Article

Red Tide Outreach in Florida: Message Framing, Environmental Emotions, and Support for Mitigation

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Abstract: "Red tide" is the popular name for a harmful algal bloom that occurs frequently in Florida waters and has significant impacts on the environment, the economy, and human and animal health. This paper addresses the limited understanding of public attitudes surrounding red tide and the potential for message framing to increase support for mitigation action. A sample of Florida residents (n = 498) was randomly shown a digital article framed around different red tide impacts (economic loss, human health risks, ecosystem damage, or harm to charismatic species) or a control article not framed around a specific red tide impact. Participants were then queried about their emotional responses, support for red tide mitigation policies, and intentions to change their behavior to mitigate impacts. Participants reported higher levels of negative emotions after viewing the harm to charismatic megafauna framing, indicating that messaging may play a significant role in eliciting environmental emotions. Message frames did not significantly impact other policy attitudes. Results demonstrate barriers to shifting support for mitigation where public support for action is already high.

1. Introduction

"Red tide" is a popular name used to describe harmful algal blooms (HABs) causing significant environmental, economic, and human and animal health issues [1]. These blooms occur naturally in the marine environment but are believed to be exacerbated by anthropogenic influences, including global climate change [2], nutrient enrichment [3], atmospheric deposition [4], sewage effluent [5], and groundwater discharge [6]. Though red tides are found worldwide, the most frequently occurring and long-lasting blooms appear on Florida's west coast [7] and have been observed in the state's surrounding waters since the 1840s [1].

Red tide HABs are predominantly composed of the toxic dinoflagellate *Karenia brevis*, which produces potent natural neurotoxins known as brevetoxins [8]. Red tides occur when environmental conditions favorable to *K. brevis* cause rapid algal population growth and release brevetoxins into the surrounding environment in high concentrations [9]. *K. brevis* easily breaks apart in the surf, disperses into marine waters [10], and becomes aerosolized [11]. This creates two primary routes of exposure to brevetoxins, inhalation and ingestion, threatening human [12] and animal health [13].

Red tide blooms have been linked to large-scale fish kills, deaths among seabirds and marine mammals such as dolphins and the endangered Florida manatee (*Trichechus manatus latirostris*) [10], and increased frequency of stranding and mortality events among sea turtles [14]. Ingestion is a significant route of lethal red tide exposure in marine animals, with food sources such as seagrass and live fish acting as vectors for brevetoxin [13].

Exposure to aerosolized brevetoxin alone is not believed to be a direct cause of wildlife mortality; however, inhalation of *K. brevis* is known to cause sublethal effects among marine animals [13], including reduced immune system function [15,16], reflex impairment [17], decreased hearing sensitivity [18], and, potentially, diminished reproductive success [19].

Human illness associated with HABs is brought on by exposure to food, water [20], and aerosols containing brevetoxin [1]. Consumption of tainted seafood can lead to illnesses such as neurotoxic shellfish poisoning (NSP) [21], and a study by Kirkpatrick et al. [22] found that emergency room hospitalizations for gastrointestinal diseases were significantly higher during a red tide period than a non-red tide period. Exposure to aerosolized brevetoxin has been linked to respiratory issues, eye and throat irritation, nasal congestion [23], neurological issues such as headaches [23,24], and adverse health effects, including increased respiratory impairment among individuals with asthma [10].

Economic impacts of HABs include declines in property values [25]; reduced tourism and recreation in red-tide-affected areas; closure of shellfish beds and depressed shellfish commerce; public health and medicine costs from illnesses related to red tide exposure; marine animal health issues; and deposits of millions of tons of dead fish onto shores along beaches, canals, and rivers [1]. These impacts can be difficult to quantify as some of the costs of these events may go unrecognized and unreported [1].

Policy action aimed at mitigating red tide is limited, possibly because red tide is naturally occurring and known anthropogenic influences on frequency and intensity are difficult to regulate. In a 2021 report, the Florida Fish and Wildlife Conservation Commission (FWC) Harmful Algal Bloom Task Force (HABTF) proposed that additional resources were needed to protect public health from red tide and better communicate the risks of HABs [26]. The State of Florida has identified combatting HABs and improving water quality as budget priorities [27,28].

