Science for Solutions

# NOAA COASTAL OCEAN PROGRAM
Project NEWS Update

Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) Research Program Underway

The National Oceanic and Atmospheric Administration's Coastal Ocean Program, National Science Foundation, Environmental Protection Agency, and Office of Naval Research are jointly sponsoring the Ecology and Oceanography of Harmful Algal Bloom (ECOHAB) research program. Harmful algal blooms, commonly called "red tides" or HABs, are a serious economic and public health problem throughout the world. In the U.S., one of the most serious HAB problem is paralytic shellfish poisoning (PSP), a potentially fatal neurological disorder caused by human ingestion of shellfish that accumulate toxins as they feed on dinoflagellates of the genus *Alexandrium.* These organisms can cause human illness and death due to PSP, repeated shellfish harvest quarantines, and the mortality of fish and marine mammals. This phenomenon, which affects thousands of miles of U.S. coastline and numerous fisheries resources, has expanded dramatically in the last two decades, especially in the Gulf of Maine.

As part of the ECOHAB program, researchers will address fundamental issues regarding *Alexandrium* blooms in the Gulf of Maine: 1) the source of the *Alexandrium* cells that appear in the fresh water plumes in the western Maine coastal current (WMCC); 2) *Alexandrium* cell distribution and dynamics in the eastern Maine coastal current (EMCC), and 3)linkages among blooms in the WMCC, the EMCC and on Georges Bank. Utilizing a combination of numerical modeling, hydrographic, chemical, and biological measurements, moored and drifting current meters, and satellite imagery, we will characterize the structure and variability of the major *Alexandrium* habitats in the Gulf of Maine. Other components of the ECOHAB program include a regional study in the Gulf of Mexico *(Gymnodinium breve)*, and targeted research projects are also being initiated in California (*Pseudo-nitzschia)* , Alaska (*Alexandrium*), Long Island (brown tide *Aureococcus*), Chesapeake Bay (*Prorocentrum minimum*) and Guam (macroalgal overgrowth).
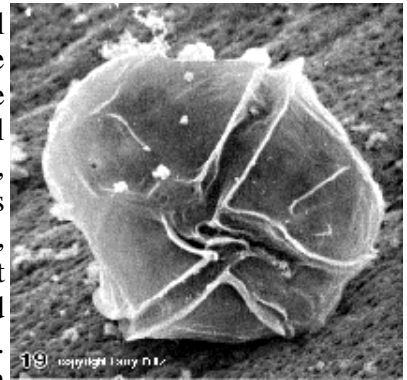
A primary goal of ECOHAB research is to develop the means to predict bloom development, persistence, and toxicity. Once we have a clear understanding of how physical and biological processes interact to promote HAB development, reliable models can be developed that can identify systems potentially susceptible to these outbreaks . This will foster rapid responses by monitoring agencies and

health departments. Further, identification of bloom favorable conditions will also permit management of specific environmental conditions to reduce bloom impacts.

<center>1</center>

From the Director's Desk......

This past summer, the toxic microbe, *Pfiesteria* or related species, killed thousands of fish in the Chesapeake Bay. Thirty-nine people suffered health effects ranging from shin rashes to memory loss, and the commercial and recreational fishing industries suffered severe economic hardships. NOAA responded immediately to this crisis by allocating funds for fish lesion assessment and by participating in Maryland's Technical Advisory Committee. With a focus on the longer term, COP led other Federal agencies, on behalf of the White House, in drafting the *"National Harmful Algal Bloom Research and Monitoring Strategy,"* focusing initially on *Pfiesteria.* Implementing this *National Strategy* can not happen soon enough as similar outbreaks have been confirmed in Delaware, Florida, and most dramatically in North Carolina where billions of fish have been killed in incidents dating back to 1989.

However, Pfiesteria is but one of many species of toxic algae collectively known as "harmful algal blooms" (HABs). Historically uncommon, HAB impacts are becoming more prevalent and severe. While scientists struggle to identify the causes of individual HABs, a common factor that seems to support many HAB events is excess nutrients, primarily from nonpoint sources. Excessive nutrients are not only a likely contributor to HABs, but also a significant factor in coastal eutrophication. A recent NOAA study found that 51% of the Nation's estuaries exhibit hypoxic conditions (dissolved oxygen < 2mg/l) each year and 30% become anoxic. Nowhere is this more apparent than in the northern Gulf of Mexico.

