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Public Perceptions of Florida Red Tide Risks

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Abstract

This research integrates theoretical frameworks of risk perception, social amplification of risk, and the role of place-specific contexts in order to explore the various perceptions surrounding Florida red tides. Florida red tides are naturally occurring events that are increasing in frequency, duration, and severity. This has implications for public health, the local economy, and ecosystem health. While many of the negative impacts of Florida red tides are not easily controlled, some of the secondary impacts may be mitigated through individuals' responses. However, public perception and consequent reactions to Florida red tides have not been investigated. This research uses questionnaire surveys, and semi-structured interviews, to explore the various perceptions of the risk surrounding red tides. Surveys and interviews were conducted along two Florida west coast beaches. The results indicate that the underlying foundations of the social amplification of the risk framework are applicable to understanding how individuals form perceptions of risk relative to red tide events. There are key differences between the spatial locations of individuals and corresponding perceptions, indicating that place-specific contexts are essential to understanding how individuals receive and interpret risk information. The results also suggest that individuals may be lacking efficient and up-to-date information about Florida red tides and their impacts because of inconsistent public outreach. Overall, social and spatial factors appear to be influential as to whether individuals amplify or attenuate the risks associated with Florida red tides.

Keywords

Aerosolized toxins; halo effect; harmful algal blooms; natural hazards; neurotoxic shell-fish poisoning; red tide; social amplification

1. INTRODUCTION

Florida red tides are highly concentrated blooms of microscopic algae, *Karenia brevis*, which occur annually along the coastlines of Florida and occasionally along other Gulf Coast states. Different species of microalgae blooms, or red tides, occur around the world and are more appropriately referred to as harmful algal blooms (or HABs) since the water discoloration can vary greatly from species to species. *K. brevis* red tides produce potent neurotoxins that pose health threats to humans and marine organisms, both through ingestion and through inhalation of the toxins. When a *K. brevis* bloom concentrates and drifts close to shore, people can be affected by these two routes of exposure.

One health impact, neurotoxic shellfish poisoning (NSP), is caused by the consumption of affected bivalve shellfish. Although no human deaths have been reported from NSP, symptoms

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may include nausea, diarrhea, and lack of motor coordination, pupil dilation, tingling of fingers and toes, and, sometimes, the reversal of hot and cold sensations.(1) The morbidity and mortality of NSP are relatively minor compared with the more serious paralytic shellfish poisoning (PSP) and ciguatera fish poisoning caused by other HABs. However, the potential threat of NSP remains an important issue for Florida residents and visitors.(1) Symptom and mortality rate differences between NSP and other types of HAB-related poisonings may confuse those unfamiliar with Florida-specific red tides. Since the 1970s, NSP reports to the state health agencies have been an infrequent occurrence in Florida, largely because of effective state monitoring of shellfish harvesting beds. The more commonly experienced health implication from Florida red tides emanates from the aerosolized toxins.

Red tide cells are broken apart by wind and wave action, releasing their toxins into the air and sea spray.(2) These airborne toxins can provoke respiratory problems such as coughing, eye irritation, sneezing, and respiratory irritation.(3,4) Beachgoers, as well as coastal residents and workers, are all at risk from the aerosolized toxins. In addition, people with asthma can have changes in both symptoms and spirometry values after a one-hour exposure to the airborne toxins.(5,6) Both the number and the severity of symptoms increase after just one hour of exposure and symptoms can persist for several days.(7,8) The extent to which these health effects interrupt outdoor activities or well-being may influence how individuals perceive Florida red tides and the need for bloom mitigation or control techniques.