Because red tides are believed to be exacerbated by human influences, mitigation efforts on individual and government levels may be helpful in reducing the severity of blooms. The harmful effects of nutrient enrichment may be reduced through the implementation of and adherence to water pollution control policies [25], reduction of impervious ground and surface cover [29], conversion of outdated septic systems [30], and use of rainwater collection devices such as rain barrels, among other methods. Individuals may also contribute to mitigation efforts by choosing to vote for local and state politicians who promise to prioritize red tide issues. Since global climate change is a known driver of HABs [2], steps taken by individuals to minimize their contribution to climate change (e.g., shrinking personal carbon footprints through reducing direct emissions and being a low-carbon consumer and citizen [31]) may also help to lessen the severity and harmful impacts of red tide blooms.

Despite the frequency with which red tide occurs in Florida and the significance of its environmental, economic, and health impacts, social science research surrounding HABs in Florida waters is relatively limited. Some existing research focuses on Florida residents' perceptions of and opinions about water, water quality, and related issues within the state (e.g., [32–34]). Leal et al. [32] and Borisova et al. [34] both surveyed perceptions of water issues in Florida's groundwater and surface waters, including rivers, lakes [32,34], channels, wetlands, springs, estuaries, oceans, and bays [32]. Leal et al. [32] found that most survey respondents considered water quality and quantity issues extremely or highly important. Borisova et al. [34] reported that 14% of respondents had no opinion/did not know about surface water quality in their area, while 28% had no opinion/did not know about groundwater quality in their area. Odera and Lamm [33] explored opinions about water in Florida among the region's public. The authors found that while 84% of survey respondents considered Florida's water issues extremely or highly important, these beliefs did not always correlate with willingness to take action to conserve water [33]. Familiarity with water-related policies among the general public was also found to be low [33].

Other research has centered around public perceptions of red tide and its risks [25,35–38], with some studies examining red tide perception through the lens of

existing news coverage [39] and social media posts [40]. Still, other studies explore human behavior related to red tide [25,35–37]. Cahyanto and Liu-Lastres [35] compared perceptions of red tide and related behavior changes among Florida residents and visitors, considering the influence of media exposure on individuals surveyed. Their findings indicated that individuals with more media exposure perceived greater red tide risk and were more likely to adopt behavior changes such as avoiding beaches and changing travel plans.

Kirkpatrick et al. [25] investigated perceptions of red tide alongside knowledge about and adherence to a local fertilizer ordinance in Sarasota County by surveying Florida residents and "snowbirds" (individuals living in Sarasota for three to six months per year). The authors found that most participants were unfamiliar with local fertilizer regulations, and fewer than 25% of these individuals reported knowingly complying with these regulations. Morgan et al. [36] examined the impacts of red tide on South Florida residents' participation in four marine-based activities (beachgoing, saltwater fishing from a boat, saltwater fishing from a pier, and patronage of coastal restaurants). The authors found that the probability of individuals cutting short, delaying, or relocating these activities was directly related to the amount they participated in each activity, with the exception of boat fishing [36]. Attendance records of Sarasota County lifeguards during a red tide period and a non-red tide period were compared by Nierenberg et al. [41] and showed a statistically significant increase in absenteeism (vacation days and sick days) during the red tide period.

Social science research exploring perceptions of and responses to red tide can fill important gaps in our existing knowledge and understanding of HABs. This research is significant in its potential for use in better assessing local impacts of red tide blooms [40] and identifying potentially dangerous misperceptions about red tide [37]. Social science research may also be useful in informing our knowledge of how red tide risk is perceived [35,38,39], discerning behavioral changes contributing to economic losses caused by red tide [35,36,41], measuring adherence to and considering the effectiveness of water pollution control policies [25], and contributing to our understanding of Florida residents' knowledge of and attitudes toward state and local water issues [32–34].

Social science approaches are also critical in recognizing opportunities for improved education and outreach. Message framing is a communication strategy [42] centering around the way issues are articulated and approached [43]. Different frames can be used to highlight or deemphasize elements of reality and elicit varying reactions among audience members [43]. Strategic message framing may serve to increase effectiveness in the way messages are delivered to target audiences [43]. This strategy can be useful in motivating behavior changes [42] by emphasizing consequences like gain, loss, or fear [44]. Different types of message frames, such as those discussing positive and negative consequences, may differ in their ability to bring about behavior changes (e.g., [45]).

