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Education and notification approaches for harmful algal blooms (HABs), Washington State, USA

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ABSTRACT

While numerous strategies have been used to educate and notify the public about potential hazards from exposure to Harmful Algal Blooms (HABs), at present there are no national guidelines or suggested outreach approaches. To raise public awareness and determine effective HAB outreach methods, two Washington State agencies and three counties in the Puget Sound region implemented several education and notification strategies. These approaches were rated for effectiveness by state and county public health and water quality professionals. At the state level, the most effective action was a three-tiered advisory posting protocol for notifying external users that was introduced to local health jurisdictions at workshops around the state. Supplemental permanent signage is recommended for lakes with blooms to overcome the time lag between HAB onset and testing/posting. The state also implements effective notification of toxicity test results through a web-based HAB database and listserv. Lake residents were best notified through electronic alerts including email and social media while mailers to lake residents were useful during initial HAB events and to gain subscribers to electronic alerts. Press releases were most valuable when used sparingly for severe blooms or for blooms in large lakes. Initial analyses of lake recreational use indicates these strategies encourage behavior change in lake users. Based on these findings, a general framework for HAB outreach and a specific notification strategy is proposed to assist other regions or agencies that are developing HAB education and notification programs.

1. Introduction

Water quality plays a critical role in the daily lives of people, as shown by recent incidents in drinking water with lead in Flint, Michigan (2015) and toxic cyanobacteria in Toledo, Ohio (2014) and Florida (2016). Cyanobacteria (blue-green algae) are photosynthetic organisms found in marine and freshwater environments, and many species produce metabolites that are toxic to people, pets and wildlife. The risk to human health due to increasing presence of these toxins is of concern (De Figueiredo et al., 2004; Svrcek and Smith, 2004) since people are exposed to harmful algal bloom (HAB) toxins through drinking water, recreational activities, aerosols and consumption of fish and shellfish (Gupta et al., 2003; Walker, 2015). In the Toledo area, more than 400,000 people were without drinking water for 56 h after HAB toxin concentrations spiked above an action level developed by the U.S. Environmental Protection Agency in the drinking water plant finished water (Cha and Stow, 2015; Ho and Michalak, 2015; Jetoo et al., 2015). In Lake Okeechobee, Florida, a cyanobacterial bloom covered roughly 33 square miles of the lake and affected water quality downstream to the Atlantic Ocean. Detection of blooms and their associated toxins have been increasing over time, in part from contributions of anthropogenic phosphorus and nitrogen inputs into water bodies (Newcombe et al., 2012; Paerl et al., 2011). Better understanding of water quality issues such as HABs, nutrients and regional climate change is necessary to improve policies, protect public health, and inform consumer choices.

Washington is one of many states experiencing increased HABs from cyanobacteria in lakes, ponds, streams, and rivers. Microcystins (MC) are the most common group of cyanobacterial toxins

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found in freshwater HABs in Washington lakes (Jacoby and Kann, 2007; Trainer and Hardy, 2015). There are around 100 MC variants of varying hepatotoxicity (Niedermeyer, 2016), and MCs have been implicated worldwide in bird, fish, livestock, wildlife, and human deaths (Mez et al., 1997; Azevedo et al., 2002; Ibelings and Chorus, 2007; Chen et al., 2009; Handeland and Ostenivic, 2010). Many Washington lakes also have cyanobacteria that produce anatoxin-a, a rapid acting neurotoxin. In addition, detectable levels of cylindrospermopsin (a liver toxin) and saxitoxin (a neurotoxin) have been found in a few state lakes (Trainer and Hardy, 2015). Effective communication about the presence and risks of cyanotoxins found in lakes should be part of any HAB monitoring program.

The need for action to improve communication about HAB exposure risks was one of five recommendations for addressing HABs and hypoxia by the 2016 Harmful Algal Blooms and Hypoxia Comprehensive Research Plan and Action Strategy developed by the National Science and Technology Council Subcommittee on Ocean Science and Technology (NSTC, 2016). Increasing reports of human illnesses resulting from HAB exposures in the U.S. and elsewhere add to the urgency of developing practical tools to alert the public of potential risks. Most HAB toxicity studies, however, focus on information for scientists, not the public. Although communication is key to helping society become more scientifically literate, effective communication is difficult since methods to communicate science to the public are constantly changing (Smith et al., 2014). Evidence-based communication and education offer the potential to address the situation (NSTC, 2016).

