

## HAB IMPACTS ALONG THE WASHINGTON COAST – STAKEHOLDER OUTREACH

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The two most important shellfish harvest activities that occur along the Pacific Coast of Washington State are the recreational Pacific razor clam (*Siliqua patula*) and commercial Dungeness crab (*Cancer magister*) fisheries. However, stakeholders in these two major fisheries have found their activities disrupted several times over the last decade by sudden increases in domoic acid levels in these shellfish, as a result of harmful algal blooms (HABs). Convincing stakeholders that HAB events truly pose a threat to human health has been a major challenge for the state fishery and health managers.

Stakeholders include the thousands of recreational fishers who sometimes travel long distances to participate in the extremely popular razor clam fishery; the hundreds of business owners who greatly benefit from the money spent by clam diggers that stay overnight or pass through Washington's small coastal communities; and the many tribal fishers who harvest razor clams for both commercial and subsistence purposes. They also include the 200 licensed Dungeness crab fishermen whose livelihood depends on this highly valued commercial product, and the owners of the crab processing and distributing facilities and their hundreds of employees.

Realizing that having accurate information allows these stakeholders to make correct decisions, WDFW has taken steps to provide information in a variety of forms, including: (1) the agency website to post general domoic acid levels in shellfish in both tabular and graphical formats; (2) annual public meetings held in various communities around the state each fall; and (3) a series of news and press releases. Also WDFW has facilitated domoic acid discussions between commercial Dungeness crab fishers, processors, state fishery managers and human health managers during the annual Tri-State Dungeness Crab Committee process with representatives from Washington, Oregon and California.

Since the summer of 2000, Washington State has been the recipient of a grant from NOAA Centers for Coastal Ocean Science Monitoring and Event Response for Harmful Algal Blooms (MERHAB) Program. This funding has allowed WDFW shellfish managers to set up a plankton-monitoring program to augment standard clam testing. A federally funded state-employed technician regularly collects and analyzes plankton samples from waters adjacent to productive razor clam beaches and Dungeness crab grounds. The data received from this monitoring program has given managers notice of pending HAB problems allowing WDFW to provide all affected stakeholders time to adjust their activities and avoid the serious disruptions that have occurred in past years. Washington State's MERHAB grant has also allowed WDFW to be a part of the larger collaborative effort of several state, tribal, federal and private partners under the umbrella of the Olympic Region Harmful Algal Bloom (ORHAB), a project that brings together the expertise of multiple partners to help look at additional ways of monitoring for HAB events.

The ORHAB project has been able to provide even more detailed information on the HAB events that can result in fishery closures. ORHAB has used a variety of outreach tools to disseminate this information ranging from maintaining a web site with details about the project, to sending a quarterly newsletter to stakeholders, to nurturing close ties to legislative representatives, both state and federal, who are regularly approached by constituents looking for solutions to HAB-related problems. ORHAB played a key role during the 2003 state legislative session where, though Washington State was facing decreasing tax revenues, lawmakers passed a bill that created a surcharge on all recreational shellfish licenses. The monies generated by this surcharge will help fund a state-supported plankton monitoring program intended to sustain the ORHAB effort once federal funding expires.

## **PIN THE PART ON THE DINOFLAGELLATE: A HANDS ON LEARNING ACTIVITY**

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Marine science education often uses animals with high student appeal, such as manatees, sea turtles, whales and dolphins, to introduce science concepts. The challenge in teaching microalgae concepts is to make the activity equally appealing and engaging to students. The activity created used an enlarged diagram of a marine dinoflagellate, *Karenia brevis*, to introduce anatomy and function concepts. The activity was simple in design, requiring only a large color diagram of the organism (laminated for durability) and hook and loop fasteners for placement of parts in the appropriate area. Because of its simplicity in design, the activity is inexpensive and can be easily reproduced. Written key words were also created and laminated to reinforce vocabulary and spelling.

This activity was found to reach a wide age range from elementary school students to high school students. The facilitator could adjust the prompts to assist the students in the proper labeling based on age. At the elementary level, basic anatomy concepts such as “nucleus” and “flagella” could be introduced. At the middle school level, labeling of the “chloroplasts” could lead to discussion of photosynthesis and the food web. At the high school level, discussion could be focused on primary productivity and harmful algal blooms (HABs). The concepts taught in this activity easily address many key points in the National Science Education standards, such as the structure and function of living systems and the diversity and adaptations of organisms.

This activity could easily be adapted to numerous algal organisms in both the marine and freshwater environments.

## **PUBLIC OUTREACH MATERIALS REGARDING HARMFUL ALGAL BLOOMS AND THEIR POSSIBLE EFFECTS ON HUMAN HEALTH**

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The potential interactions between marine and freshwater harmful algal blooms (HABs) and humans are increasing. Humans are exposed through food, drinking water, and recreational and occupational water use to an increasing number of organisms and their toxins. Nevertheless, the amount of clinical and epidemiologic research concerning acute and chronic human health effects from the HAB organisms and their toxins is relatively sparse. At the same time, the public is increasingly aware of and interested in the potential dangers associated with exposure to HABs. Public health authorities and researchers must respond to these public health concerns. The development of appropriate educational and outreach materials based on limited scientific databases is the challenge of informing the public concerning the possible human health effects of HAB organisms and their toxins, and their prevention. Educational materials developed by a group of researchers and public health personnel for general HABs, Florida Red Tide Toxins (brevetoxins), Cyanobacteria, and Ciguatera are discussed, as well as methods for their dissemination.