Results of studies on environmental message framing are often inconsistent. Some have found that respondents were more willing to give money and time to wildlife conservation organizations when exposed to positive frames [46], while others suggest that negative framing was more effective in eliciting pro-environmental behaviors among consumers [45]. Though negative frames may sometimes be useful, overly negative communications can result in feelings of being overwhelmed or helplessness among audiences, which may lead to decreased engagement and motivation to act pro-environmentally [47]. Some research suggests that demographic factors like gender could impact responses to different types of frames [48], but other studies have shown this to be unpredictably variable [46]. Because environmental communications may convey a wide array of topics to a wide array of target audiences, neither positive nor negative message framing can be considered definitively "better" in efforts to drive behavioral change. With studies on this topic remaining contradictory, future research may help to reveal which types of frames are most appropriate and effective for specific subjects and target audiences.

One approach that may hinder environmental communication campaigns is focusing on simply informing the public about environmental issues in the hope of increasing pro-environmental behavior [49]. Scientists may believe that facts "speak for themselves" (p. 3)

and should, therefore, be sufficient to cause behavior changes among audiences [43]. Although awareness of environmental issues is an important factor in the adoption of pro-environmental behaviors [50], research has shown that in most cases, knowledge alone is not enough to bring about behavior changes [49]. This gap between knowledge and behavior is documented in existing environmental research (e.g., [51,52]). It is clear that communication campaigns need to go further to address the task of changing behavior, which can be difficult even if the desired change is minor and the new behavior shows distinct benefits when compared to the old [49]. Information may be transmitted in more impactful ways when the goal of eliciting action is consciously incorporated into strategic communications.

According to Carmi et al. [53], although providing knowledge is an important part of creating changes in behavior, environmental knowledge must evoke emotions in order to drive behavioral change. Emotions are important factors in the way information is collected, stored, and used to develop judgments [54]. In conservation messaging, emotions may play a role in persuasion, as they significantly affect people's perspectives and cognitive efforts, such as decision making and message processing [54]. To drive changes in behavior, it is vital to consider emotions not only when designing the content of message frames but also when evaluating the impacts of different frames.

Message framing allows us to incorporate individual motivations, such as values, into communication efforts [55]. Value frames in environmental communications may be anthropocentric (human-focused), ecocentric (ecosystem-focused), or biocentric (focused on the inherent value of living things) [56]. These frames will be most effective when they represent the values of their target audiences. For example, Kolandai-Matchett and Armoudian [57] note that while anthropocentric value frames are highly effective among general audiences, ecocentric value frames are suitable specifically for individuals who believe in the intrinsic value of nature. However, predicting an audience's values is not always a straightforward task.

Social science research on red tide is relatively limited, and much of it is outdated. This study aims to expand on existing research to assess how message framing might be used in public-facing outreach on red tide. We used a randomized experimental design to expose participants to message frames emphasizing different aspects of red tide impacts, including eco- and anthropocentric values. Impacts of different frames were measured to assess (a) the immediate emotional reaction of participants, (b) levels of support for various red tide mitigation strategies, and (c) intentions to change personal behavior to mitigate red tide impacts. We explored associations between key individual differences and outcome variables and discussed implications for conservation messaging and policy outreach.

2. Materials and Methods

An online survey was distributed to a sample of Florida residents (n = 498) ages 18–78 (M = 39.28, SD = 11.87) via crowdsourcing website Mechanical Turk (www.mturk.com) (accessed on 1 August 2023). Data collection took place in late June 2022, and all information was submitted anonymously to limit biases (e.g., social desirability and response bias). Participation eligibility was limited to English–speaking Florida residents over the age of 18 with access to computers or other internet-accessible devices. Eligible participants accessed the questionnaire through the online survey platform Qualtrics (www.qualtrics.com) (accessed on 1 August 2023) and were compensated $1.00 upon completion. The survey was expected to take about 5 min. An attention check question was included in the questionnaire, and responses from participants who answered this question incorrectly were excluded. The resulting sample size after these exclusions was 433. This research protocol was approved by the University of Miami's Institutional Review Board (protocol #20191209).

Upon entering the questionnaire, those surveyed were shown, at random, one of four mock news article clips about red tide or an excerpt of information about red tide, which served as a control. Each of the four articles was designed using a different message frame: economic loss, human health risks and impacts, environmental damage, or harm

to charismatic species (see Supplementary Materials). A timer was utilized to ensure that participants viewed their articles for at least 30 s.