As an emerging environmental public health issue for people and a threat to pets and wildlife, HABs are of concern not only to local health jurisdictions (LHJs) but also to lake residents and external lake users, defined as people who use lakes but do not live on the lakeshore. Although tracking blooms and getting toxicity results to the public as soon as possible are essential for developing appropriate messaging for limiting HAB exposures and protecting lake users, there is a need to blend quantifiable data (toxin concentrations) with qualitative data (density and extent of bloom) to determine the level of risk present. In the case of HABs, communication is challenging because the variability (spatial, due to currents, wind speed and direction, waves, water releases, tides in estuarine and marine waters; and temporal, due to seasonal patterns, lake mixing, toxin levels – higher in scums and mats) associated with HAB distribution is so great and health risks are often ongoing before warning signs are posted. An additional concern is that a lake that is posted may appear safe in certain areas even if there are toxins present in other areas. Pet owners, veterinarians, clinicians and various agencies also need to be aware of the presence of toxic blooms (Hilborn et al., 2014). Since ill pets and livestock are often the first indicator of toxicity presence (Backer and Miller, 2016), it is crucial for pet owners to be able to identify signs and symptoms of HAB exposure.

The ultimate goal of an effective HAB outreach program is for people to take actions to reduce risks to themselves, their family members (including small children) and their animals. Therefore, a successful HAB outreach program should fulfill three functions: (1) raise awareness of health risks to people and pets associated with HABs, (2) educate people to recognize the potential of toxin production at a particular water body (e.g., the presence of a scum and/or a posting), and (3) clearly indicate what precautions people should take if HABs are present. To accomplish these functions, the outreach program should include elements that address both education and awareness of HABs as well as notifications to alert residents, LHJs, and the general public about toxicity levels or presence of a toxic bloom. Accordingly, in this paper "outreach" is used as the umbrella term for all HAB communications, including education and notifications. Naturally, there is overlap between these elements; for example, notifications of specific HAB events often include information to educate the public about causes and potential risks of cyanotoxins.

While several states have developed protocols for notifying the public of blooms, at present there are no national guidelines for effective communication strategies to alert the public of HAB presence or for providing information on HAB health risks. In Florida, a state with annual fresh water and marine human HAB exposures, agencies have employed a variety of outreach strategies to enhance information sharing and convey research results to the public (Kirkpatrick et al., 2004). One activity, an automated call processing menu system allowing callers to speak directly with trained poison information specialists in Spanish or English, was the first known HAB educational outreach effort to be evaluated for use and satisfaction (Fleming et al., 2007). Other effective efforts used in Florida include basic print material, an interactive website, and video and social networking. Florida investigators concluded the best way to reach specific stakeholders was to develop unique products for specific needs (Kirkpatrick et al., 2004). This advice was followed in Louisiana where HAB outreach efforts focused on educating fishermen about algae and HABs (Smith et al., 2014). Based on survey results, researchers created an educational brochure to distribute to people in fishing areas.

Many other states provide state-level outreach programs in partnership with federal and local agencies. For example, Iowa relies primarily on fact sheets, photos, and public reporting of illnesses. Massachusetts employs photos and brochures in many languages. In Wisconsin, emphasis is on reporting of HAB-related illnesses and providing web-based educational materials (WDHS, 2016); and in Oregon, HAB educational materials available from the state public health website include brochures, posters, fact sheets, and journal articles (OHA, 2016).

In Washington State, several HAB-focused programs at the state and local level were implemented over the past ten years. The purpose of this paper is to evaluate these outreach programs then to recommend the most effective outreach approaches based on evaluation results. Information used in this evaluation comes from four sources:

- A five-year pilot project, HABISS (Harmful Algal Bloom-related Illness and Surveillance System) developed by Centers for Disease Control and Prevention (CDC) that involved the Washington Department of Health (DOH), the Washington Department of Ecology (Ecology), and three counties that have experience with numerous lakes that produce HABs;
- County-led outreach by the three counties supplementing HABISS efforts;
- State-level work by state agencies to provide educational materials and create/support a website with up-to-date state-wide toxicity testing results; and
- A targeted outreach effort by DOH to reach veterinarians throughout the state.

Using an evaluation of ongoing education and notification activities, a framework is presented for the design of a HAB outreach program as well as identification of key areas for future communication development.

2. Methods

2.1. Background

Prior to undertaking the HAB outreach activities described in this paper, DOH developed HAB toxicity guidelines and a three-tier (Caution, Warning, Danger) management protocol for posting water bodies and informational signs for each tier (DOH, 2008;