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Florida Red Tide Perception: Residents versus Tourists

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Abstract

The west coast of Florida has annual blooms of the toxin-producing dinoflagellate, *Karenia brevis* with Sarasota, FL considered the epicenter for these blooms. Numerous outreach materials, including Frequently Asked Question (FAQ) cards, exhibits for local museums and aquaria, public beach signs, and numerous websites have been developed to disseminate information to the public about this natural hazard. In addition, during intense onshore blooms, a great deal of media attention, primarily via newspaper (print and web) and television, is focused on red tide. However to date, the only measure of effectiveness of these outreach methods has been counts of the number of people exposed to the information, e.g., visits to a website or number of FAQ cards distributed. No formal assessment has been conducted to determine if these materials meet their goal of informing the public about Florida red tide. Also, although local residents have the opinion that they are very knowledgeable about Florida red tide, this has not been verified empirically. This study addressed these issues by creating and administering an evaluation tool for the assessment of public knowledge about Florida red tide. A focus group of Florida red tide outreach developers assisted in the creation of the evaluation tool. The location of the evaluation was the west coast of Florida, in Sarasota County. The objective was to assess the knowledge of the general public about Florida red tide. This assessment identified gaps in public knowledge regarding Florida red tides and also identified what information sources people want to use to obtain information on Florida red tide. The results from this study can be used to develop more effective outreach materials on Florida red tide.

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Keywords

Florida red tide; *Karenia brevis*; seafood safety; resident risk perception; tourist risk perception; communication tools; outreach and education; evaluation of outreach and education; harmful algal blooms and public knowledge

1. Introduction

The Gulf of Mexico has annual blooms of the toxin-producing dinoflagellate, *Karenia brevis*. Blooms during the last decade have increased in frequency and intensity (Glibert et al., 2005). Wind and wave action lyse the *K. brevis* cells, releasing of the suite of neurotoxins, called brevetoxins, produced by the dinoflagellate, (Poli et al., 1986; Baden et al., 1995). The toxins then accumulate in the water or become part of the marine aerosol (Pierce and Kirkpatrick, 2001). Although many shellfish (clams, mussels, oysters and whelks) harbor the toxin without apparent effect to that animal, *K. brevis* blooms, in high concentrations, are responsible for high mortalities in fish, sea birds and marine mammals (Sievers, 1969; Steidinger and Baden, 1984). When *K. brevis* blooms concentrate near and onshore, human health is affected. The effects of brevetoxins on human health take place through at least two exposure routes examined to date: consumption of brevetoxin-contaminated seafood and breathing brevetoxin-aerosols. Thus, these toxic blooms have implications for ecosystem health, public health, local economies and the fishery industry.

Eating brevetoxin-contaminated shellfish (clams, mussels, oysters and whelks) may cause neurotoxic shellfish poisoning (NSP), resulting in an acute illness which may require emergency room and intensive hospital care for several days (Watkins et al., 2008). NSP has an onset time of minutes to three hours, and may last several days. NSP is not deadly, but has symptoms that may include tingling of extremities, nausea, diarrhea, pupil dilation, loss of motor coordination and reversal of hot and cold sensations (Baden et al., 1995; Poli, 2000; Fleming et al., 2001). Although NSP morbidity and mortality is relatively minor compared to other fish and shellfish poisonings caused by harmful algal blooms (Fleming et al., 2001), both Florida residents and visitors see this threat as an important issue (Kirkpatrick et al., 2004a). NSP can occur when people recreationally harvest shellfish and are not aware that shellfish beds are closed to harvest (Watson et al., 2008), or, theoretically, through ingestion of commercially harvested shellfish. However, there is an active state monitoring program of shellfish beds for brevetoxin and *K. brevis* cells, which results in early closures of commercial, aquacultured, and recreational shellfish beds.

Reported cases of NSP are rare. Although an increase in gastrointestinal illness in emergency rooms during a Florida red tide has been documented, many cases of NSP go undocumented if the symptoms are too mild for the person to seek medical care or result in cases of unrecognized and untreated cases of NSP (Kirkpatrick et al., 2009). In addition, many health care providers may not realize that NSP is a reportable disease in Florida (Hopkins et al., 1997; Watkins et al., 2008), and thus it is under-reported even when treated in a health care setting. According to Watkins et al. (2008), the majority of NSP cases reported to and investigated by the Florida Department of Health were associated with illegal recreational shellfish (including whelk) harvesting.