Known as the "dead zone", an area roughly the size of New Jersey becomes hypoxic each summer off the Louisiana coast. This zone doubled in size to 7000 square miles after the "Great Mississippi River Flood of 1993", and has not diminished appreciably. Scientists participating in the COP's Nutrient Enhanced Coastal Ocean Productivity study determined that the cause of the hypoxic zone was the nutrient loading from the Mississippi and Atchafalaya Rivers. Many of those scientists are participating in the integrated assessment of the causes and consequences of Gulf hypoxia under the auspices of the White House Office of Science and Technology Policy.

The problems associated with nonpoint source pollution into coastal waters are many - coastal eutrophication and HABs are increasing, resources are being detrimentally impacted, human health is threatened, and coastal economies are suffering However, the answers as to how to best mitigate the impacts of nonpoint are unclear. Currently, there are only fragmented research and management policies that are addressing the problem. What is needed is a comprehensive research and management approach to address coastal non-point source pollution, harmful algal blooms, and eutrophication.

In this Issue

2

COP Projects Develop New Technologies

Coastal Ocean Program projects have developed a number of new and innovative models, methodologies, and technologies that have greatly improved resource managers' ability to manage our Nation's coastal resources. Several new technologies and methodologies have been developed from COP's fisheries oceanography studies. The South Atlantic Bight Recruitment Experiment and Northwest Atlantic GLOBEC Program developed an **Optical Particle Counter** and **Video Plankton Recorder** , respectively. These devices allow real-time observations of individual plankton species while underway which improves both sampling accuracy and efficiency. Bering Sea Fisheries Oceanography Coordinated Investigations (BS-FOCI) used a P-3 Orion aircraft, which proved to be a highly effective oceanographic platform, to estimate **phytoplankton concentrations using color**

COP Project Coordinator Profile

Sue Banahan coordinates four projects for NOAA's Coastal Ocean Program: Complexity and Stressors in Estuarine Systems (COASTES), the Brown Tide Research Initiative, Coastal Remote Sensing, and the Pacific Northwest Coastal Ecosystem Regional Study (PNCERS).

COASTES is a study of the cumulative effects of nutrient and toxic element enrichment on the Patuxent River Estuary, MD. Another regional study is the Pacific Northwest Ecosystem Region Study (PNCERS) which begins its first year of investigations into the critical processes affecting the living resources in estuarine

remote sensing equipment. BS-FOCI adapted a **dual frequency hydroacoustic analytical procedure** that pioneers visualization of the spatial and temporal distributions of juvenile fish and their prey.

In the area of coastal water quality, a **mass balance Water Quality Model**, developed from the Nutrient Enhanced Coastal Ocean Productivity study, estimates how changing nutrient inputs from the Mississippi River plume effect phytoplankton and dissolved oxygen concentration in the inner Gulf of Mexico shelf region. In the Chesapeake Bay, a sampling protocol that **estimates atmospheric deposition of nitrogen** to the Bay's surface waters was developed as part of the Atmospheric Nutrient Input to Coastal Areas (ANICA) study. Deposition rates to the bay surface are estimated through the use of **instrumented Chesapeake Bay Observing System buoys**. Also developed from ANICA was the **Regional Acid Deposition Model** (RADM). Though developed for acid rain applications, the RADM model was successfully applied to improve estimates of atmospheric nitrogen deposition to the Chesapeake Bay watershed and

and coastal ecosystems.

BTRI supports a series of research studies focused on understanding the causes of brown tide blooms in the shallow embayments of Long Island, NY. One of Susan's longer term responsibilities has been in COP's remote sensing element. She works with her counterparts at the National Environmental Satellite, Data, and Information Service (NESDIS) and the NOAA Coastal Services Center to support research to advance the applications of remote sensing technology to monitoring and management of the coastal environment.