Most scientists agree that Florida red tides are occurring more frequently, staying onshore longer, and increasing in geographic extent.(1,9–11) This leaves many Florida residents, visitors, local business owners, government officials, and researchers with a myriad of questions regarding the causative source (or sources) for this increase. Additionally, there is a growing interest in control and mitigation techniques that may alleviate health problems, economic losses, and biological impacts. With each red tide “season” or bloom, there are presumably various alterations of daily activities by all affected individuals. These include individuals experiencing health impacts, enduring economic losses to their business, avoiding beaches littered with dead fish and/or toxic aerosols, and monitoring and researching the biological community, or even those individuals who are unsure and wary of what constitutes a Florida red tide.

Though there is an extensive literature on the red tide organism, there continues to be few publications on the socioeconomic impacts. In the last decade, numerous human health publications have surfaced to inform the medical community and public alike of the health impacts of Florida red tides. Because HABs appear throughout nearly all coastal states in the United States, it is difficult to find region-specific economic impact studies for Florida. Most studies focus on the national scale and include all types of HABs and other types of invasive macroalgae (seaweed).(11–13) The economic assessments are typically divided into four major sectors: public health, commercial fishing, recreation and tourism, and monitoring and management efforts.

Furthermore, there is virtually no published research on the public’s perception of Florida red tide events. Some of the existing economic and health impact studies have included a small section within their surveys attempting to address perception, but this is not their overall focus and most are not based in Florida.(14–16) Before implementing any type of red tide control or mitigation strategy, it is important to understand how the public perceives and understands Florida red tides and possible mitigation techniques. It is through the perception of risk events that individuals respond and behave accordingly.(17) However, their knowledge and behavior may not be consistent with the actual risk surrounding the event and can, therefore, have far-reaching social and economic impacts.

The behavior of individuals may influence economic impacts during and following a bloom. If individuals are told that a particular area is prone to red tide events, they may decide to avoid it altogether. Similarly, if individuals receive partial or piecemeal information regarding shellfish poisoning during a red tide, they may avoid all seafood, not just the particular species that might cause NSP. These types of behaviors can be passed on through social networks and, in turn, can lead to significant economic losses to tourism industries, restaurants, local businesses, and the seafood industry. The economic impact literature has referred to this as the “halo effect,” or the repercussions of the public’s aversion to seafood not affected by red tides or from areas not impacted by blooms.(11–15) Many researchers attribute negative media coverage as a major cause of adverse consumer reaction.(11,13,14)

Kasperson *et al.*(18) described this effect as the “social amplification of risk,” and later developed the concept into a more formal theoretical framework.(19,20) The framework is based on the postulation that “social and economic impacts of an adverse event are determined not only by the direct physical consequences of the event, but by the interaction of psychological, cultural, social, and institutional processes that amplify or attenuate public experience of risk and result in secondary impacts.”(19) Extending this concept, Masuda and Garvin(21) further emphasize the role of place and culture in the perception of risk. They argue that place is central to the cultural basis from which individuals perceive risks,(21) while Gustafson(22) identifies perspectives that correspond to the role of gender in risk perception. Similarly, age may also play a role in risk perception because of the differential vulnerability of age groups to health risks. For instance, elderly individuals may be at greater risk to the health effects of certain hazards (in this case, red tides) and therefore have heightened perceptions of risk.(23) This article addresses the following research questions surrounding Florida red tide events:

1. What is the public’s perception of risk concerning Florida red tide blooms, and how does this vary between different social groups?
2. What causes do people associate with Florida red tides?
3. What impacts do people associate with Florida red tides?

2. METHODS

To examine these questions, two survey instruments were developed. The first survey included a series of questions about Florida red tides and demographic information. These were primarily fixed-response questions that required the respondents to address degrees of concern based on a Likert scale. The second survey was more extensive and qualitative in approach. In addition to the basic questions in the first survey, other open-ended questions were added to permit more discussion of red tide concerns. Both surveys and interview protocols were conducted with the approval of the University of South Florida Institutional Review Board Human Subjects Review Committee.