The second route of human brevetoxin exposure is through inhalation. Through bubble-mediated transport, brevetoxins in the water become aerosolized (Blanchard, 1989; Pierce et al., 1990) and have been demonstrated to travel up to 1.6 kilometers inland (Kirkpatrick et al., 2010). Inhalation of these aerosolized brevetoxins by healthy individuals can lead to upper respiratory irritation, such as nose and throat irritation, eye tearing, sneezing and coughing

(Backer et al., 2005). Epidemiologic studies on asthmatics have demonstrated changes in lung function as well as increases in both upper and lower respiratory symptoms after a one hour visit to the beach during a Florida red tide bloom (Fleming et al., 2005, 2007a; Milian et al., 2007). Emergency department respiratory visits are significantly higher, especially for pneumonia, asthma, and bronchitis, during periods of Florida red tide blooms as compared to similar periods of no Florida red tide (Kirkpatrick et al., 2006). The cost-of-illness for emergency department diagnosed illnesses associated with a *K. brevis* bloom have been estimated to be \$18 to \$26 million along the Florida Gulf Coast and \$2 to \$4 million for Sarasota County (Hoagland et al., 2009).

In addition to ingestion and inhalation routes of exposure to brevetoxin, anecdotal reports of people who swim in the ocean through Florida red tide blooms have reported itchy, inflamed, red skin, as well as conjunctivitis. There is no evidence of chronic or permanent disabling effects (Hemmert, 1975).

Few studies have investigated public perceptions of Florida red tide. Kuhar et al (2009) examined if negative effects from red tide change activities of tourists and Florida residents. In addition, the study examined how people communicate their perceptions of Florida red tide. Numerous outreach materials, including Frequently Asked Question (FAQ) cards, exhibits at local museums and aquaria, public beach signs, and many websites (www.mote.org, www.floridamarine.org, www.redtideonline as a few examples) have been developed to disseminate information to the public about Florida red tide. In addition, during intense onshore blooms, a great deal of media attention, primarily via newspaper and television, is focused on red tide. In general, the measure of effectiveness of these outreach methods has been counts of the number of people exposed to the information, e.g., visits to a website or number of FAQ cards distributed. The only study to date to measure outreach effectiveness found a 70% satisfaction of the Florida red tide information received (Fleming et al., 2007b). Relatively little assessment has been conducted to determine if these materials are effectively reaching either residents or tourists. This study addressed this knowledge gap by creating and implementing an evaluation tool for the assessment of public knowledge about Florida red tide. The objective was to learn what the general public knows about Florida red tide. This assessment will aid the various agencies and grassroots organizations developing outreach materials by identifying gaps in public knowledge regarding Florida red tides and identifying sources people prefer to use to obtain information on Florida red tide.

2. Methods

A group of Florida red tide outreach educators created a survey for assessing knowledge about Florida red tide and how people prefer to receive information on red tide. The survey consisted of 38 questions specific to Florida red tide, including questions about the organism, toxins, ecology, health symptoms, seafood safety, and uses of current information sources. Because the survey did not collect any personal information from participants, the study was given exempt status by Florida Department of Health's Institutional Review Board. All surveys were conducted between August 2005 and January 2006 during which a Florida red tide bloom occurred throughout the 2005 year and into February 2006 with over 300 million cells per liter on some days.

Eligibility criteria for study participation were: 1) at least 18 years of age; and 2) either a tourist (individuals visiting the Florida Gulf Coast for less than one month) or resident (individuals living in a Florida Gulf Coast county for greater than 6 consecutive months in a year). The surveys were conducted at various locations in Sarasota County, Florida that would have a large number of potential participants. Survey sites were: Mote Marine Aquarium, Siesta Key

Public Beach, Lido Public Beach, Ken Thompson Park (during a festival), and the Westgate Shopping Mall.

All analyses were done using Stata version 8.0 (StataCorp LP, College Station, TX). Chi-square tests were used to determine whether there were significant differences between residents and tourists.

3. Results

3.1 Demographics

The number of residents surveyed was 92, and the number of tourists was 100. Table 1 shows resident participants were between 18 and 89 years of age, while tourists were between 18 and 70 years of age, with the greatest percent in the 50 to 69 year old range. For both residents and tourists, 53% of those interviewed were female.