After viewing these articles, individuals were asked to respond to survey questions by selecting answers on Likert-type scales. Where items were collated into a single-measure Cronbach's alpha (α) is provided as an indicator of internal reliability:

- Emotional response (5 items): participants reported to what degree the articles made them feel five different emotions (anxious/worried, angry, disgusted, sad, or happy) on a five-point scale from "none at all" to "a great deal";
- Support for policy action (11 items): respondents indicated their support for different policy actions to mitigate the frequency and severity of red tide outbreaks using an 8-point scale from "unsure/don't know" to "strongly support" (α = 0.88);
- Personal experience with red tide (5 items): participants designated ways in which they or people they know have been affected by red tide on a five-point scale from "strongly disagree" to "strongly agree" (α = 0.77);
- Intention to take personal action (12 items): individuals surveyed described their intentions to make behavior changes and take personal actions to reduce red tide and its impacts using a five-point scale from "strongly disagree" to "strongly agree" (α = 0.86);
- Environmental attitudes (9 items): respondents reported their positions on environmental issues on a five-point scale from "strongly disagree" to "strongly agree" (α = 0.76).

At the end of the survey, demographic information was collected for the purposes of data characterization and exploring possible correlations between demographic data and survey responses. Participants were asked to share their gender identity, age, education level, household income range, ethnicity, race, political identity and affiliation, and zip code.

The Kruskal–Wallis test was utilized as a non-parametric alternative to an analysis of variance (ANOVA). This test was used to determine differences in survey answers regarding emotional responses, support for policy action, personal experience with red tide, intent to take personal action, and environmental attitudes among participants who were assigned different message frames. Spearman's Rho was performed as a non-parametric correlation measure to identify ways in which differences in demographic and identity information related to key outcome variables.

3. Results

3.1. Demographic Data

Just under half (48.0%) of respondents identified themselves as male, whereas 50.8% identified themselves as female. The remaining 1.2% of the sample either identified as gender variant/gender non-conforming, selected "prefer not to answer", or did not respond to this question. Participants ranged in age from 18 to 78 (M = 39.28, SD = 11.87). More than half (57.3%) of participants held a bachelor's degree as their highest level of education. Of the remaining respondents, 0.7% had not achieved a high school degree, 7.9% were high school graduates, 12.2% had completed 1–4 years of college but held no degree, 6.7% had an associate's degree, and 15.2% had completed at least one graduate degree. Household income ranged from under $15,000 (6.7% of participants) to over $100,000 (9.9% of participants). About half (48.5%) of respondents fell within an income range of $36,000–$74,999. Most participants identified as White (81.8%) and non-Hispanic or Latino (75.1%). Other respondents identified as American Indian or Alaska Native (1.2%), Asian (2.1%), Black or African American (11.8%), or other (2.1%).

About half (47.6%) of participants described themselves as moderately or extremely liberal, while 29.8% described themselves as moderately or extremely conservative, and 22.4% identified as politically neutral. Just under half (46.7%) of respondents identified as Democrats, while 28.4% identified as Republicans, 19.4% identified as independent, and 0.7% identified as belonging to another party. Additionally, 4.8% of participants did not associate with any political party. Individuals from 304 Florida zip codes participated in this survey. These zip codes were distributed throughout the state, and most were located inland rather than along coasts.