The respondents were selected using a convenience sample based on beachgoers at the Siesta Key public beach in Sarasota County, Florida, and Fort DeSoto State Park in Pinellas County, Florida. These two sites were chosen as they fit into the research criteria: the beaches were easily accessible, they were widely used by the public, they included a diverse population of residents and tourists, and they both had seen occurrences of red tide. The surveys and interviews were conducted from April 2007 to September 2007. It should be noted that there was not an onshore *K. brevis* bloom at either of these sites during the project.

Although the social amplification framework is widely accepted and used to help explain the public’s adverse (or attenuated) reaction to major hazardous events,(19–21,24,25) there are few studies providing comprehensive and replicable methodologies. Therefore, survey

questions were developed to triangulate the useful themes and methods from an array of studies, (19,21,26,27) while modifying the variable classes to better represent risk perceptions related to Florida red tides (a high-probability, low-consequence hazard).

The survey data for the fixed-response questions were analyzed using the SPSS software. The open-ended responses were coded into similar responses and compared with each other. Nonparametric statistical tests were used to produce contingency tables, including chi-square (χ^2), Spearman's rho (rs), and the Wilcoxon (W) rank-sum test.(28)

3. RESULTS

The data in Table I show the demographic traits of the survey population. A total of 59 surveys were successfully completed, with over 70% being residents of Florida. Only 25% of the respondents were below age 25, most had some level of college education, and very few worked in the health business. This latter question was included in case health employees exhibited greater awareness of the health problems associated with red tides. Another question asked from where the respondents had received most of their information on red tides. As can be seen, most referred to television and radio or newspaper articles.

The interviewees were asked a number questions that focused on perception and awareness of the traits, impacts, and causes of red tides (see Questions 1–7) and others that addressed potential control and mitigation measures (Questions 8–11), as shown in Table II. The responses to these questions were analyzed based on several demographic variables identified in the literature as possible influences in perception. These included sex, age, education, occupation, and residency. In addition, familiarity and experience with red tides were included as possible explanatory variables.

Several characteristics stand out as key explanatory variables, as shown in Table III. However, there were few significant relationships with the demographic variables. Women and older respondents experienced higher levels of health problems than men and younger respondents, but for the most part, sex and age did not affect the respondents' outlooks in this regard. Similarly, those in health-related occupations rated the risk from red tides higher than those not in health occupations, seeing more health problems, greater risk from eating seafood during a red tide bloom, and expressing higher levels of concern. Of greater significance are those variables that are related to residency, familiarity, and experience. There were significant differences between the responses of visitors to the beaches and those of local residents. Visitors were more likely to state that red tides are naturally occurring in comparison with Florida residents, whereas residents are more likely to see red tides as occurring more frequently and lasting longer (data not shown). Personal experience with red tides also affected perception and awareness. Those who experienced red tide blooms rated health problems higher, and had higher levels of concern than non-experienced respondents, but they were less likely to perceive risks in eating seafood during red tides; experienced respondents were also more likely to perceive red tides as occurring more frequently and lasting longer.

4. DISCUSSION

This research indicates a relationship between the level of uncertainty and the perceptions of risk, which is demonstrated by individuals unable to accurately describe basic facts of Florida red tides also attributing greater risk to eating seafood during a bloom. Familiarity is a key factor in risk perception, and higher levels of uncertainty lead to higher risk perceptions.(29) This suggests that a person's uncertainty concerning event characteristics could lead to the amplification of associated risk, in this case, the risk of eating seafood during a red tide. By amplifying the risk of eating seafood, individuals also may pass this message on to other

individuals who are not knowledgeable about the subject, the resulting behavior of which could contribute to the “halo effect.”

The data also indicate that direct experience with the impacts of Florida red tides causes higher levels of concern for individuals, which can be expected if those impacts include health effects. Increased or continuous experience with the effects may also lead individuals to believe that red tides are occurring more often, becoming more severe, and lasting longer. Individuals who have experienced impacts may be more likely to seek out information concerning red tides, especially if they experienced health effects. Perhaps, by obtaining more information, individuals also obtain information concerning the risk of eating seafood during a bloom.