3.2 General Florida Red Tide Knowledge Questions

Of the 192 participants that completed the survey instrument, only one, a tourist, had not heard of Florida red tide before the survey (Table 2). When asked what the make up of Florida red tide is, the majority of residents and tourists (59.8 % and 68 % respectively) correctly identified algae. For the question “What causes Florida red tide?” participants were allowed to check multiple responses. The correct answer of “it isn't known” was the most commonly selected option (44.6% of residents and 31% of tourists). The only significant differences between residents and tourists were for answers of “fertilizer” and “I don't know,” with residents significantly more likely to choose these responses ($p=0.01$ and $p=0.02$, respectively). Tourists rated “weather” as a cause of Florida red tide second most frequently following “it isn't known.”

The most significant difference between residents' and tourists' knowledge of Florida red tide occurred in perceptions of when Florida red tide can occur. More tourists than residents inaccurately responded that Florida red tide can occur during high tides and when the ocean's water is warm ($p=0.009$ and 0.001 , respectively). The majority of residents (53.3%) correctly reported that red tides can occur ‘all year round’ compared to only 21% of tourists ($p<0.0001$). Table 2 also shows residents' and tourists' knowledge of the impacts of Florida red tide. Correct answers to this question are: dead fish and other marine life; stinky beaches; problems for human health; and impacts on local economy. While very few residents chose the incorrect response of weather changes (17.4 %) as being caused by Florida red tide, tourists were significantly more likely to chose this response (30%, $p=0.04$).

Table 3 shows the number and percentages of residents and tourists having correct answers to each of the questions on knowledge of Florida red tide. For questions where more than one response could be selected, descriptive statistics are given both for any correct answer and for all and only correct answers. There are significant differences between residents and tourists regarding knowledge of when red tide can occur for both any correct and all correct responses, and for all correct answers for the question concerning what a Florida red tide can cause.

3.3 Human Health Questions

Table 4 shows the responses from participants to questions concerning the human health effects of a Florida red tide. When asked “Is it safe to catch and eat fish during a Florida red tide?” there was no significant difference between resident and tourist answers; however, both residents and tourists either answered as “I don't know” (19.8% and 23%, respectively) or responded incorrectly that it was unsafe (62.6% and 55%, respectively). The question regarding the harvesting and eating shellfish during Florida red tides yielded significant differences in the answers of residents and tourists ($p<0.0001$); only half of the tourists responded that

recreationally harvested shellfish were unsafe to eat, whereas 78% of residents correctly identified this as a health risk. In contrast, only 46.2 % of residents and half of the tourists correctly believed that it was safe to eat shellfish from stores and restaurants (commercially harvested); one third of residents and 27% of tourists believed this behavior was unsafe. The responses indicate much uncertainty regarding shellfish safety during a Florida red tide.

The correct answer to the question of swimming in the ocean during a Florida red tide is that it is safe, since there is a lack of scientific evidence to the contrary. However, only about half of residents and 21% of tourists responded that it was safe to swim ($p<0.0001$). The analysis of what human health symptoms (non-dermal) are related to Florida red tide (coughing, throat and eye irritation, respiratory irritation, sneezing, and headaches) and those symptoms that are not (diarrhea and vomiting) showed no significant differences between residents and tourists in responses (data not shown).

For the final environmental health question about whether there have been deaths related to Florida red tide, only 7.6 % of residents believed there had been reports of human deaths, but 40.2% did not know. In contrast, the tourists were split nearly evenly between their responses of “yes”, “no”, and “I don't know.” The differences between the residents' and tourists' answers were significant ($p<0.0001$).

Table 5 shows the number and percentage of correct answers for residents and tourists to questions regarding the human health effects of Florida red tide. There were significant differences between residents and tourists in the likelihood of getting the correct answer for the questions of the safety of harvesting and eating shellfish ($p<0.0001$), the safety of swimming ($p<0.0001$), and reports of human deaths from Florida red tide ($p=0.005$), with residents having more correct answers for each of these questions.

3.4 Beach and Information Resource Usage Questions

The final set of questions (Table 6) focused not on Florida red tide knowledge but on personal attitudes and behaviors of the survey participants. After asking about safety in swimming, the question of “would you go into the water during a red tide?” was asked of the participants with tourists (38%) significantly more likely to go into the water than residents (30%) ($p=0.01$). Because of the harmful aerosols and esthetically unpleasant nature of Florida red tide on the beach, “Would you travel to the beach during a red tide?” was asked. This question also showed a significant difference ($p=0.003$) of opinions between residents and tourists; however, in contrast to willingness to go in the water, more residents (46.7%) than tourists (33%) were willing to travel to the beach.

