches than I go to or was out-dated.

- Keep up the good job.

- Too much emphasis on taxes and donations (which would come mostly from people living near the water). Our universities should be funded (grants sponsored by commercial and volunteer sources) to study and perform some of the suggested approaches named above.

- I don't know much about what causes red tide, but I do know that when Lake Ochocobee (not spelled right) is not opened and let to drain into the river Ft Myers beach and all the waters going to Ft Myers beach are much cleaner.

- I DON'T BELIEVE THAT RED TIDES WILL BE REDUCED UNTIL THE FERTILIZER COMING DOWN THE MISSISSIPPI IS REDUCED. THIS I BELIEVE IS THE PRIME SOURCE FOR RED TIDE IN THE GULF.

- Red tide is nothing new to Florida waters, just better reported. it has been reported in the old logs of sailing ships.

- I would consider contributing time.

- I think prevention is key and that people need to be educated about what causes this problem and that golf courses add to the problem with the amount of water they consume and the fertilizer used. However, I also feel that as a home owner on the river I need to also curb my water and fertilizer use just as much.

- No new taxes! Forget controlling or eliminating red tide. It is natural, and there will be unintended consequences.

- Red tides have been around long before man or fertilizers. When I was a small kid growing up on the island we had awful red tides. There was almost no population then. The fish always come back. The red tide always subsides. The tourists always come back. Government needs to stay out of it. We don't need more taxes or meddling with nature!

- I learned that you want my money to do your study of red tides and you should get your money from a private grant.

- I don't want to pay any more taxes for anything.

- Human health consequences should be investigated thoroughly.

- I believe that immune compromised people are at extremely high risk for complications and even death during red tide episodes. I know of 2 cases of death in the 2005-06 red tide episode that were immune compromised individuals that lived on the coast.

- Let heaven and nature sing.

- Stop letting companies dump their waste chemicals into Tampa Bay.

- I feel we fertilize too much, but towns and states are responsible. They fertilize freely with no thought of the harm they are doing.

- First we need to develop an earth friendly fertilizer. Second, a place in Ocala has developed a fire ant sterilizer that does not disturb the eco-system. I believe that if we eradicated the use of over the counter fire ant control, this would be of benefit in helping with red tide.

- Stop opening the locks at Lake Okechobee.

- Red tide is a matter that needs to be paid close attention. In general I am confident additional alternate solutions will be found. Meanwhile, people need to be made aware of its importance and impact.

- I appreciate your efforts to develop knowledge.

- Most people are probably most concerned about the things which most affect them. For me red tide is an afterthought. Life is so hectic red tide issues aren't much more than a blip on my radar of life. Not to say the research is unimportant because there is a lot of important information being researched every day that I am unaware of which greatly affects my life.

- I have wondered about the effect of mining debris, e.g. francolite, on the severity of red tide. I wrote a letter to the *Herald Tribune* that they never published. Does phosphate detritus play a role in red tide?

- One unbiased organization should consolidate the research, information and issues for public support communications. The most extensive and easily accessible literature appears to be coming from non-objective purveyors.

- God created red tide as a part of the system, it is a natural way of controlling other things and fish.

- As far as I know restricting fertilizer in the summer is a huge mistake and prevents nothing other than unhealthy plants and lawns, so leave it alone!

- Don't mess with it; it will only cause other problems that may be a greater burden than a little inconvenience like going to the beach.

- Be careful thinking taxing will do the job... those of us who still work for a living can't continue to pay taxes for the rest who aren't.

- While it seems most probable that fertilizer runoff is a major contributor - the practices employed by the Army Corps and SFWMD may have greater impact on our coastal waters. I am of the opinion that mismanagement of C-43 has done tremendous damage.

- Just a thank you to whomever is working diligently to control the problems associated with red tide, including the offering of the survey for completion/education.

- It’s fair to tax us if we can eliminate the red tide; if this a political tactic, we'll fall right into the other worthless surveys made the last twelve months.

- A HEALTH AND ECOOMIC PROBLEM.

- Because of my asthma I cannot leave my house or open the windows during a red tide or red drift algae bloom. It is very important to our family to have a solution to this problem. It is definitely a drawback to the tourists to have to walk around dead and rotting fish on the beach.

- I think you missed the most important cause of red tide on the west coast. Water releases out of Lake OKEECHOBEE.

- When red tide is in the area we cannot go outside and enjoy our beach because of difficulty breathing. We have neighbors who have moved and tourists who have not returned because of the frequency of it in the past few years. The dead fish on the beach that are not cared for by the county make the beach experience unacceptable for those who come to enjoy Florida as well as we who live here. Something has to be done to solve this problem. The million dollar condos that the developers have forced on us are going to remain empty if a solution is not found shortly.

- Due to the increase in red tide blooms since 2004 we need to take a more active role in control of the *k. brevis* algae. Through satellite monitoring I believe we can notify the public of potential outbreaks in red tide using the Sea WiFS sensor aboard the orbitbiew 2 satellite. My suggestion is to initiate another red tide conference with the University of Florida, Rosenstiel School at the University of Miami and Mote Marine Laboratory to be located in the Lee County Area shortly and to initiate potential solutions to the Red Tide problem. Chuck Weisinger: weisguy@weisbuy.com

- Just want scientific data, not may be from all the do-gooders.

- Red tide blooms were reported by ship's logs in the 18 hundreds. This is not something new; it is just better observed and reported today!

- I think that much of our tax money is wasted on foolish things. Think Charlotte County and the wasted money on Murdock. I do not support new taxes... start using the $$$ we are paying now to pay for programs like stopping red tide.

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BIOGRAPHICAL SKETCH

Kristen Lucas was born in Hollywood, Florida. She obtained her undergraduate degree in economics with a minor in business administration in 2007 at the University of Florida. After taking courses in environmental economics, she decided that she would like to focus her education on environmental and natural resource economics. She continued into her graduate education at the University of Florida in the Food and Resource Economics Department where she subsequently obtained her Master of Science.