The finding that women attribute higher risk to health effects is consistent with the theory that women and men can have different levels of concern over the same risks, as proposed by Gustafson.(22) The rated health symptoms during a bloom increased with age, which is in accord with other research studies that have reported that elderly people have intensified perceptions of risk because of increased health concerns.(23) The finding that individuals employed in health-care professions consider red tide effects riskier than others suggests that, perhaps, there is some bias stemming from the work environment and/or profession. It is clear from the results of both the quantitative and the qualitative analysis that how individuals perceive risk is influenced by social characteristics. The categories in which the individuals are grouped (e.g., male, female, and older age group), however, do not capture all influential factors through cognitive processes.

There were no significant differences between Florida residents and visitors in how they rate the effects and level of concern for red tides. Although more visitors feel that red tides are naturally occurring, Florida residents more strongly agree that red tides are occurring more often, are lasting longer, and are becoming more severe. Perhaps, residents amplify these concerns because they are more frequently impacted by red tides and because red tides are covered more often in the news media. Since this type of red tides is most common in Florida, it can be expected that news about them is more frequent within Florida, especially along the coast where they are most severe.

5. LIMITATIONS

While this research provides useful insight into how individuals perceive Florida red tides, the implications may be specific to the west coast of Florida and/or the specific beaches selected as survey sites. Since the sample size was small and the interviews were limited to beachgoers, the results may be reflective of the people who attend the two west coast beaches. To determine whether the results can be generalized to the larger population, future research should investigate the perceptions of individuals in other regions of Florida and a different sampling design should be used. For instance, Florida red tides also occur along the Panhandle and occasionally on the East Coast; therefore, the perceptions of those individuals may indicate other areas for improved risk communication. Additionally, a more in-depth analysis of public media may provide useful information as to how the discussions about red tides are formed and communicated to the public as risk messages.

Finally, this research has shown that the role of place-specific contexts cannot be overlooked. Masuda and Garvin(21) discussed the concept of place and place attachment as an influential factor in risk perceptions. The approach used to investigate the role of places has been modified in this research, yet it continues to provide meaningful insight into the various ways by which place can influence perceptions. Future research in this area should include a more in-depth exploration of how the various aspects of place and place attachments can influence perceptions of risk as well as the use of improved methods for identifying key spatial components.

6. CONCLUSIONS

The overall objective to provide an initial step for understanding the perceptions of individuals related to red tides has shown that there are key characteristics identified that may influence whether individuals amplify or attenuate risk information:

- Women and older individuals may amplify the risk of health impacts and other risks because they feel more vulnerable to the health effects.
- Individuals in health-care professions may amplify the risk of red tide effects, such as health impacts and the risk of seafood consumption, because of the nature of their profession.
- Greater experience with the effects of Florida red tides may lead individuals to believe that red tides are increasing in duration, severity, and frequency.
- Individuals who believe red tides are occurring more frequently, becoming more severe, and lasting longer believe more strongly about the influence of pollution on red tides, thereby becoming potential amplification stations to other individuals.
- Uncertainties about red tides may result in amplified perceptions of the risk surrounding the consumption of seafood, contributing to the “halo effect.”

Thus, in the social amplification of the risk framework,(18) individuals are hypothesized to decipher risk messages subjectively according to their own rationale and beliefs before passing the information on to others. Influential factors in forming these perceptions of risk are said to include age,(23) gender,(22) education, and place-specific contexts.(21) The underlying processes of the framework are supported by this research, with clear indications that certain characteristics do play a role in whether individuals amplify or attenuate risk information. For instance, gender and age are important social factors that influence the formation of risk perceptions, particularly for the health risks from red tides.