To gain information on how outreach information might be sourced to be most effective, participants were asked where they would go to learn more about red tide. The three main sources of information cited by both residents and tourists were TV, the Internet and Mote Marine Laboratory. Significant differences were found between residents and tourists in preferences for information from the Internet and Mote Marine Laboratory ($p<0.0001$ and $p=0.005$, respectively); the Internet was cited most frequently by tourists (80%) and Mote Marine Laboratory most by residents (66.3%).

Informational beach signs about red tide with a toll free number to call for more information were being introduced on some of the local beaches during the time of the study. Thus, the survey evaluated the potential use of these signs and phone number. More than 80% of both groups would read beach signs with red tide information; however, 52.2% of residents and only 14% of tourists would dial a toll free number to learn more. The relative lack of interest in calling a toll free number on the part of the tourists was not due to an inability to call; at the

time of the survey 75% of tourists and 67% of residents were carrying a cellular telephone (data not shown).

4. Discussion

Florida red tide blooms are natural phenomena that occur at different times throughout the year. Communities that are affected by these phenomena have a need for accurate information on Florida red tide throughout the year. We have shown a substantial lack of knowledge and a prevalence of misperceptions about Florida red tide on the part of both residents and tourists. These misperceptions can be harmful in two ways: some activities that are established to be unsafe are viewed by people as safe (e.g., harvesting and eating shellfish), and other activities that are safe are perceived as unsafe (e.g., eating shellfish in a restaurant; swimming). These misperceptions influence behavior in such a way that can be harmful to both individual health and the economy of areas affected by Florida red tide. Therefore, improved educational outreach is needed.

There are several important findings from the study that should be highlighted. First, although more than half of the residents surveyed knew that Florida red tide can occur all year round, less than 25% of tourists had this information and more than half of tourists and nearly 33% of residents believe that Florida red tide only occurs when ocean temperatures are warm. This misperception may be caused in part by the strong media and regulatory messaging regarding shellfish contamination from the bacteria, *Vibrio spp.* Having the strong seasonal (summer months) messages concerning *Vibrio spp.* outbreaks and the stigma of raw oysters from the Gulf of Mexico during these outbreaks may be the cause of misperceptions. Individuals may be confusing these two natural phenomena.

An alternative explanation of the misperception may be more closely related to the social amplification of risk. Social amplification occurs when individuals form heightened risk perceptions by subjectively deciphering risk messaging, and then distributes these amplifications of risk within social and cultural networks (Kasperson et al., 1988). Determining whether the misperception of when Florida red tide occurs is stigma resulting from *Vibrio spp.* messaging or whether the perceptions about the occurrences of Florida red tide blooms are related to social amplification is beyond the scope of the current study. However, Kuhar et al. (2009) describes the social amplification of risk as a probable influence in relation to many Florida red tide messaging issues.

A study by Whitehead et al. (2003) estimated the effects of information about a *Pfiesteria spp.* bloom on risk perceptions, seafood demand, and willingness to pay for a mandatory seafood inspection program. The authors found that the perceived risk of seafood consumption increased with the announcement of a *Pfiesteria* related fish kill; and consequently, the demand for seafood decreased. The second important finding from our study supports Whitehead et al. (2003), as a large percentage of our participants, both residents and tourists, had incorrect information about the safety of eating shellfish in different situations. Only half of the tourists surveyed were aware that recreational shellfish harvesting is not safe during Florida red tide; the rest are split evenly between not knowing and thinking shellfish harvesting is safe; 78% of residents know it is unsafe. However, only about half of both tourists and residents believe it is safe to purchase seafood in grocery stores and restaurants. This may lead to unwillingness to eat shellfish, which can have severe economic consequences for the shellfish and restaurant industries. A total of 59% of those surveyed believe that it is unsafe to recreationally fish during a bloom, while only 20% know it is safe. Thus, just as with a *Pfiesteria spp.* bloom, perceptions about a Florida red tide bloom may have a huge economic effect on the charter fishing and bait shop industries of the Gulf Coast.

