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Strategies to Address Red Tide Events in Florida: Results of a 2010 Survey of Coastal Residents[1]

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Introduction

In Florida, a "red tide" generally refers to a bloom of *Karenia brevis*, which is a marine algae species commonly found in the Gulf of Mexico. An algal bloom occurs when there is a rapid increase in the population of an algae species. When an algal bloom causes ecological or economic damage, it is then termed a harmful algal bloom (HAB) event. HABs occur worldwide, with a suite of consequences due to the differences in algal species. Different nations and regions have adapted to HABs in a variety of ways, including distinct strategies designed to prevent, control, and/or mitigate the negative effects of HAB events. In Florida, *Karenia brevis* has accounted for nearly all HABs. These HABs are called red tides because they can turn the water a reddish-brown color. This algae species is also unique in that the toxins produced during a red tide are a neurotoxin that can kill fish and marine mammals, and become airborne and affect the respiratory system of humans. The fact that red tides can affect humans is potentially disastrous to a state like Florida that is heavily dependent on seafood, marine-based recreation, and coastal tourism. Since the 1960s, red tides have occurred nearly every summer along the Gulf Coast and caused millions of dollars in damage and lost revenue (Morgan, Larkin, and Adams 2010; Adams et al. 2008, Morgan, Larkin, and Adams 2008; Larkin and Adams 2008; Backer 2009). While a variety of strategies for addressing HABs have been implemented around the world, some strategies are likely to face local opposition if they would increase costs to residents or would cause harm to other aspects of the marine environment.

This study sought to gather information on the public's concern for, experience with, and knowledge of red tides. In addition, this study sought to determine public preferences for three alternative red tide mitigation, control, and prevention strategies. Mitigation strategies are those that aim to reduce the negative impacts of a red tide once it has been detected. Control strategies aim to shorten the duration of a red tide once it has been detected. Prevention strategies aim to take action to reduce the probability that a red tide will occur in the future. In this study, the following three types of new programs were proposed as prevention 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 biological or chemical control programs.

To collect the information required for this study, a survey was administered in February 2010 to residents in Florida's coastal counties where red tides are a common occurrence. With respect to the proposed red tide strategies, residents were asked whether they would vote for the establishment of each type of program that included a cost to them

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(that was varied across respondents). To evaluate these responses, residents were asked about their fertilizer use, beach use, and dependence on coastal water quality in addition to socio-demographic characteristics. Information was also gathered on residents' level of knowledge of red tide events and their familiarity with and use of red tide information supplied by alternative agencies, organizations, and media outlets. The results of this study can help summarize public opinion, inform policy makers, and evaluate specific programs intended to address the potentially harmful effects of red tide events in Florida that can be used to better target future educational messages.

Survey Procedures

The survey was administered by mail to residents in twelve coastal counties where red tides are a common occurrence. The counties were divided into three geographic regions: the Northeast (St. Johns, Flagler, Volusia, and Brevard Counties); the Southwest (Manatee, Sarasota, Lee, and Charlotte Counties); and the Northwest (Bay, Okaloosa, Franklin, and Gulf Counties). The number of surveys sent to each region was stratified based on the proportion of the study population in each region. In addition, the number of surveys sent to each region was equally divided into one of eighteen versions. The versions were created by varying the order of the red tide strategies — prevention, mitigation, and control — that needed evaluation. This approach was used to control for the potential of ordering bias in the evaluation of the three management strategies. In total, 800 questionnaires of each version (14,400 in total) were mailed in early 2010.

Survey Results and Findings

A total of 1,454 out of 14,400 mail surveys (10.1%) were returned and evaluated. There were 607 responses from the Northeast region (9.9%), 707 from the Southwest region (10.7%), and 140 from the Northwest region (8.4%). The average age of respondents was 60 years. The average length of residency in Florida was 24 years, and the average number of months respondents resided in Florida was 11 months. The average distance of respondent residencies to the coast was nine miles. The majority of respondents (57%) had a college degree or higher. In addition, the incomes of the majority of respondents (56%) fell between $30,000 and $90,000. Finally, the majority of respondents (92%) were Caucasian in ethnicity.

Nearly 94 percent of respondents reported awareness of the term "red tide." This share has increased from a similar study conducted in 2001, when only 89 percent of residents in two southwestern counties reported being aware of the term (Larkin and Adams 2008; Stevely, Larkin, and Adams 2008). The following results specific to red tides are based on surveys from those respondents that were aware of the term "red tide."

