"All Farms are Coastal"
Hypoxia and Harmful Algal Blooms in the US

Issue:

Harmful algal blooms (HABs) and hypoxia (too little oxygen in bottom water to support marine life) are interrelated issues affecting an increasing number of Great Lakes and coastal ecosystems. Virtually every coastal state has reported recurring blooms, and a recent national assessment revealed that over 60% of our Nation's estuaries experience hypoxic conditions. There are several causes of HABs and hypoxia; some are natural, but others are human-induced such as nutrient runoff, largely from agricultural sources, that can stimulate the overgrowth of algae. Just one harmful algal bloom event can cost tens of millions of dollars to local coastal economies and the annual costs associated with HABs over the past few decades have been conservatively estimated at $82 million/yr.

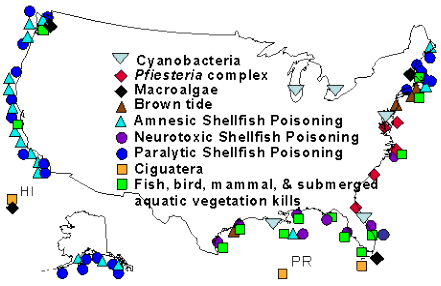
US estuaries experiencing hypoxia as of 2007 (R. Diaz, VIMS)

How We Work:

The 1998 Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) and the 2004 reauthorization established an Interagency Task Force to develop assessments and plans and authorized funding for research programs on HABs and hypoxia. Our HAB programs are the interagency Ecology and Oceanography of Harmful Algal Blooms (**ECOHAB**) the NOAA Monitoring and Event Response for Harmful Algal Blooms (**MERHAB)** program and the new NOAA Prevention, Control and Mitigation (**PCM**) program. Our hypoxia programs include the NOAA Coastal Hypoxia Research Program (**CHRP**) and the NOAA Northern Gulf of Mexico (**NGOMEX**) Program. Involving Federal, State, and academic partners, all of these programs support multi-year, interdisciplinary extramural research studies to address the issues of HABs and hypoxia in an ecosystem context. The 2004 Oceans and Human Health Act established a NOAA Oceans and Human Health Initiative (**OHHI**) which funds intramural and extramural research on HABs and other health problems in an ecosystems context.

Impacts of HABs and Hypoxia

- Fish kills
- Loss of critical coastal habitats
- Closure of shellfish harvesting
- Mass mortality of protected marine species
- Unsafe beaches
- Serious threats to human health from algal toxins



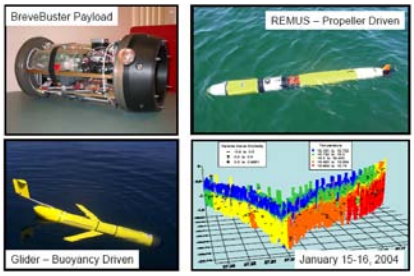
Harmful algal blooms in U.S. waters (modified from http://www.whoi.edu/redtide/HAB distribution/HABmap.html)

Accomplishments:

The following are products from our research that help to aid state coastal resource and public health managers and advance our knowledge of HABs and hypoxia :

Florida HAB Forecasts: In 2004 the HAB Bulletin on the west coast of Florida became operational. Satellite imagery, wind data, and transport models are used to identify potential HABs and predict their movement. This information is then relayed to coastal managers so they can more effectively target expensive and time-consuming field sampling to confirm the presence of toxic algae. A prototype is being tested for the Texas coast.

Transition of ORHAB from federal to state funding: The Olympic Region Harmful Algal Bloom (ORHAB) partnership, comprised of federal, state and local management agencies, coastal Indian tribes, marine resource-based businesses, public interest groups, and academic institutions, developed a state of the art monitoring program for domoic acid, a potent algal neurotoxin, in razor clams on coastal beaches. Initially funded by NOAA in 2000, the State of Washington allocated funds from shellfish harvesting license fees to continue the program in 2004 and beyond.



AUVs (Slocum Glider and REMUS) with automated sensor for *Karenia brevis* (Breve Buster) and example of temperature and red tide abundance data during operation (graphics provided by Gary Kirkpatrick, Mote Marine Lab)

Models of HABs (*Alexandrium*) in the Gulf of Maine: NOAA-supported researchers made the first-ever annual prediction of a severe red tide in the Gulf of Maine in 2008 and then provided weekly forecasts of the location and severity of the red tide. The advance warning allowed state shellfish managers to plan for a difficult season and the weekly forecasts led to more targeted monitoring to minimize shellfish harvesting closures protecting human health.

Hypoxia Forecasts: The size of the hypoxic area known as the "dead zone" on the Louisiana shelf has been forecasted annually since 2003 from Mississippi River nutrient loading, based on 20 years of NOAA ecosystem research. The models have been used to evaluate nutrient reductions needed to reduce the size of the hypoxic area and the effectiveness of management actions.

In water HAB sensor: NOAA, NSF, ONR, and NASA have supported research on the optical characteristics of the Florida HAB, *Karenia brevis*, which has led to an in-water sensor that detects blooms in situ in real time. The sensor has been used on ship board for mapping, on moorings to provide early warning or on Autonomous Underwater Vehicles (AUVs) to confirm blooms that have been detected by satellite remote sensing (see figure). Numerous other sensors are under development to improve HAB monitoring.

Comprehensive Hypoxia Assessment: The number of areas in coastal waters with too little oxygen to support most marine life, otherwise known as dead zones, has greatly increased since the 1960s both worldwide and in the US according to NCCOS - funded research which was published in Science in August 2008. Research attributes this dramatic trend to increasing nutrient pollution and the burning of fossil fuels, a finding which reinforces the need for management actions to reduce nutrients in coastal waters.

Event Response: NOAA provides either emergency funding or technical assistance to state and federal coastal managers and public health officials to reduce the impact of HABs. In 2008 assistance was provided in response to the severe red tide in the Gulf of Maine and a new, unusual outbreak along the Texas coast.

Recent HAB and Hypoxia Reports and Plans:

National Assessment of Efforts to Predict and Respond to HABs in US Waters, 2007
http://www.cop.noaa.gov/stressors/extremeevents/hab/habhrca/Predict_Resp_IntRpt_0107.pdf
Scientific Assessment of Freshwater HABs, 2008
http://www.cop.noaa.gov/stressors/extremeevents/hab/habhrca/FreshwaterReport_final_2008.pdf
Harmful Algal Bloom Management and Response: Assessment and Plan, 2008
http://www.cop.noaa.gov/stressors/extremeevents/hab/habhrca/HABMngmt_resp_9_08.pdf
Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change, National Estuarine Eutrophication Assessment Update, 2007
http://ccma.nos.noaa.gov/publications/eutroupdate/
Assessment of Coastal Hypoxia and Eutrophication in US Waters, 2003
http://www.eutro.org/documents/HABHRCA%20hypoxia.pdf

For more information visit http://www.cop.noaa.gov or contact Rob Magnien at Rob.Magnien@noaa.gov