Harmful Algal Blooms and Hypoxia in the Northeastern United States

Introduction

Dead fish or dolphins lining a beach. Shellfish closures. Respiratory problems. Harmful algal blooms (HABs) and hypoxia (severe oxygen depletion) are harming an increasing number of coastal and Great Lakes communities, economies, and ecosystems. Virtually every coastal state has reported recurring blooms and over half of our Nation's estuaries experience hypoxic conditions. Impacts include massive fish kills, devastation of critical coastal habitats, loss of commercially valuable and culturally vital shellfish resources, illness and death in populations of protected marine species, and threats to human health. HAB outbreaks pose an immediate and long-term challenge to the tourism industry, which underpins the economies of many coastal communities. Just one harmful algal bloom event can impose millions of dollars in losses upon local coastal economies. Scientists at the National Oceanic and Atmospheric Administration (NOAA) are leading efforts to understand, predict, and ultimately mitigate HABs and their impacts.

The Problem

Research into the types, causes and effects of HABs is a relatively new field of investigation and the list of species and types of impacts are expanding rapidly. NOAA and its partners are working to better understand HABs in the context of the ecosystems that both foster their growth and suffer their impacts in order to mitigate, and in some cases, prevent their impacts.

Some harmful algae produce toxins which cause illness in humans and marine organisms, like the microscopic alga, *Alexandrium*, which blooms in New England waters and produces a potent toxin that accumulates in shellfish and can cause paralytic shellfish poisoning (PSP) in human consumers. Last year, the New England region suffered its most extensive HAB outbreak in 30 years, closing harvesting areas from Maine to Massachusetts and resulting in a NOAA-declared fisheries failure and regional economic impacts of $10 to $15 million. Some fisheries such as roe-on scallop, are permanently closed due to shellfish toxicity, resulting in millions of dollars of lost revenue.

Hypoxia, caused by excess algal growth, is also a problem in the Northeast. In 2003, severe hypoxia in Narragansett Bay, RI resulted in a large fish kill, prompting a new state law to limit nitrogen discharged into the bay.

Alexandrium blooms in New England result in extensive shellfish harvesting closures to protect humans from paralytic shellfish poisoning (PSP). *Photo: WHOI*

Program Description

In the northeastern United States, NOAA supports multi-year, interdisciplinary research studies to address the issues of HABs and hypoxia in an ecosystem context. Working closely with our federal, state, and academic partners, NOAA has 1) investigated the factors that regulate the dynamics of HABs and how they cause harm; 2) developed linked bio-physical models that form a critical base for building ecological forecasts; and 3) applied molecular methods and bio-chemical analysis to the detection and tracking of algal species and their toxins. Through these efforts NOAA has made considerable progress in the ability to detect, monitor, assess, and in some cases, predict HAB and hypoxia events.

NOAA HAB and Hypoxia Programs in the Northeast

- ECOHAB
- MERHAB
- CHRP
- Event Response
- Marine Biotoxins

Accomplishments

The interdisciplinary research supported through NOAA's programs are helping to advance the state of the science and are leading to results with direct application to the needs of state coastal resource and public health managers. Recent successes in detecting and forecasting events demonstrate the value of these research investments for helping coastal managers in their efforts to reduce and ultimately prevent the detrimental effects caused by these phenomena.

HAB Detection and Forecasting: Research on *Alexandrium* in the Gulf of Maine has greatly enhanced management capabilities in the region. New molecular methods for rapidly detecting and mapping *Alexandrium* allow blooms to be tracked in almost real time. Recently developed, coupled biological and physical models can now be used to forecast the spread of a bloom and to understand the factors leading to events. In addition, data collected during and after the expansive 2005 *Alexandrium* bloom will improve predictive capabilities in future years. For example, new cyst seed beds left by the 2005 event will be mapped and compared to 2004 cyst distributions and new areas will be monitored to evaluate the potential southward expansion of these events in 2006 and subsequent years.

New methods of detection allow researchers to track blooms in almost real time. *Photo WHOI*

Event Response: NOAA has established a suite of programs which provide immediate assistance to state and federal coastal managers and public health officials to reduce the impact of HAB events. In 2005, NOAA responded to the largest *Alexandrium* bloom in New England in 30 years by providing immediate assistance to enhance mitigation efforts during the bloom and by providing follow-up assistance to improve prediction and response in 2006 and future years. Data collected with Event Response funding directly enhanced mitigation efficiency by allowing managers to focus toxin sampling in newly exposed areas as well as in areas that could possibly be reopened for shellfish harvesting.

Looking to the Future

NOAA is assisting resource managers to anticipate and respond to HAB/hypoxia events in the Northeast via:

Hypoxia Forecasts: NOAA is funding research to predict low oxygen levels in Narragansett Bay. This ecosystem-scale project aims to characterize and predict the oxygen dynamics through coordinated, multidisciplinary research involving monitoring, development of predictive models, and examination of historical oxygen conditions. These efforts will help decision-makers better predict the response of the ecosystem to future nutrient decreases that result from recently enacted nutrient control strategies.

Prediction of HAB Impacts: Current efforts related to *Alexandrium* in the Gulf of Maine include a collaborative, integrative project geared toward refining and transitioning predictive models to operational use. Research also recently identified a genetic change that causes toxin resistance and accumulation in softshell clams. This discovery could eventually be used to reduce PSP incidents and harvesting losses. Researchers have also shown that zooplankton (small crustaceans) can develop toxin resistance and are investigating what the implications are for bloom control and toxin transfer through the food web to higher animals like fish, birds, and whales.

Resources: Contact Dr. Quay Dortch, ECOHAB Program Coordinator, 301-713-3338 x157, quay.dortch@noaa.gov; or contact NOAA at HABS@noaa.gov; website: http://www.cop.noaa.gov/