This research demonstrates that individuals may not be obtaining current and accurate information about Florida red tides and the impacts. In particular, there appears to be insufficient transfer of information regarding the safety of eating seafood during a bloom, the extent of the health impacts from aerosolized toxins, and the appropriate sources of information about the current status of red tides. Efforts to provide the public with information through websites, pamphlets, and hotlines are underway. The results from this research indicate that increased efforts in specific areas of public education are needed.

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Table I

Demographics and Selected Sources for Florida Red Tide Information

<i>N</i> = 59		Total (%)
Gender	Florida residents	43 (73)
	Visitors to Florida	16 (27)
	Male	23 (39)
	Female	36 (61)
Age	18–25 yrs	2 (3)
	26–35 yrs	13 (22)
	36–45 yrs	9 (15)
	46–55 yrs	19 (32)
	56–65 yrs	12 (20)
	66–75 yrs	3 (5)
	76+ yrs	1 (1)
Education level	High school	9 (15)
	Some college	13 (22)
	Associate's or technical	6 (10)
	Bachelor's degree	22 (37)
Occupation	Graduate or professional	9 (15)
	Occupation in health	8 (14)
	Occupation not in health	51 (86)
Sources of information*	TV or radio	39 (66)
	Newspaper	25 (42)
	Internet	19 (32)
	Friends or family	16 (27)
	Local sources	4 (7)
	State or federal agencies	2 (3)
	Other (e.g., lifeguards)	6 (10)

* Multiple responses accepted.

Table II**Closed/Likert Scale Survey Questions**

1	On a scale of 1 to 5, with 1 being no symptoms at all and 5 being severe symptoms, how would you rate the health impacts you experience during an active red tide bloom?
2	On a scale of 1 to 5, with 1 being not at all risky and 5 being very risky, how risky do you think eating seafood is during a red tide bloom?
3	On a scale of 1 to 5, with 1 being not at all concerned and 5 being very concerned, how concerned are you about Florida's red tides?
4	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Florida's red tides are naturally occurring.
5	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Florida's red tides are occurring more frequently.
6	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Florida's red tide blooms are lasting longer and are more severe.
7	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Florida's red tides are directly affected by urban growth.
8	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Any potential control methods should be used to prevent red tides.
9	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? Control methods should be used even if the impacts of doing so are unknown.
10	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? There should be stricter regulations to prevent coastal pollution and runoff.
11	Of the following statements, please indicate the level to which you agree on a scale of 1 to 5, with 1 being strongly disagree and 5 being strongly agree? More research should be done before doing anything.

p-Values of Close-Ended Responses Between Groups

Table III

	1. Severity of Health Symptoms	2. Risk of Eating Seafood During Bloom	3. Level of Concern	4. Naturally Occurring	5. Occurring More Frequently	6. Lasting Longer and More Severe	7. Affected by Urban Growth	8. Any Control Method	9. Control Methods with Unknown Impacts	10. Stricter Runoff and Pollution Regulations	11. More Research Before Anything
<i>N</i> = 59											
Male vs. female [†]	0.09	0.38	0.15	0.66	0.44	0.24	0.15	0.50	0.40	0.19	0.01
Age *	0.00	0.34	0.17	0.98	0.92	0.84	0.93	0.39	0.78	0.16	0.20
Education *	0.37	0.35	0.42	0.34	0.28	0.06	0.17	0.96	0.19	0.58	0.15
Occupation in health industries vs. not [†]	0.03	0.01	0.02								
Residence vs. visitors [†]	0.14	0.39	0.49	0.03	0.00	0.01	0.50	0.26	0.71	0.37	0.98
Familiarity with red tide vs. unfamiliar [†]	0.16	0.01	0.19	0.25	0.64	0.43	0.70	0.94	0.34	0.88	0.96
Have experienced red tide vs. not [†]	0.00	0.08	0.07	0.47	0.03	0.02	0.32	0.31	0.09	0.29	0.11

* Spearman's rho.

[†] Wilcoxon's rank-sum test.

Note: Shaded cells show significant differences at 0.01 and 0.1 levels.