Center for Sponsored Coastal Ocean Research

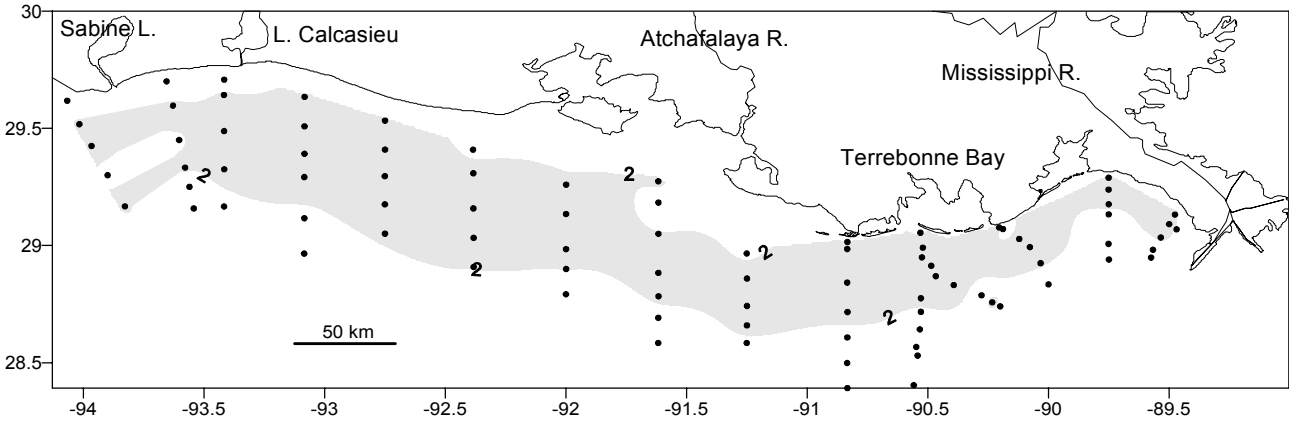
Project News Update

Science for Solutions Spring 2002

Scientists Work for a Better Understanding of the Causes and Cures of Hypoxia in the Gulf of Mexico

NOAA's Center for Sponsored Coastal Ocean Research (CSCOR) is sponsoring a new multi-year, interdisciplinary research project, the Northern Gulf of Mexico Coastal Ecosystem Research Project, with the ultimate goal of enabling improved predictions of future effects of nutrient loading, eutrophication, hypoxia, and climate change on the Gulf of Mexico ecosystem.

In July 2001, the largest hypoxic zone ever recorded was measured at 20,720 km^2, an area approximately the size of Massachusetts.



Source: Rabalais, Louisuana Universities Marine Consortium

Background

The incidence of severe oxygen depletion, either hypoxia (<2 mg of oxygen per liter), or anoxia (0 mg/l), is a growing concern for U.S. estuarine and coastal waters. Increased primary production in the offshore Mississippi River plume and strong water column stratification lead to hypoxia. Prolonged oxygen depletion can cause mass mortalities of aquatic life, with consequences to coastal commercial fisheries that can be disastrous. Since CSCOR's inception, its sponsored investigators have documented a hypoxic zone (the dead zone) on the Louisiana continental shelf with seasonally

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Contact Center for Sponsored Coastal Ocean Research

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From the Director's Desk....

Environmental laws have greatly decreased the amount of harmful discharges into the nation's coastal waters. These laws have focused largely on controlling point sources of pollution such as industrial waste and municipal wastewater. Unfortunately, the battle to control the large flow of nitrogen and phosphorus into coastal waters from non-point sources have not benefited from a comparable national effort. The resultant nutrient pollution is the common denominator that links an array of problems along the nations coastlines. These problems include harmful algal blooms, the hypoxia induced dead zones, eutrophication, fish kills and loss of sea grass and kelp communities. Coastal managers and scientists alike recognize that nutrient pollution is perhaps the largest problem for the nation's coastal areas. Two recent reports highlight the recognition of the severity of the nation's problem of nutrient pollution. The Coastal States Organization (CSO), in developing a Coastal Ocean Science Research Agenda, required a consensus from state managers who deal on a daily basis with coastal issues. The CSO thus developed a survey for state coastal program managers to identify specific priority coastal management issues in each coastal state. The survey identified nutrient overload as the number one issue. The second indicator of the serious naure of the nation's problem with nutrient pollution came from the National Research Council's Ocean Studies Board. This Board issued a report, *Challenges in Ocean Policy*, which stated that nutrient pollution is one of two significant ocean issues that are 'likely to require high level attention and policy decisions during the coming four years'.