3.2. Did Different Treatment Frames Elicit Different Emotions?

Participants exposed to different treatment frames reported different emotional reactions (Figure 1). Respondents who read the framed articles (economic loss, human health risks and impacts, environmental damage, and harm to charismatic species) experienced significantly more sadness compared to respondents in the control group ($\chi^2(4) = 31.29$, $p < 0.001$). The "harm to charismatic species" frame elicited significantly more sadness and anger than any other frame ($\chi^2(4) = 19.98$, $p < 0.001$) and significantly more disgust than the control ($\chi^2(4) = 9.73$, $p < 0.05$). Significantly greater anxiety was reported by participants who were assigned the "harm to charismatic species" and "economic loss" frames compared to the control (anxiety $\chi^2(4) = 16.41$, $p < 0.01$). The "harm to charismatic species" frame produced the most anxiety, while the "economic loss" frame produced significantly more anxiety than the "environmental damage" and "human health risks and impacts" frames. There was not a significant difference in feelings of happiness among participants exposed to the different frames (happiness $\chi^2(4) = 5.90$, $p = 0.21$).
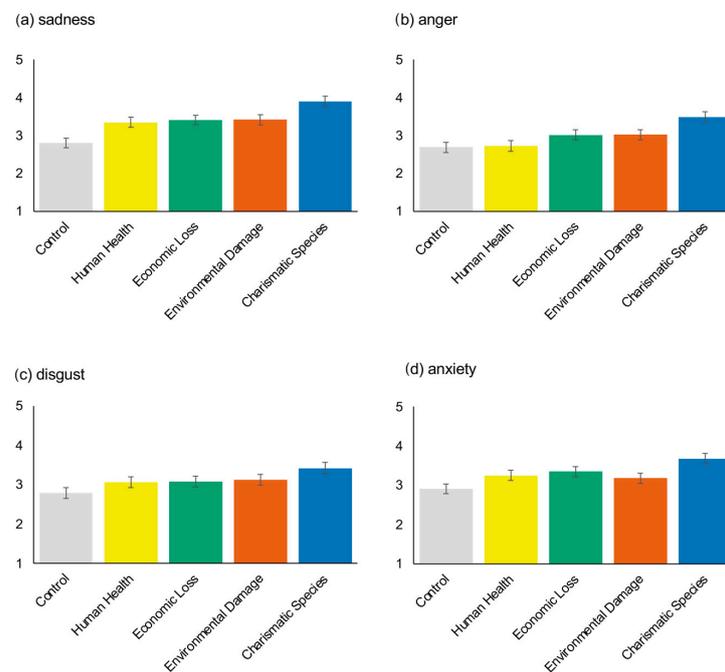

Figure 1. This figure compares respondents' emotional reactions to the different articles presented in our survey. Schemes follow the same formatting.

3.3. Did Different Treatment Frames Relate to Other Key Outcomes?

There were no significant differences in support for red tide policy action ($\chi^2(4) = 4.95$, $p = 0.29$), beliefs that addressing red tide should be a priority ($\chi^2(4) = 3.46$, $p = 0.49$), or intention to take personal action among respondents exposed to different treatment frames ($\chi^2(4) = 5.99$, $p = 0.20$).

3.4. How Do Different Outcomes, Covariates, and Individual Differences Relate to Each Other?

Correlations between key variables and individual differences are presented in Table 1. Our results showed that negative emotional responses (anger, sadness, anxiety, and disgust) to the red tide articles were related to beliefs that addressing red tide should be a priority, intention to take personal action, and support for policy action. Participants who had been impacted personally by red tide reported stronger emotional reactions—including happiness—to the articles. Personal experience with red tide is also related to the intention to take personal action and the belief that addressing red tide should be a priority. Respondents of different ages, genders, political parties, and political ideologies reported having similar amounts of experience with red tide and its impacts.