Thus, it is clear that stronger efforts need to be made to educate the public about recreational seafood safety and the differences between commercially bought seafood and recreationally harvested seafood. However, it is unclear what sources of information and what types of information would be most successful in improving knowledge about seafood consumption. The agencies responsible for seafood regulation do not have an equal mandate to educate the public. Their role is to protect the public from unsafe seafood, not the promotion of safe seafood. And even if they did more aggressive outreach and education on seafood safety, it is questionable if they would be the most effective disseminator of the information. Two national studies have shown that less than half of people surveyed trust government agencies regarding food safety issues (Knight et al., 2007; Hicks et al., 2008). This speaks directly to trust and transparency issues public risk perception has of regulatory agencies (Lofstedt, 2006).

The lack of information and uncertainty about where and how to provide information to reduce misperceptions is an important problem not just for seafood consumption, but for all aspects of Florida red tide. To meet these informational needs, more targeted outreach and education messages, and rigorous, consistent evaluation of these messages, are needed.

Mote Marine Laboratory (MML) and its website are often looked at in the local Sarasota community as the epicenter for public outreach materials for information regarding Florida red tide, *Karenia brevis*, specifically. Information and feedback from MML's website are concordant with results in this study (Kirkpatrick et al., 2004b); during a red tide bloom, evidence from the emails sent from the website's "contact us button" that many of the red tide emails into the lab are inquiring about areas of (mis)information that were identified in this evaluation. When there is not an active bloom in the area, very little public attention is reported and little information is requested.

Besides MML, the other top two sources identified as places where individuals receive information on red tide are through the Internet and reports from local TV news stations, with tourists using the Internet more than residents. Another potential source of information is more informal communication between locals and tourists or seasonal residents, speaking directly to the theory of social amplification of risk. Many of the seasonal residents and tourists that travel from both national and international cities to visit Sarasota throughout the year rely heavily on the year round residents and local businesses for public and community information.

There are current sources of information, but there are potential problems in terms of the accuracy, currency, and consistency of the information provided. There is coordination among sources of information, with the different sources including scientists, policy makers, and government agencies responsible for Florida red tide information. Even a coordinated approach to public outreach and education creates a wealth of communication challenges including forging a consensus about the message (Lofstedt, 2006). In addition to the other challenges, the issues of how to communicate uncertainty, as many of the human health effects of Florida red tide toxins are still in the research stages and are not well described, as well as how transparent these authorities should be about early research findings, are still debated.

It is critical to note that development and outreach activities and materials need to be developed based on empirical evidence of what information individuals need and how they will use information that is provided. Too often evaluation and feedback are not used when creating and disseminating outreach materials for the general public about harmful algal blooms and other marine hazards. This study was designed specifically to evaluate what the Florida residents and tourists know and do not know about *Karenia brevis* blooms; thus, this research provides essential information for development and dissemination of effect outreach information. For example, our results indicate that calling a toll free number for information is not an avenue that tourists would take to obtain information about red tide, while beach

signage and information on the Internet are used. Although over 80% of those surveyed requested public beach signs with red tide information, only 14% of the tourists would call a toll free red tide health hotline number for additional information. This information is consistent with evaluations for the Aquatic Toxins Hotline, where only 8% of the callers reported using the number from the signs, while 39% found the number on the Internet, 18% from a newspaper or magazine article, and 15% heard about the number from a friend (Fleming et al., 2007b).

Florida red tide FAQ cards are available for free and are distributed at beaches as well as via MML and other environmental awareness venues throughout the Gulf Coast of Florida. Evaluation of the use and retention of the knowledge gleaned from the FAQ cards has not been conducted. Often consumer advisories and informational brochures are tested on anglers. Burger et al. (2008) evaluated the effect of one such brochure on fish consumption advisory by pregnant women. The authors found that gender and language were factors in the efficacy of the brochure, however, more importantly, of those who understood the brochure less than 30% would change their behaviors because of the newly acquired knowledge. A final challenge is that even when accurate and appropriate information is conveyed, individuals may not change their behavior.

Future surveys should address more comprehensive questions about preferred formats and sources for disseminating seafood safety messaging, as this study is in agreement with past studies (Fleming et al., 2007b; Knight et al., 2007; Hicks et al., 2008) that the Internet is the major source accessed by consumers. As the Internet is one of the fastest growing and changing sources of free communication available to both consumers and outreach and education developers, more focus on how to relay Florida red tide outreach and education messages were trust and transparency issues as well as how to relieve both stigma from other hazards and social amplification of the risks can be addressed. Additionally, more evaluations are needed of usage of present outreach techniques, to aid the concentrate of efforts toward the most usable information and manner of dissemination.