CSCOR's vision is the highest quality science delivered in time for important policy decisions

CSCOR is continuing our interest in the Gulf of Mexico hypoxia problem in our new project entitled Northern Gulf of Mexico Coastal Ecosystem Research. There is a pressing need for data and information to provide options and solutions for the nutrient pollution of the Gulf of Mexico region. CSCOR is focusing on this problem area in order to provide managers and policy makers with the high quality, peer reviewed scientific information needed for decisions that will achieve results.

Nutrient pollution is indeed one of our most pressing national environmental problems. I welcome your ideas on ways to address this serious research and management issue.

David Johnson, Director, CSCOR

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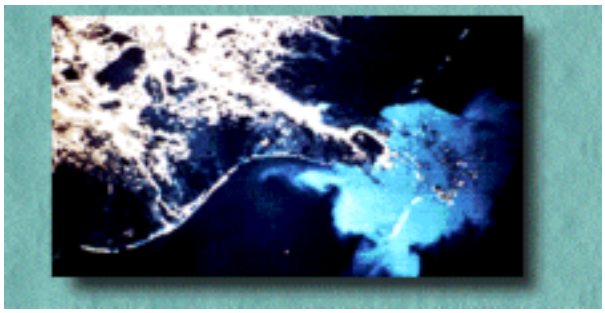
depleted oxygen levels. Computer models and scientific research have established a strong link between nutrient loading from the Mississippi and Atchafalaya River system and this hypoxia. From 1990 - 1996, CSCOR sponsored the Nutrient Enhanced Coastal Ocean Productivity (NECOP) study, with the goal of understanding the effect of anthropogenic nutrient loading to the shelf waters of Louisiana and Texas. Forty academic and federal scientists from fourteen institutes joined in the interdisciplinary NECOP investigation, which helped document the extent of nutrient input and hypoxia in the northern Gulf of Mexico and establish a direct link between increasing river-borne dissolved nutrients, hypoxia in the bottom waters and the associated ecological changes. Despite this increased awareness of the causes of the hypoxic zone, in July of 2001, a hypoxic zone approximately the size of the State of



This satellite photo illustrates the magnitude and influence of the Mississippi River sediment plume on the northern Gulf of Mexico.

Massachusetts, the largest zone ever, was recorded.

Recent Direction

In 2000, an integrated assessment of hypoxia in the Northern Gulf of Mexico concluded that the complex nature of nutrient cycling and

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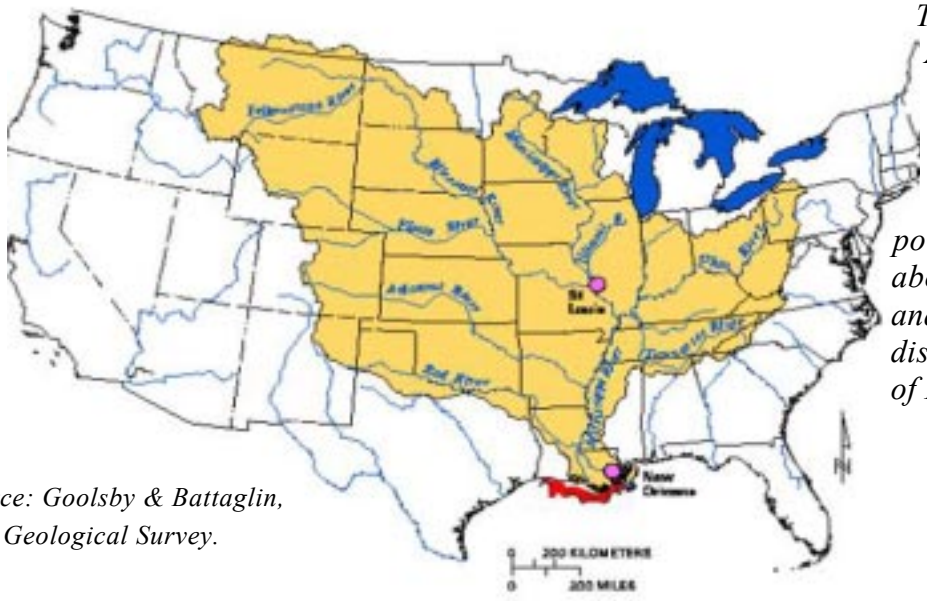