Table 1. Spearman Rho correlations between key variables and individual differences. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Variable	M	SD	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
1. Support for policy	5.69	0.85																
2. Personal behavior	3.92	0.78	0.56 **															
3. Addressing red tide should be a priority.	4.03	0.91	0.53 **	0.55 **														
4. Sadness	3.36	1.27	0.30 **	0.35 **	0.29 **													
5. Happiness	2.18	1.50	−0.20 **	0.02	−0.08	−0.19 **												
6. Anger	2.97	1.30	0.23 **	0.36 **	0.28 **	0.64 **	0.02											
7. Disgust	3.09	1.30	0.23 **	0.35 **	0.22 **	0.56 **	0.11 *	0.68 **										
8. Anxiety/worry	3.26	1.22	0.20 **	0.42 **	0.24 **	0.60 **	0.04	0.64 **	0.56 **									
9. Gender	0.51	0.50	0.06	0.11 *	0.04	0.10 *	−0.16 **	0.02	0.003	0.07								
11. Political identity (liberal)	3.22	1.30	0.18 **	0.17 **	0.18 **	0.02	−0.03	0.07	0.01	0.11 *	0.10 *							
12. Age	39.29	11.87	0.07	0.10 *	0.08	0.05	−0.13 **	−0.01	0.03	−0.02	0.05	0.06						
13. Environmental attitudes	2.56	0.43	0.57 **	0.61 **	0.46 **	0.27 **	−0.10 *	0.21 **	0.24 **	0.25 **	0.15 **	0.26 **	0.10 *					
14. Personal experience with red tide	3.39	0.96	0.10	0.36 **	0.14 **	0.20 **	0.45 **	0.30 **	0.34 **	0.35 **	−0.03	−0.01	−0.04	0.18 **				
15. I live somewhere that is impacted by red tide	3.67	1.20	0.22 **	0.24 **	0.14 **	0.13 **	0.12 *	0.15 **	0.14 **	0.17 **	0.08	0.02	0.003	0.20 **	0.57 **			
16. I or someone I know has lost income because of red tide	2.84	1.47	−0.11 *	0.22 **	0.04	0.12 *	0.56 **	0.29 **	0.28 **	0.28 **	−0.11 *	−0.01	−0.10 *	−0.01	0.77 **	0.23 **		
17. I or someone I know has been made sick by red tide	2.97	1.46	−0.08 *	0.19 **	0.01	0.15 **	0.48 **	0.22 **	0.25 **	0.24 **	−0.11 *	0.001	−0.09	0.04	0.79 **	0.28 **	0.66 **	
18. I have personally observed the effect of red tide on the environment (e.g., dead fish, etc.)	3.63	1.37	0.23 **	0.31 **	0.15 **	0.17 **	0.10 *	0.18 **	0.22 **	0.23 **	0.10 *	0.001	0.07	0.22 **	0.68 **	0.44 **	0.29 **	0.37 **

Political ideology is also related to key outcomes. Compared to conservative participants, those who described themselves as liberal were more likely to believe that red tide should be a priority, declare an intention to take personal action, and support policy action. However, there was not a significant difference in these outcomes among Democrats, Republicans, and respondents associated with other political parties. Our findings also indicate that intent to take personal action was more frequently reported by women than men.

4. Discussion

In this paper, we present the first study to explore how message framing could affect Floridians' support for red tide policy action and emotional responses to red-tide-focused content. Though our survey results showed that support for policy action did not differ significantly among participants exposed to different treatment frames, significant differences in emotional responses among the five groups were identified. While happiness was consistent across experimental groups, respondents who read the "harm to charismatic species" article reported elevated levels of sadness, anger, disgust, and anxiety. Comparatively greater feelings of anxiety were also noted by participants assigned the "economic loss" frame, and all four of the framed articles elicited significantly more sadness than the control.

These results indicate that the use of message framing in red tide outreach may play a significant role in eliciting environmental emotions. Some of our findings align with ideas found in the existing literature. The significant emotional impact of the "harm to charismatic species" frame was not necessarily a surprising result, as humans tend to possess an inherent sensitivity toward wildlife [58] and may, therefore, experience negative emotions when animals are threatened. This result supports Kolandai-Matchett and Armoudian's [57] assertion that human–nature relationship frames, which center around love and empathy toward wildlife, might be more effective in marine conservation outreach than frames based on guilt and fear.

Kolandai-Matchett and Armoudian [57] also suggest that value frames based on anthropocentrism may be more effective for general audiences than those based on ecocentrism. Negative emotions such as anxiety were reported at significantly higher levels in response to the "economic loss" frame compared to the "environmental damage" frame. However, these emotions were also reported at significantly higher levels in response to the "charismatic species" frame compared to the "human health risks and impacts" frame. This may reveal red tide risk perceptions and priority hierarchies of respondents. Our findings could suggest that participants perceive red tide as a greater risk to animal health than human health and a greater risk to the economy than the environment. On the other hand, these results may indicate that respondents prioritize economic loss over environmental damage from red tide and are more concerned about harm to charismatic species than the generally non-lethal human health effects caused by these blooms.

The existing literature states that "environmental knowledge can drive environmental behavior only if it arouses environmental emotions" [53] (p. 183). Despite the documented emotional impacts of the various treatment frames and the widespread agreement among participants that addressing red tide should be a priority, the results of our survey showed no significant differences in support for red tide policy action or intention to take personal action among members of the five participant groups. Other studies, such as Odera and Lamm's [33] study of public opinions about water in Florida, show a similar discrepancy between survey responses assigning great importance to certain issues and responses indicating comparatively lower motivation to take personal action to mitigate these issues. In the case of our study, this may relate to Markowitz and Guckian's [47] suggestion that negative message framing can cause feelings of helplessness among audiences and ultimately lead to decreased engagement and motivation to act pro-environmentally. Future studies on red tide message framing should consider exploring the efficacy of more positive frames as motivators of policy action support and personal behavior change.