5. Conclusion

In conclusion, this study found widely inconsistent and incorrect responses across tourists and residents alike regarding knowledge of Florida red tide. When queried as to what information source they would use, the Internet was cited as one of the most used tools used by tourists, so more focus on Florida red tide general information, including food safety and general biology, needs to be developed for that medium. Local TV news media should be disseminating the same general information that is broadcast over the Internet so that there is less confusion and dilution of the key safety messages. Evaluation of Florida red tide informational tools is needed on a regular basis, as there are changes over time to both informational content needed, due to continuous research findings, and which informational resources are used by the public, as social networking styles and sites change.

More research on risk perception and what factors influence the public's behaviors, attitudes, and beliefs about red tides, human health risks, and communication of uncertainties is needed. Ideally, this research should be based on the social science of media communication and risk perception. Future research should also include safety issues and investigations of hazardous events, not necessarily from the Florida red tide organism, which could create a stigma or socially amplified risk responses to Florida red tide perceptions.

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Table 1

Demographics of individuals in the study; number (percentage) and tests of significant differences between residents and tourists.

	Resident n=92	Tourist n=100	χ^2	p-value
Age				
18-29	16 (17.4)	29 (29)		
30-49	28 (30.4)	23 (23)		
50-69	33 (35.9)	48 (48)		
70-89	15 (16.3)	0 (0)	21.73	<0.0001
Female	49 (53.3)	53 (53)	0.001	0.97

Table 2

Descriptive analysis of the original answers to the questions concerning general Florida Red Tide knowledge in number (percentage), and tests of significant differences between FL residents and tourists

	Resident		Tourist		χ^2	p
	Yes	No	Yes	No		
Have you heard of FL red tide?	92 (100)	0 (0)	99 (99)	1 (1)	0.925	0.336
What is the make up of FL red tide?						
bacteria	26 (28.3)		22 (22)			
algae	55 (59.8)		68 (68)			
virus	0 (0)		2 (2)			
I don't know	11 (12.0)		8 (8)		3.51	0.319
What cause FL red tide?						
pollution	20 (21.7)	72 (78.3)	16 (16)	84 (84)	1.036	0.309
fertilizer	19 (20.7)	73 (79.4)	8 (8)	92 (92)	6.347	0.012
bacteria	21 (22.8)	71 (77.2)	19 (19)	81 (81)	0.425	0.514
weather	16 (17.4)	76 (82.6)	29 (29)	71 (71)	3.600	0.058
it isn't known	41 (44.6)	51 (55.4)	31 (31)	69 (69)	3.762	0.052
I don't know	15 (16.3)	77 (83.7)	6 (6)	94 (94)	5.223	0.022
When can FL red tide occur?						
during high tides	3 (3.3)	89 (96.7)	14 (14)	86 (86)	6.848	0.009
when the ocean's water is warm	27 (29.4)	65 (70.7)	53 (53)	47 (47)	11.029	0.001
during winter months only	1 (1.1)	91 (98.9)	0 (0)	100 (100)	1.093	0.296
all year round	49 (53.3)	43 (46.7)	21 (21)	79 (79)	21.527	<0.0001
I don't know	14 (15.2)	78 (84.8)	11 (11)	89 (89)	0.753	0.386
What can FL red tide cause?						
dead fish and other marine life	89 (96.7)	3 (3.3)	92 (92)	8 (8)	1.993	0.158
stinky beaches	80 (87.0)	12 (13.0)	91 (91)	9 (9)	0.804	0.370
problems for human health	77 (83.7)	15 (16.3)	83 (83)	17 (17)	0.017	0.897
weather changes	16 (17.4)	76 (82.6)	30 (30)	70 (70)	4.181	0.041
impacts on the local economy	66 (71.7)	26 (28.3)	60 (60)	40 (40)	2.927	0.087

	Resident		Tourist		χ^2	p
	Yes	No	Yes	No		
I don't know	1 (1.1)	91 (98.9)	5 (5)	95 (95)	2.424	0.120

Table 3

Descriptive analysis of the numbers (percentage) of individuals getting correct answers to general Florida Red Tide Knowledge questions in number (percentage); and tests of significant differences between FL residents and tourists.