## **COLLABORATIVE, INTERNATIONAL PROGRAMS ON HABS**

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For decades HABS have been studied around the globe, but the comparative studies on the underlying reasons for these blooms, and the means to mitigate them when they do occur, have not been undertaken. It is now well recognized and accepted that our understanding of the population dynamics of organisms, their impacts, and the potential management implications, is dependent on working within a global arena. Although HAB impacts may be local, solutions may be found in distant locales. Several efforts have been initiated to bring a multidisciplinary, collaborative approach to the study of HABS.

The Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Programme was initiated under the auspices of the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO to address the need for broad-based advancement in the understanding of HABS. The mission of GEOHAB is to “foster international cooperative research on HABS in ecosystem types sharing common features, comparing the key species involved and the oceanographic processes that influence their population dynamics.” GEOHAB is not a source of research funding; rather, research will be supported by national funding agencies that must respond to national scientific priorities utilizing nationally based facilities, resources and expertise. GEOHAB will, however, coordinate and build on related national, regional and international efforts in HAB research within an ecological and oceanographic context, much like other large-scale ocean research projects, such as the Joint Global Ocean Flux Study (JGOFS) and the Global Ocean Ecosystem Dynamics (GLOBEC) project. The GEOHAB Scientific Steering Committee is currently planning the implementation of four Core Research Projects, representing ecosystem types in which HABS are recurrent phenomena, including (1) HABS in Upwelling Regions, (2) HABS in Semi-confined Eutrophic Zones and Estuaries, (3) HABS in Fjords and Coastal Embayments and (4) HABS in Stratified Regions. The initial Core Research Projects will encourage involvement of the scientific community and international Open Science Meetings are being held on each of these four topics to encourage wide participation.

A significant new program for joint research in Europe and the US is currently underway through financial support from the European Commission (E.C.) and the U.S. National Science Foundation (NSF). This collaborative EU-US Programme on HABS builds on a joint workshop that was held in September 2002 in Italy. The outcome of that workshop was a planning document which outlines the opportunities provided by this program. The first call for proposals was announced this fall, and proposals are currently under review. The rationale for comparison of similar harmful algal events and taxa across environmental and species is compelling. The global research community, as well as HAB management community will benefit from these collaborations.

## STATE OF DELAWARE HAB SURVEILLANCE MONITORING PROGRAM

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The Delaware Department of Natural Resources and Environmental Control initiated a HAB Surveillance Monitoring Program as an expansion of the existing *Pfiesteria* Surveillance Monitoring Program, which started in May 1998. This State Program is truly a partnership effort between experts in academia and state and federal natural resource agencies from Maryland to Florida. They assist Delaware in conducting analyses not available within the State and in confirming HAB species identifications.

The Program is dynamic. Spatial and temporal monitoring changes are made to reflect newly acquired knowledge from local and regional monitoring efforts as well as from research programs. New technologies and detection tools are added to the program as needs arise to document existing environmental conditions. Recently, the State developed a Standard Operating Procedure for the use of a commercially available biotoxin kit.

The Program now consists of both an estuarine and a freshwater component. In the Delaware Inland Bays, we monitor for HABs using light microscopy and DNA molecular probes. Up to 45 water-based environmental variables are recorded per collection. Sediment sampling is conducted in the spring and fall to locate potential HAB “seed banks”. Continuous monitoring of salinity, temperature, and DO exists at 8 sites within the three waterbodies. Water sample collections are performed by both State agency scientists and citizen monitors, who also serve as the “eyes and ears” for the State in detecting episodic HAB events.

The freshwater surveillance monitoring effort is directed toward obtaining information on bluegreen algae blooms in ponds/lakes historically known to exhibit bloom conditions. We test selected lakes for microcystin, a toxin associated with *Anabaena* and *Microcystis*, using both a field application kit and a more quantitative laboratory analysis.

## **DEVELOPMENT AND DISSEMINATION OF A FREQUENTLY ASKED QUESTION (FAQ) CARD ABOUT THE FLORIDA RED TIDE, *Karenia brevis***