Source: Goolsby & Battaglin, U.S. Geological Survey.

The Mississippi-Atchafalaya River System drains approximently 41% of the conterminous United States. Non-point sources contribute about 90% of the nitrogen and phosphorus discharging into the Gulf of Mexico.

ECOHAB Research Points to a Change in Domoic Acid Indicator Species

Domoic Acid, a neurotoxin responsible for amnesic shellfish poisoning and synthesized by diatoms of the genus *Pseudo-nitzschia*, has been linked to the death of hundreds of marine birds and mammals, and is a threat to human health as well as fisheries resources. California Health Services Shellfish Program for harmful algal bloom toxin monitoring currently uses the sea mussel (*Mytilus californianus*) to track the occurrence of domoic acid. By using two new possible sentinel species, researchers at University of California, Santa Cruz have found a more reliable way of tracking domoic acid. The sand crab (*Emerita analoga*) better tracks the inshore pattern of domoic acid in plankton than the mussel, and the commercially harvested anchovy *(Engraulis mordax*) better tracks the combined pattern of onshore-offshore phytoplankton toxicity. The rise and fall of domoic acid in the sand crab and the anchovy is in synchrony with *Pseudo-nitzschia* abundance. This synchrony, in combination with the abundance of these common species, recommends them as reliable and cost effective monitoring tools.

Engraulis mordax

Emerita analoga

Schematic of monitoring equipment

ECOHAB Supports State of the Art Monitoring System for Maryland River

What makes an estuary ripe for the fish killing toxic dinoflagellate, *Pfiesteria*? Researchers at the University of Maryland have developed a suite of instruments in the Pocomoke River estuary to study the circulation and bio-optical properties in the region of previous outbreaks of toxic *Pfiesteria*. The goal is to detect conditions of circulation, turbulence, and stratification favorable to *Pfiesteria* blooms, and to develop the necessary climatologies to support laboratory studies. A pressure sensor tide gauge was installed to monitor baritropic

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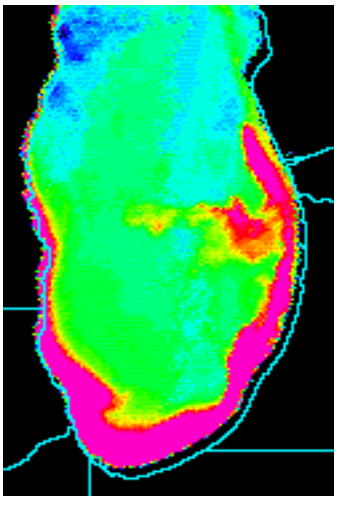
Predicting the Lake Michigan Sediment Plume

Episodic Events-Great Lakes Experiment (EEGLE) is a study of contaminated sediments affecting the overlaying waters on Lake Michigan through sediment resuspension. This episodic sediment resuspension plume is an annual, month long springtime event and has ecological consequences through the transport and transformation of biogeochemically important materials. EEGLE field activities were completed in 2001 and the focus is now on modeling and synthesis. EEGLE modelers are working in close cooperation with the Great Lakes resource management community, especially in support of the Great Lakes Coastal Forecast System. The goal of the modeling is to create a linked hydrodynamic sediment transport biological model. Through models, predictions will link hydrodynamic sediment transport and ecological factors. Linking environmental factors to the plume will greatly aid resource managers in planning to minimize the plume's effect on coastal residents.