Before joining NOAA in fall of 1992, Susan was a research assistant and manager of the stable isotope laboratory at University of Maryland's Horn Point Laboratory. While there, she assisted in studies of nitrogen uptake and remineralization as part of the Chesapeake Bay Land Margin Ecosystem Research project. Prior to that, Susan was at Texas A & M University, participating in investigations into the distribution of radioisotopes in the water column and their use as water mass tracers in the northern Gulf of Mexico.

Coastal Ocean Program

New Technologies, cont.

the bay itself, and in defining the Chesapeake Bay airshed.

Research conducted during the Estuarine Habitat Program has resulted in significant advancement in wetlands restoration capabilities. **Seagrass transplant technology** was improved and made more costeffective as a result of work to

Remote sensing techniques have been used extensively in COP projects to analyze changes in coastal habitats and for monitoring coastal environmental conditions. The Coastal Change Analysis Program (C-CAP) conducted change analyses by comparing Landsat Thematic Mapper (TM) imagery for emergent wetlands and adjacent uplands and aerial photography for submerged aquatic vegetation. A **land classification and change detection protocol** was developed that

characterize the physical attributes and evaluate function of natural and transplanted seagrass beds in North Carolina and Florida. **Micropropagation and tissue culture techniques** have been established for the successful culture and nursery production of several marine plant species: *Ruppia*, *Spartina* , and *Zostera* . This effort entailed the stepwise development of growth media, supplements, and conditions conducive to the growth of meristematic plant sources. Investigators also found that *in vitro* propagated *Ruppia maritima* showed successful increases in shoot numbers and areal coverage after one year, suggesting that this species can be propagated *in vitro* and used successfully for habitat restoration.

change detection protocol was developed that allows users to quickly assess changes in land cover and aquatic habitat over time. Regional **CoastWatch** nodes provide region-specific, near real-time and real-time remote sensing data to registered user groups. For example, the Southeast CoastWatch node uses a PC-based, on-line system for receiving, displaying, and manipulating high-resolution, near real-time sea-surface temperature (SST) imagery from the Advanced Very High Resolution Radiometer (AVHRR). This data was used, for example, to track a severe harmful algal bloom that occurred off the North Carolina coast in 1987, negotiate a management conflict involving the flounder fishery, and track protected sea turtles along the east coast.

CENR to Conduct a Gulf of Mexico Hypoxia Assessment

The Coastal Ocean Program has supported research into the effects and potential causes of Gulf of Mexico hypoxia over the last several years. Results from the Nutrient Enhanced Coastal Ocean Productivity (NECOP) Program have indicated that there is a link between the nutrient content of the Mississippi River discharge and the hypoxic zone. The Louisiana Hypoxia Management Conference was held in December 1995 to begin the process of restoring water quality in the region. Although a Federal response strategy is still in development, two actions are proposed. The first is an ecosystem/watershed management plan that identifies near-term "win-win" actions in the basin to reduce excess nutrient loads. The second is a scientific assessment of the causes and consequences of hypoxia to guide and refine nutrient load reduction strategies, and to identify information gaps.

This hypoxia science assessment, coordinated through the White House Committee on Environment and Natural Resources (CENR) and led by NOAA, will address environmental changes in the system and develop the data and sciencebased tools needed to formulate water resource policies, improve ecosystem health, and protect valuable living resources and their habitats in the Mississippi watershed and Gulf of Mexico shelf area. The assessment will build upon the outcomes of

CENR Assessment, cont.

the December 1995 Louisiana Hypoxia Management Conference and efforts that have brought together scientists, managers, and regulators to discuss the extent, characteristics, causes, and effects of hypoxia in the northern Gulf of Mexico.

The assessment will include a series of six reports, documenting the state of knowledge about the causes, consequences, and potential controls of hypoxia. They will be developed by relevant experts and reviewed independently. The individual reports will: 1) describe the scope of hypoxia; 2) evaluate the ecological and economic consequences of hypoxia; 3) identify the sources of nutrients within the Mississippi/Atchafalaya system; 4) estimate the effects of reducing nutrient loads; 5) identify and evaluate methods to reduce nutrient loads; and, 6) evaluate the social and economic costs and benefits for reducing nutrient loads. Each of the reports will also identify critical additional technical information needed to fill gaps in our understanding of the problem and refine future assessments. The leaders of the individual reports include experts from academia and federal agencies on both the receiving waters of the Gulf of Mexico and the upper Mississippi River basin. In addition, each team will include specialists from a wide range of disciplines that are wellsuited to address the complex issues of the hypoxia problem.