Respondents that were aware of the term "red tide" reported experiencing several negative effects during a bloom. Eighty-two percent reported experiencing the odor of dead fish and 74 percent indicated that they had seen dead animals on the shore. In addition, 69 percent reported that they or a family member had likely experienced the negative health effects of red tide (burning eyes, scratchy throat, coughing, etc.). Sixty-four percent reported changing their plans to visit a beach because of a red tide event. However, very few reported having changed a hotel or restaurant reservation (6% and 19%, respectively); this is likely because respondents are all local residents that knew in advance to make alternative plans.

Respondents' knowledge of the causes and effects of red tide with respect to the safety of seafood consumption during a red tide event was measured through a series of true/false questions. Respondents were also allowed to indicate that they did not know the answer. Unfortunately, respondents were largely unaware of the effects of red tide on seafood. Only 13 percent knew that it was safe to consume recreationally caught shrimp and crab during a red tide (since the toxins do not accumulate in these species), and only 15 percent knew that recreationally caught finfish are safe to consume during a red tide (these results are largely unchanged from the 2001 study). These findings are important since commercial and recreational fisheries help support local communities and provide value to local residents. More respondents were aware that recreationally caught oysters are also unsafe to eat (43% answered correctly), but that seafood bought in stores or restaurants is safe because the coastal waters are monitored and harvesting is closed if red tide cell counts exceed a specified threshold (44%). That is, if the seafood is being sold, it was harvested from open waters and thus considered safe to eat.

Respondents' knowledge of the causes and effects of red tide with respect to human health and the environment was also measured through a series of true/false questions. Respondents knew that red tide conditions can vary greatly within short distances (92% answered correctly). They were also aware that people with asthma are more affected by red tide (78% answered correctly). Nearly half were aware that the algae that cause the blooms are always present in the Gulf of Mexico (45%). However, there were several notable misconceptions among the respondents, namely that "red

drift" is synonymous with "red tide," that reddish-brown water indicates that humans will have respiratory problems, and that red tides are the same all over the world (17%, 18%, and 9%, respectively, incorrectly believed these statements to be true). These misconceptions are important since, for example, respondents might believe that what they read about other HABs applies to Florida.

The majority of respondents (76%) were at least somewhat, if not very, concerned about red tide issues. Only 24 percent were unconcerned. Of those that were concerned, the primary reasons for being concerned was that red tide affects human health (32%) and prevents beach-going activities (24%). Among those who indicated that they were unconcerned, the primary reasons for being unconcerned were that red tide is a natural occurrence (44%) or that it had not affected the respondent (29%).

Approximately three-quarters of respondents indicated that they searched for information on red tide often or sometimes (77%), while less than one-quarter (23%) indicated that they never searched for information on red tide. Respondents were also asked how frequently they search for information from a series of informational sources. Eighty-nine percent of respondents obtained information about red tide from the television sometimes or frequently, and 82 percent from local newspapers; these respondents were more dependent on these sources than in the 2001 study where 70 percent reported using newspapers and 62 percent reported using television as information sources. In addition, the reported use of all other information sources registered notable increases in use: radio (from 26% to 56%); friends or family (from 25% to 67%); public forums, meetings, or workshops (from 2% to 10%); and printed brochures (from 6% to 21%).

The evaluation of three types of programs to address the harmful effects of red tide events resulted from using a "stated preference" methodology known as "contingent valuation" (Lucas 2010; Bulte et al. 2005). This means that information was obtained by asking respondents questions in a survey such that their responses are stated instead of revealed from past behavior and they are contingent on how the valuation question was asked. Using this approach, the three proposed programs (one each for prevention, mitigation, and control) were described to respondents, including the benefits of each and how much it would cost the respondent.

The prevention strategy asked residents if they would vote for a referendum that proposed a tax on retail fertilizer sales to discourage overuse and to fund a water quality monitoring program. The level of the tax varied between 1 percent and 10 percent. Respondents were only presented with one of these levels and surveys were randomized by price level. Sixty percent of respondents indicated that they would vote in favor of the referendum. The average sales tax that respondents were willing to pay on fertilizers for the prevention strategy ranged from 5.8 percent to 19.4 percent. Higher proposed tax levels, longer Florida residency, or higher incomes were associated with lower probabilities of respondents being supportive of a tax on fertilizers (Lucas 2010). Conversely, residing in the Northeast or Southwest regions (compared to the Northwest), being very concerned about red tides, seeking information about red tides more frequently, and being very dependent on coastal water quality or quantity all increased the likelihood that a respondent would vote for the fertilizer tax and, therefore, would have a higher value for the program. In addition, if the prevention strategy was the respondents' preferred strategy, their probability of voting for the tax was higher (a potential strategic bias).