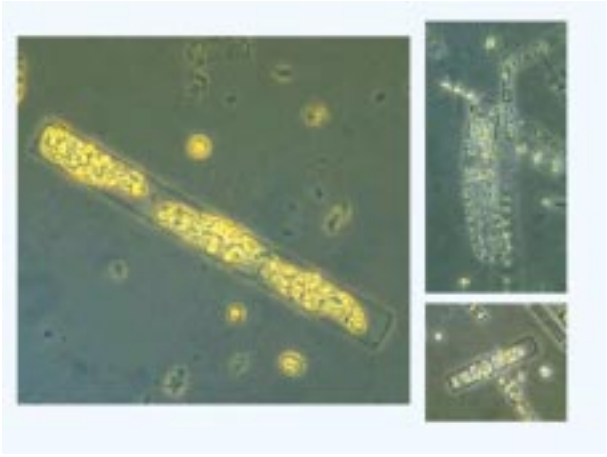
Contact John Wickham at 301-713-3338X156 or john.wickham@noaa.gov



Pink area shows extent of plume in Lake Michigan March 12, 1998.

CSCOR Project Coordinator Profile

Dr. Kenric Osgood joined NOAA's Center for Sponsored Coastal Ocean Research (CSCOR) in January 1999. He coordinates the Northern Gulf of Mexico Hypoxia Studies. Kenric will also manage a new project being initiated in 2002 investigating the effects of multiple stressors in coastal ecosystems. Kenric has a broad background in the ocean sciences which helps him with the range of projects he is involved with at CSCOR. He has a B.S. in Biology and Mathematics from the University of Maine, a M.S. in Physical Oceanography from the University of North Carolina, and a Ph.D. in Biological Oceanography from the University of Washington. Before coming to CSCOR, he was a researcher at the Prince William Sound Science Center in Cordova, AK were he worked on a multi-investigator project investigating environmental factors effecting populations of pink salmon and Pacific herring in Prince William Sound. Prior to that he was at Scripps Institution of Oceanography where he conducted research on the factors controlling the distribution and abundance of marine zooplankton. As a researcher, his work involved detailed studies on specific scientific questions that often addressed one part of broader questions. Now, as a program manager, he enjoys being able to focus on the larger picture of entire research projects and helping guide the directions of the projects.



Scanning electron microscopic image of the bloom-forming centric diatom Rhizosolenia.

West Florida Bay Algal Blooms Explained

Scientists from the South Florida Ecosystem Restoration Program, with a goal of examining the combined interactions of natural and human induced stressors on coastal degradation, have developed some insight that will help managers to better understand nuisance microalgal blooms in West Florida Bay. These results were recently published in the Florida Bay Watch Report. Presented is a summary of this interesting synthesis of recent Florida Bay research partially sponsored by the Center for Coastal Ocean Research (CSCOR).

The nuisance blooms begin in 1991 and have replaced the once luxuriant seagrass, which began to disappear in 1987. Originally, the development of diatom blooms was thought to be due to nutrient enrichment from decomposing seagrass. However, the research has pointed to another culprit in West Florida Bay; land based nutrient enrichment. Diatoms,

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Steller Sea Lion Research

A new Center for Sponsored Coastal Ocean Research (CSCOR) program investigating the food web relationships impacting Steller Sea Lions (SSL) was initiated in July 2001. The western population of SSL has been in decline for several decades and is now considered endangered. To halt this loss, managers have instituted closures in the critical habitat of SSL for directed fishing for pollock, Atka mackerel and Pacific cod. Fishing for these species is thought to cause a harmful reduction in SSL prey availability. To determine if other factors might be important in the decline of the western SSL population, CSCOR was directed to conduct research focused on potential changes in predator/prey relationships in the Gulf of Alaska and the Bering Sea. This research is coordinated with NOAA's Oceanic and Atmospheric Research, which is supporting studies on the potential impacts of ocean climate regime shifts on SSL populations.
For more information: http://www.cop.noaa.gov/Fact_Sheets/SSL.htm or contact Dr. Beth Turner at elizabeth.turner@noaa.gov