	Resident	Tourist	χ^2	p-value
What is the make up of FL red tide?				
correct answer	55 (59.8)	68 (68)	1.405	0.236
What causes FL red tide?				
at least one correct answer	41 (44.6)	31 (31)	3.762	0.052
all and only correct answers	31 (33.7)	28 (28)	0.730	0.393
Is FL red tide new?				
correct answer	88 (95.7)	98 (98)	0.873	0.350
When can FL red tide occur?				
at least one correct answer	49 (53.3)	21 (21)	21.527	<0.0001
all and only correct answers	46 (50.0)	21 (21)	17.738	<0.0001
What can FL red tide cause?				
at least one correct answer	89 (96.7)	96 (96)	0.075	0.785
all and only correct answers	48 (52.2)	33 (33)	7.223	0.007

Table 4

Descriptive analysis of the original answers to the questions concerning Human Health Issues during Florida Red Tide in number (percentage), and tests of significant differences between FL residents and tourists

	Resident			Tourist			χ^2	p
	Yes	No	DK*	Yes	No	DK*		
Is it safe to catch and eat fish during FL RT?	16 (17.6)	57 (62.6)	18 (19.8)	22 (22)	55 (55)	23 (23)	1.171	0.557
Is it safe to harvest and eat shellfish during FL RT?	6 (6.6)	71 (78.0)	14 (15.4)	25 (25)	50 (50)	25 (25)	18.008	<0.0001
Is it safe to eat shellfish from stores/restaurants?	42 (46.2)	30 (33.0)	19 (20.9)	50 (50)	27 (27)	23 (23)	0.812	0.666
Is it safe to swim in FL red tide?	44 (48.4)	37 (40.7)	10 (11.0)	21 (21)	50 (50)	29 (29)	18.955	<0.0001
Have there been reports of human death from FL red tide?	7 (7.6)	48 (52.2)	37 (40.2)	33 (33)	32 (32)	35 (35)	19.857	<0.0001

* DK = Don't Know

Table 5

Descriptive analysis of the numbers (percentage) of individuals getting the correct answer to Human Health Issues during Florida Red Tide questions in number (percentage); and tests of significant differences between FL residents and tourists.

	Resident	Tourist	χ^2	p-value
Is it safe to catch and eat fish during FL RT?	16 (17.4)	22 (22)	0.641	0.423
Is it safe to harvest and eat shellfish during FL RT?	71 (77.2)	50 (50)	15.183	<0.0001
Is it safe to eat shellfish from stores/restaurants?	42 (45.7)	50 (50)	0.363	0.547
Is it safe to swim in FL red tide?	44 (47.8)	21 (21)	15.399	>0.0001
Have there been reports of human death from FL red tide?	48 (52.2)	32 (32)	8.024	0.005

Table 6

Descriptive analysis of the original answers to the questions concerning usage of beaches and informational resources during Florida Red Tide in number (percentage); and tests of significant differences between FL residents and tourists

	Resident			Tourist			χ^2	p-value
	Yes	No	DK*	Yes	No	DK*		
Would you go into the water during a red tide?	27 (30.0)	60 (66.7)	3 (3.3)	38 (38)	49 (49)	13 (13)	8.720	0.013
Would you travel to the beach during a red tide?	42 (46.7)	45 (50)	3 (3.3)	33 (33)	49 (49)	18 (18)	11.470	0.003
Where would you go to learn more about FL red tide?								
local TV news reports	44 (47.8)	48 (52.2)		58 (58)	42 (42)		1.992	0.158
phonebook	4 (4.4)	88 (95.7)		12 (12)	88 (88)		3.673	0.055
internet	49 (53.3)	43 (46.7)		80 (80)	20 (20)		15.540	<0.0001
Mote Marine Laboratory and Aquarium	61 (66.3)	31 (33.7)		46 (46)	54 (54)		8.007	0.005
none	0 (0)	92 (100)		1 (1)	99 (99)		0.925	0.336
other	10 (10.9)	82 (89.1)		1 (1)	99 (99)		8.642	0.003
I don't know	3 (3.3)	89 (96.7)		0 (0)	100 (100)		3.313	0.069
If you were at the beach, would you read a beach sign with red tide information?	82 (91.1)	5 (5.6)	3 (3.3)	87 (87)	8 (8)	5 (5)	0.816	0.665
Would you call a toll free number to learn more about red tide?	47 (52.2)	37 (41.1)	6 (6.7)	14 (14)	86 (86)	0 (0)	42.966	<0.0001

* DK = Don't Know