Confusion surrounding different policies and behaviors and their roles in mitigating red tide may have also contributed to the discrepancy between reported emotions and reported policy support and action intentions. Our survey, designed with the goal of brevity, did not elaborate on the potential red tide mitigation effects of each behavior and policy listed; in a longer survey, the inclusion of this information might yield different results. However, presenting participants with more information will not necessarily influence policy support or intent to act pro-environmentally. It is noteworthy that the mean scores on scales for policy support and behavioral intention were very high across our sample. This indicates that our measures of these concepts may suffer from ceiling effects. Additionally, interventions to mobilize existing support rather than further attempts to influence public attitudes may be needed.

Research suggests that emotions can predict behavioral intentions toward environmental issues like climate change [59]. Risk assessment is another potential predictor of behavior. Boso et al. [60] found that individuals in highly polluted areas of Chile who categorized health risks from air pollution as "severe" were more likely to take personal action to reduce pollution, whereas those who believed indoor air quality to be "regular or good" were less likely to take action. However, there are many other factors that may positively or negatively influence pro-environmental behavior [49], some of which are difficult to identify and document in a survey. While some of these factors, such as economic and cultural factors, can be accounted for by collecting demographic information about income and cultural background, others, such as motivation, attitudes, values, and locus of control ("an individual's perception of whether he or she has the ability to bring about change through his or her own behavior" [49] (p. 243)), are harder to record. These factors may guide individuals' decisions on whether to support certain policies or make certain behavior changes.

In addition to supplementing our understanding of the relationship between red tide message framing, emotions, and support for policy action, the results of this survey also shed light on some interesting correlations between demographic information and survey responses. For example, the relationship we found between political identity and key outcomes aligns with existing research stating that liberals generally show greater concern for the environment than conservatives [61]. Interestingly, while political ideology was predictive of beliefs that red tide should be a priority, intention to take personal action and support for policy action, political party affiliation was not. This might indicate that red tide's impacts transcend party lines and affect people in similar ways regardless of political affiliation; our results indicate the potential for tackling red tide as a bi-partisan issue. The relationship between gender and intent to take personal action in our study also aligns with existing research that states women are more likely to adopt pro-environmental behavior changes than men [62]. Differences in environmentalism among genders may stem from different cultural norms and expectations introduced to boys and girls in childhood socialization, which can shape thinking and behavior later in life [63]. Another school of thought suggests that differences in social roles between men and women may contribute to the discrepancy in environmentalism among genders [63]. Further research into this discrepancy may benefit environmental communication efforts by informing ways that messages can be tailored to maximize pro-environmental behavior changes among men.

A potential limitation in our research arises because data were collected in late June of 2022, a period during which red tide counts were either very low or not present at all in Florida waters [64]. Our survey was cross-sectional and might evoke different responses and results if duplicated during periods of varying red tide presence. Our use of an online survey may have been a limiting factor for participants, as only those with access to and experience with internet-enabled devices were able to respond. This data collection method might present a barrier for certain groups (e.g., older or less wealthy individuals). Analysis of this study's results may also be limited because of difficulties accounting for various factors influencing pro-environmental behavior and support for policy action, such as those discussed by Kollmuss and Agyeman [49]. Because our research is preliminary,

further study is needed to better understand how message framing can affect individuals' responses to red tide outreach.

5. Conclusions

To our knowledge, this study is the first to show that different message framing strategies in red tide outreach may be useful in eliciting specific emotions among Floridians. We found that different message frames evoked different emotions among respondents, and frames focusing on economic loss and harm to charismatic species were particularly evocative of negative emotions. Results of our study also revealed relationships between emotional responses to red tide outreach and factors like individual experiences, beliefs, and values. These findings fill a gap in the body of knowledge surrounding red tide communication strategies; the results of this research may help to inform the development of more effective outreach techniques and materials and thus contribute to perpetuating vital red tide mitigation efforts. Future research on message framing and red tide outreach building on the findings of this preliminary study will further benefit these efforts.

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