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The Florida coastline is well known for onshore *Karenia brevis* blooms. The State experiences onshore red tides annually which significantly affects the quality of life for residents and tourists alike. Solutions to Avoid Red Tide or START, a grassroots citizen's organization's mission is to support programs that control and/or mitigate the harmful effects of red tide. Misinformation about harmful algal blooms is common, particularly in a tourist area where people may be experiencing red tide for the first time. Although the media frequently reports the conditions of red tide blooms, informal surveys reveal that tourists do not routinely watch local news or read the local newspapers. They are on vacation. Therefore, a need was identified to develop a Travel and Leisure Project to minimize economic impacts of red tide on Florida businesses by providing accurate and factual information in a user-friendly format. The Red Tide Alliance, consisting of START, the grassroots citizen's group, Mote Marine Laboratory, a private non-for profit research laboratory, and the Florida Marine Research Institute collaborated and funded a Frequently Asked Questions or FAQ card about red tide that merchants such as hotels, motels, restaurants, and visitor bureaus could distribute. The Florida Chamber of Commerce, Visit Florida, the Hotel and Motel Association, Florida Restaurant Association, and the Florida Beach and Shore Association were some of the stakeholders who participated as focus groups to provide feedback on the cards during design and development and also obtain their support for the project. Along with FAQ's, the card provides the Marine and Freshwater Toxin Hotline number as well as the red tide/fish kill toll free number. START mailed a supply of FAQ cards to all Florida Coastal Chambers of Commerce and Florida Visitor and Convention Bureaus. START also mailed cards to businesses and communities at their request for distribution. The FAQ cards have been extremely popular and to date, START has printed 200,000 cards and received requests for dissemination of over 120,000 cards. In addition to the production of the FAQ card, a web site, [www.RedTideOnline.com](http://www.RedTideOnline.com) was established to electronically provide information. In addition to providing information, another goal of the website was to function as a portal to other red tide and HAB web sites, the Alliance partner websites as well as others. The website has received as many as 75,000 hits per month during an onshore bloom. This project may be used as a model to other communities regarding dissemination of accurate information regarding harmful algal blooms.

## **THE SOUTH CAROLINA PHYTOPLANKTON MONITORING NETWORK: THE USE OF VOLUNTEERS TO MONITOR PHYTOPLANKTON**

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The South Carolina Phytoplankton Monitoring Network (SCPMN) is a NOAA sponsored community outreach program developed to increase awareness of harmful algae to constituent groups and directly involve volunteers in coastal stewardship. SCPMN commenced in January 2001 with three school groups monitoring waters in Charleston County. In the past two and a half years, this program has expanded to 28 middle and high schools, 12 environmental citizens organizations, and 4 state parks in six coastal counties. Volunteer monitoring groups are trained in phytoplankton sampling techniques and identification methodologies.

In the monitoring network's first year and a half of existence, volunteers observed three species of potentially toxic algae including *Pseudo-nitzschia* spp., *Dinophysis caudata*, and *Prorocentrum lima*. For all three species, cell concentrations were lower than the threshold for possible human health problems. In addition, volunteer groups have reported blooms of nontoxic species including *Akashiwo sanguinea* and *Synechococcus*. These observations made by volunteer groups will be used to develop a species list and serve as a preliminary investigation of HABs in South Carolina waters.

## HARMFUL ALGAL BLOOM SCIENCE AND STANDARDS: ONE PERSPECTIVE

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There are scientific standards available as codes of ethics, codes of conduct, or requirements. Each of these has been developed to address specific issues, for example, intellectual property rights and proprietary authorship. In addition to this literature, there are articles, reports, and discussions on release and sharing of data, observations, techniques, and ideas. Institutes, governments and academics have contributed to discussions involving the following points: competition versus cooperation, how much data access to provide and when, how to resolve professional conflict problems, and other science policy issues. One particularly relevant discussion has been “Should publicly funded research be in the public domain”? There are even scenario-based videos that present the various topics, including misconduct, and give handling options.

Some of the early efforts in establishing science policy promoted openness and sharing of ideas and data as a mechanism to advance science. Today, as harmful algal bloom scientists, we are also being asked to share, collaborate or partner so the scientific community can have a more comprehensive picture of bloom dynamics, species identification and distribution, toxins and toxicity, pathways of toxin transfer, types of toxic events, etc. To this end, new analytical tools and predictive models are being developed so they can be used in management options.

Multiple component studies can require the expertise of a few to many scientists. In this cooperative, and at the same time competitive, environment the issue of intellectual property rights and authorship can arise. “How do you protect your data and ideas and still share?” becomes a paramount question.

There are arguments for “openness” versus limited or no access to data and scientists have followed both paths. Sharing can be initiated as scientific progress is made or it can be at the time of publication. This is essentially a decision of the data creator(s). Today, the amount of electronic data being generated has led to web-based data portals for shared information and data retrieval, and in some cases data management. The implications of the internet for not only data sharing but for data and scientific article dissemination is probably understated. There will obviously have to be standards for these databases, including their metadata, and for internet publications. How can the Harmful Algal Bloom scientific community be involved in evaluating standards and setting standards if necessary?

More collaborative projects to capitalize on expertise and resources can often result in multiple authors on publications. Some journals are responding with “standards of responsible authorship”, for example, restricting authorship only to those contributing to the following: original concept, design, experimentation, testing, analysis, and write-up or some other aspect detailed in their instructions to authors. In these examples, a letter of submittal has to be signed by all authors indicating that they accept responsibility for the content of the manuscript. For a young harmful algal bloom scientist in today’s competitive yet cooperative environment, there may be more effort needed to gain recognition and be successful in grant funding. Hopefully, openness and sharing will still be part of our fiber.