The six reports, to be completed by summer 1998, will be used to develop a final integrated assessment that will assist the evaluation of a series of policy alternatives for decision makers. The integrated assessment, to be completed in late summer or early fall 1998, will review possible measures and approaches and, for each, address social and economic costs, identify the level of

Fisheries Oceanography Studies Near Completion

In 1991, the Coastal Ocean Program funded two interdisciplinary Coastal Fisheries Ecosystems projects: the Bering Sea Fisheries Oceanography Coordinated Investigations (BS-FOCI), and the South Atlantic Bight Recruitment Experiment (SABRE). The objective of BS -FOCI was to develop an understanding of stock structure and recruitment variation in Bering Sea walleye pollock. BS FOCI constructed and applied a coupled multispecies biophysical model (NPZF) to investigate the production dynamics of the pelagic ecosystem on the Bering Sea, especially in regards to the early life history stages of walleye pollock. This model relates the distribution of nutrients, phytoplankton, and zooplankton to the growth rate of larval fish. Results show that conditions for growth over the shelf are very different from those over the slope and basin. Larval pollock on the shelf experience better growth conditions later in the spring, while over the slope and basin, food supplies are available earlier but in lower abundance.

This work has led to a better understanding of how and why variable physical and biological processes regulate dynamics of biological production in upper ocean ecosystems. Given appropriate realtime biophysical oceanographic data from moorings, ship and satellite observations, this model predicts larval pollock growth rate. This information is vital to an understanding of the potential contribution of the year class to the fishery. The NPZF model, when coupled with models treating larval mortality or juvenile growth and mortality, can provide predictions of pollock recruitment strength to NMFS to help manage the resource.

government responsible for implementation, evaluate institutional feasibility, and address potential legal and political considerations.

The objective of SABRE was to develop an understanding of the factors that affect menhaden recruitment variability in the South Atlantic Bight. Findings from the study are being synthesized and will be reported in a special

5

Fisheries Oceanography Studies, cont.

dedicated issue of *Fisheries Oceanography* in late 1998. SABRE developed biological-physical models to study the transport of egg and larval menhaden from offshore spawning areas to estuarine nursery habitats, the transport of larval menhaden to estuarine nursery areas, and the link between variation in larval transport and variation in estuarine ingress. Successful larval transport was predicted to be variable and linked to wind conditions, intrusion of Middle Atlantic Bight shelf water south of Cape Hatteras, and interactions between flow and bathymetry. In all, the models reasonably predicted both physical and biological observations made during SABRE field efforts and reasonably estimated both the timing and larval age at estuarine ingress into Oregon, Ocracoke, and Beaufort Inlets.

The modeling effort has provided important insights into the recruitment dynamics of other winter spawning, estuarine-dependent species (e.g., flounder, spot, croaker). The models also highlights the oceanographic links between the southern Middle Atlantic Bight and northern South Atlantic Bight and suggests these links could be very important in the larval survival of menhaden, as well as many other species. Finally, the models provide a bases for assessing the effect of jetties on near-inlet circulation and larval fish ingress along the southeastern U.S. coast.

COP Teams with NSF to Study the Great Lakes

Many of the Great Lakes have been strongly influenced by human activities resulting in habitat loss and excessive loading of nutrients and contaminants. Over the past few decades, nutrient and contaminant point source controls have been successful in reducing nutrient overenrichment problems and improving water and habitat quality. However, the inputs of nutrients to some regions of Lakes workshops, the CoOP Scientific Steering Committee, and the COP Coastal Ocean Council, an opportunity to submit proposals for a coordinated five-year study in the Great Lakes was initiated in December 1996 to address the combined interests of NSF and NOAA. Teams of investigators were encouraged to submit integrated, multiinvestigator, multidisciplinary proposals of

the lakes, particularly coastal and bay regions, are still too high to sustain desirable ecosystems and are now thought to originate predominantly from uncontrolled and poorly understood nonpoint sources. While oceanographic in scale (the lakes are large enough to be significantly influenced by the earth's rotation), the lakes are, at the same time, closed basins in which the influence of coastal processes are magnified beyond that of most coastal marine systems. Thus, the Laurentian Great Lakes represent systems dominated by their coastal nature. Both NSF and NOAA regard the Great Lakes as part of the U.S. coastal zone and recognize that many features of the Great Lakes can best be studied using oceanographic methods.