The control strategy asked residents if they would vote for a referendum that proposed a three-year ad-valorem property tax to fund pilot studies of ways to stop blooms (both biological and chemical controls were described). The level of the tax varied between $5 and $15 per $100,000 of assessed taxable property value. Forty-nine percent of respondents indicated that they would vote for the property tax. The average property tax that respondents were willing to pay on the assessed value of their homes for the control strategy ranged from $8.96 to $10.11 per $100,000. Approximately 50 percent of respondents preferred biological controls. Twenty-one percent preferred chemical controls, and the remaining 23 percent preferred neither. Respondents reacting to higher proposed tax levels and those having a higher level of knowledge about red tides reduced the probability that the respondent would be willing to vote for the tax and, thus, willing to pay for the control strategy (Lucas 2010). While the former is expected (i.e., higher prices reduce demand), the latter is an interesting result since it implies that the more people know, perhaps that blooms are a natural occurrence with a long history, the less accepting they are of attempts to stop them. Those respondents who spend more months in Florida during the year are also less willing to pay, perhaps because they recognize the seasonality (unlike part-time residents who might want to be sure that the coasts are red-tide free during their time in Florida). Similarly, those that preferred neither strategy over either biological or chemical controls were also less likely to vote for a tax to support this type of program. Finally, having paid property tax in Florida in

2009 did not affect responses. Conversely, there were many factors that increased the probability of supporting this control strategy, including whether the control strategy was their preferred strategy or whether it was the first strategy they evaluated (i.e., strategic and order bias, respectively); if the respondent was from the Northeast or Southwest region; and if they sought out information on red tides more frequently, were very dependent on water quality or quantity, had higher incomes, or had been residents of Florida longer (perhaps they have had more time to witness the losses associated with red tide events and recognize the benefits of having a means to control a bloom).

The mitigation strategy asked residents if they would make a one-time donation to a trust fund that would support a beach conditions reporting system for three years. The level of the donation ranged from $5 to $25 for three years of access (only those that paid would have access). Approximately 36 percent of respondents indicated that they would donate to the trust fund for three-year access to beach information reported by the system. The average donation that respondents were willing to pay into the trust fund for this mitigation strategy ranged from $3.16 to $8.36. This level of support is the lowest among the three strategies; however, there was some confusion among respondents in the Northeast region about whether the system would include beaches in the Northeast. Respondents reacting to higher proposed donation levels were less likely to be willing to donate (Lucas 2010). Unsurprisingly, the more days spent at the beach, whether the resident is very concerned about red tide, if this strategy was their preferred strategy, and the more frequently they seek out information on red tide events, the higher the probability that they would donate. Those with more education were also more likely to donate. Perhaps surprisingly, those that reside in Southwest Florida and those that have heard of the system were also more likely to be willing to donate. This is surprising since you might expect those residents to know that the system is currently available for free, which some noted as their reason for not supporting it. That being said, it is possible that this is an example of strategic bias; regardless, the information provides support for the program despite some confusion about geographic coverage.

Conclusions

The findings from this study have several potentially significant implications for extension personnel, educators, and managers in coastal counties in Florida that have been affected by red tides. First, there appears to be a lack of knowledge among residents regarding the causes and effects of red tide, especially concerning the safety of seafood consumption. Although this lack of knowledge did not significantly affect the willingness to pay for strategies to address red tides, it is cause for concern, and additional education and outreach efforts should be made throughout the state. Residents need to understand that it is safe to consume recreationally caught shrimp and crab during a red tide, but not recreationally caught finfish; over three-quarters of respondents were misinformed, indicating a potential for educators and media to greatly reduce red-tide-related illnesses. In addition, seafood bought in stores or restaurants is safe to eat during a red tide but less than half of respondents knew this. Promoting restaurants and retail outlets as continual sources of safe seafood not only helps local businesses but also helps support sustainable coastal fishing communities. Also, approximately 90 percent of respondents believe (incorrectly) that HABs are the same all over the world. Educational and media campaigns that focus only on red tides in Florida could help to prevent lost economic activity in coastal regions that are typically associated with red tide events.

Second, approximately three-quarters of respondents indicated that they searched for information on red tide often or sometimes. The vast majority of respondents relied on television and local newspapers; these respondents were more dependent on these sources than in the 2001 study (Larkin and Adams 2008; Stevely, Larkin, and Adams 2008). In addition, the reported use of all other information sources registered notable increases in use, including that over half reported getting information from the radio or friends or family. Although less popular, the use of public forums, meetings, or workshops and printed brochures also had notable increases. Thus, any education efforts should consider multiple formats in order to reach the largest audience.

Lastly, the results of the evaluation of the three potential programs indicate that the public is most willing to pay for prevention programs, followed by control programs, with mitigation programs being the management strategy for which they are least likely to pay. The strategy that had the most support overall was prevention. This may seem surprising since the questionnaire emphasized that this strategy carried the most amount of uncertainty with regards to its effectiveness for addressing red tides. 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, respondents were told that 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.

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