Harmful Algal Bloom Research in California

The Problem

Harmful algal blooms (HABs) are a national concern affecting an increasing number of coastal ecosystems with virtually every coastal state now reporting recurring blooms. Impacts have included the devastation of critical coastal habitats, loss of economically and culturally vital shellfish resources, illness and death in populations of protected marine species, and serious threats to human health posed by algal toxins. The average economic impact from HABs in the U.S. has been conservatively estimated at $82 million/year, and just one harmful algal bloom event can cost local coastal economies tens of millions of dollars.

In California impacts are mainly caused by recurring blooms of two genera (*Alexandrium* and *Pseudo-nitzschia*) that produce potent neurotoxins that accumulate in fish and shellfish. The State monitors seafood toxin levels and, if toxins accumulate above regulator limits, closes both commercial and recreational harvesting in order to prevent paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP) in humans. Bioaccumulation of algal toxins through the food web has been linked to significant wildlife mortality events of fish, birds, and marine mammals, especially protected species like sea lions.

Program Description

In recognition of the impacts of the HABs and in support of the Harmful Algal Bloom and Research Control Act (HABHRCA), the NOAA Center for Sponsored Coastal Ocean Research (CSCOR) administers three national HAB research programs. The interagency (NOAA, EPA, NSF, NASA, ONR) Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) program, the Monitoring and Event Response for Harmful Algal Blooms (MERHAB) program, and the HAB Event Response Program. ECOHAB and MERHAB support multi-year, interdisciplinary research to address the issues of HABs through a combination of a regional ecosystem and targeted research

NOAA Extramural HAB Programs
• ECOHAB • MERHAB • Event Response Program

approaches. Projects include a mix of investigators from academic, state, Federal (including NOAA labs), and non-profit institutions. These projects lead to management-based outcomes that facilitate HAB prevention, control, and mitigation. Accomplishments include advances in management capabilities for predicting bloom initiation and transport, detecting toxic cells and toxins, and quantifying bloom socioeconomic and ecological impacts. The HAB Event Response program provides immediate assistance to state and federal coastal managers and public health officials to reduce the impact of emerging HAB events through rapid, coordinated assistance during toxic algal blooms, related health incidents, and marine animal mortality events.

CSCOR HAB Research in California

In 1998 the HAB Event Response program provided assistance to California that allowed for a rapid response to a mass sea lion mortality event. Since then, CSCOR has invested millions of dollars in supporting research on toxic HABs in California leading to advances in understanding factors that regulate the dynamics and impacts of these HABs and developing management tools for HAB assessment, prediction, and response (see appended list of projects). Achievements from ECOHAB projects include the use of remote sensing (satellites and ocean observing systems) for tracking HABs, molecular methods for the detection and tracking of algal species and their toxins, and the development of mechanisms for bloom control. The MERHAB program has initiated two ecosystem-scale intensive MERHAB programs in Central and Southern California focusing on improving the State's ability to identify, detect, and respond to blooms and developing an automated system to warn coastal resource, health, and water quality managers of impending blooms. These interdisciplinary research studies are helping to advance the state of the science and meet the needs of state coastal resource and public health managers. Considerable research has been conducted on *Pseudo-nitzschia* and *Alexandrium* in other areas of the west coast which is directly applicable to problems in California.

CSCOR Approach Helps Mitigate Recent California HAB Bloom
Recent successes in detecting HAB events demonstrate the value of CSCOR research investments in helping coastal managers undertake efforts to minimize the detrimental effects caused by these phenomena.
In 2007 levels of cells and toxins from an ongoing HAB reached record levels in Southern California coastal waters. NOAA-MERHAB sponsored researchers at the University of Southern California and the University of California Santa Cruz provided crucial data to State Department of Public Health officials enabling the protection of human health with: 1) a timely statewide quarantine of sport-harvested mussels, and 2) consumption advisories in five Southern California counties for other sport-harvested shellfish, sardines, anchovies, and crab viscera. Using new detection technologies, some of which were developed in partnership with NOAA labs, researchers detected the bloom in late March and initiated more intensive sampling in both Central and Southern California to document the event.

Looking to the Future
NOAA CSCOR HAB programs are making advances in the capacity for resource managers to anticipate and respond to HABs in California. Efforts are underway to implement HAB monitoring and toxin detection programs that incorporate innovative technologies to increase the precision and lead time of warnings for local communities. In 2008, CSCOR will co-sponsor a Regional Workshop for Harmful Algal Blooms in California Coastal Waters to compare current HAB detection methods and improve data sharing among HAB scientists, a critical step towards the development of statewide coordinated HAB response efforts. Research needs identified in this workshop will help guide future HAB research investments by CSCOR and partner agencies. In California, and around the nation CSCOR HAB programs will continue to provide crucial steps toward the development of operational forecasting blooms of toxic algae, advancing mechanisms for prevention and control, and event response assistance.

FOR MORE INFORMATION:

Go to http://www.cop.noaa.gov/stressors/extremeevents/hab/welcome.html#current .

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CSCOR Harmful Algal Bloom Efforts in California

In California over the last decade CSCOR has funded over $6 Million in research projects focusing on *Alexandrium* and *Pseudo-nitzschia*. Additional funding for California HAB research has been provided by other ECOHAB agency partners.

Ecology and Oceanography of Harmful Algal Blooms (ECOHAB)

Regulation of *P.australis* by C,N,Si Interactions. University of California Santa Cruz, San Francisco State University. To examine the ecophysiological characteristics under which the Pseudo-nitzschia genus becomes dominant in coastal waters and initiates domoic acid (DA) production.

Domoic Acid in a Coastal Food Web. University of California Santa Cruz, NOAA, UC Davis. Investigate transfer of domoic acid through food webs to determine the chronology of toxin passage into key food web intermediaries, both benthic and pelagic chronic effects of HABs on the viability, fecundity, and recruitment of key fish species in the marine environment to provide insight into the relationships between HABs and the productivity of marine fish populations.

A New Chemosenser for Domoic Acid Based on Molecular Imprinting. University of California Santa Cruz. Develop a new method for detection toxin in water.

The Role of Trace Metals in Regulating Domoic Acid Production and Release by Toxigenic Diatoms. University of California Santa Cruz. Investigate the role of the availability of iron and copper in the water in inducing production of the toxin, domoic acid, by Pseudo-nitzschia.

Dynamics and Mechanisms of HAB Dinoflagellate Mortality by Algicidal Bacteria. University of California, San Diego/Scripps Institution of Oceanography. Determine species and develop models of the process by which bacteria attack HABs in order to understand natural control mechanisms.

Monitoring and Event Response for Harmful Algal Blooms (MERHAB)

California Program for Regional Enhanced Monitoring of Phyco-Toxins (Cal-PReEMPT). University of California. Expand the current capabilities of the California Department of Health Services by incorporating new in-field monitoring technology, implementing a tiered decision-making process, and relying on a volunteer network to enhance monitoring capabilities on HABs of *Alexandrium* and *Pseudo-nitzschia*. Coupled to remote sensing to allow for better detecting, tracking, and study of HAB events.

RAPDALERT - Rapid Analysis of Pseudo-nitzschia and Domoic Acid, Locating Events in Near Real Time. University of Southern California, University of California. Pilot project for shifting much of the burden of HAB monitoring to an automated system to ensure early warning of impending blooms while minimizing unnecessary and expensive field-based sampling and lab-based testing. Results will advance understanding and ability to predict HAB events.