Based on the recommendations from NSF-Coastal Ocean Processes (CoOP) and NOAACOP Great

modeling and process studies with the overall goal of improving understanding, predictability, and management of Great Lakes resources. (continued on page 7)
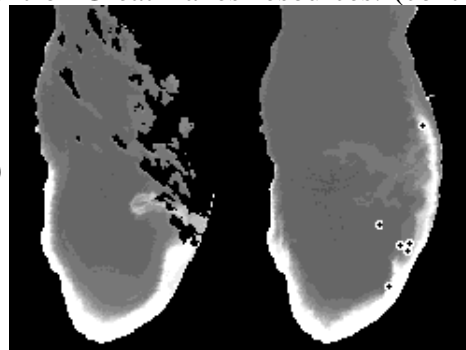

Figure 1. Turbidity Plume in Lake Michigan (03/22/96 & 04/01/96) - from NOAA 12/14 AVHRR Visible band (Channel 1) imagery

Lake Michigan Study, cont.

The first proposal recommended for joint funding by NSF and COP will be based in southern Lake Michigan and focus on the annual recurrent coastal plume that was first documented in the late 1980s (Figure 1). Evidence suggests that this episodic coastal plume may be the major mechanism for cross-margin sediment transport in Lake Michigan. While focusing on a particular episodic process in southern Lake Michigan, the program results will be applicable to similar events in many coastal areas. In addition to Lake Michigan, a second study will be centered on the relatively pristine coastal waters of Lake Superior. With a similar focus on sediment and contaminant transport along the persistent coastal Keweenaw Current, this study will offer a contrast to the more heavily impacted waters of Lake Michigan. Preliminary studies began in the Fall of 1997.

Project Notes

GLOBEC Northeast Pacific - U.S. Global Ocean Ecosystem Dynamics (GLOBEC) is beginning a major program in the Northeast Pacific to study the effects of climate change on salmon. Researchers involved in NE Pacific GLOBEC program have adjusted their research strategy for the El Nino conditions in the Northeast Pacific. This El Nino event, predicted to be one of the strongest recorded, offers scientists a unique opportunity to study this climate and ecosystem altering phenomenon. Large sea surface

temperature anomalies developed off the Pacific Northwest coast in May, with temperatures running 3-4E F above normal. Because of the predicted physical impacts on Northeast Pacific ecosystems, U.S. GLOBEC is working with NOAA, NASA, NSF, and several universities to accelerate its sampling to capture this event. Two transects are also being added off northern California.

Coastal Remote Sensing - The successful launch of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is welcome news to researchers funded through the COP/NESDIS Coastal Remote Sensing Science. These projects, started in 1996, are developing the algorithms (i.e., equations) necessary to interpret ocean color data collected by SeaWiFS, and other sensors to be launched in the near future. Prior to the launch, researchers have been making bio-optical measurements in the coastal waters of southern California, Gulf of Mexico, South Atlantic Bight, Chesapeake Bay, Gulf of Maine, Bering Sea, and the Great Lakes. The availability of the high resolution color data from SeaWiFS will allow scientists to make adjustments to the algorithms that will be used to produce maps of chlorophyll, water clarity, suspended sediments, and other parameters used to monitor coastal water quality.

NOPP Project Selection for FY 1998 Underway - The National Oceanographic Partnership Program (NOPP) was created to coordinate and strengthen oceanographic efforts to advance economic development, protect quality of life, and promote science education through knowledge of the ocean. NOAA's administrator Dr. D. James Baker is the vice-chair of the National Oceanographic Research Leadership Council and COP's Don Scavia is vice-chair of the Interagency Working Group which has been directed to implement NOPP. Funding available for FY 1998, to be provided through the Navy's Office of Naval Research, totals approximately $10M in two general topic areas: Observational Technologies and Prediction Systems. Proposals were due January 20, 1998.