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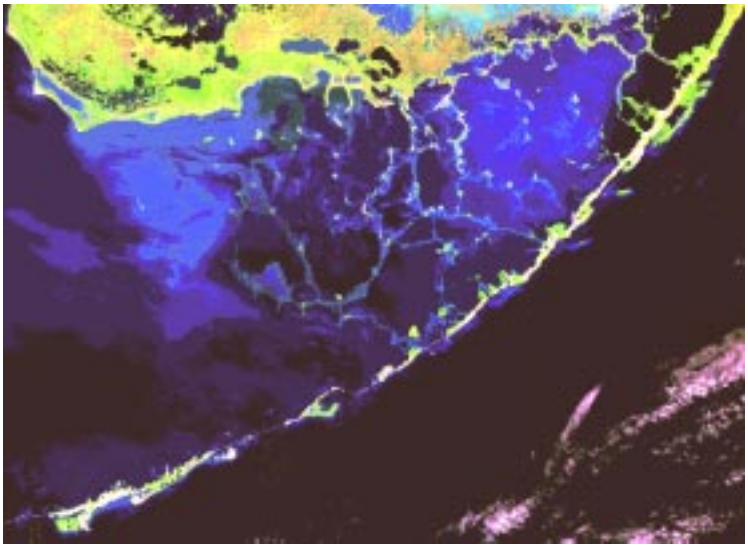
unlike other Florida microalgae, require silicate to grow. Freshwater flow with land-based nutrients is a major source of silicate. Researchers began to wonder if the fresh water plumes of Shark River Slough, the major source of fresh water into West Florida Bay, are the major source of the silicates. After a regional drought, which ended in the fall of 1991, there was a subsequent dramatic increase in freshwater flow in Shark River Slough, which provided silicate to fuel the first occurrence of the diatom bloom in 1991. Apparently, the adequate concentrations of nitrogen and phosphorus were available to support diatom blooms prior to 1991, perhaps from the decomposition of seagrass and the increased bottom suspension, but silicate was lacking. Since 1991, the onset of the rainy season creates a yearly fresh water plume causing the initiation of the bloom in June off Cape Stable. Maximum diatom abundance occurs in West Florida Bay in October through December, when fresh water flow is maximal. The highest dissolved silicate concentrations occur near the mouth of the Shark River while levels decline to undetectable levels at the easternmost extent of the diatom bloom. In addition, the peak diatom abundance in West Florida Bay coincides precisely with the depletion of silicate concentrations to undetectable levels. This relationship probably is caused by the rapid uptake of silicate and conversion to biogenic silica by diatoms. Scientists have found that the silicate is reused after the diatoms die through silicate regeneration, which is the dissolution of biogenic silica from the diatom skeletal remains. The importance of biogenic silica dissolution in providing silicate has recently been demonstrated in field experiments where biogenic silicate desolation provided up to 70% of the daily silicate demands of diatoms in West Florida Bay. Silicate regeneration halts with low temperatures and new silicate source from fresh water plumes decreases with the onset of the dry winter months, thus the bloom dies. This is an interesting hypothesis that warrants further study. For more information about the CSCOR Florida Bay preject, contact Larry Pugh at 301-713-3338 X160 or larry.pugh@noaa.gov.



Satellite Image of West Florida Bay.

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transport within the system requires an adaptive management scheme. Long-term monitoring, research, and assessment will provide managers with continual feedback allowing management actions to adjust to interpretations of new scientific information. To address these recommendations, CSCOR initiated the Northern Gulf of Mexico Coastal Ecosystem Research Project in 2000. CSCOR published the first Announcement of Opportunity to submit research proposals in March 2000 from which three projects were initiated. The primary focus of this first year of funding was monitoring the spatial and temporal changes in the distribution of the hypoxic zone. Studies were also initiated to extend modeling efforts to predict changes in oxygen budgets and severity of hypoxia under altered hydrologic scenarios and to better define the relationships among nutrient fluxes, nutrient ratios, phytoplankton species composition, and carbon production and flux. The carbon (i.e. organic material) flux fuels the growth of the hypoxic zone. In January 2001, a second Announcement of Opportunity to submit research proposals was published, resulting in the initiation of three projects investigating the effects of the hypoxic zone on fisheries. In order to fully develop a predictive capability, a more intensive project is being planned. The overall goal of the project is to obtain the ability to input different possible physical forcing and nutrient loading scenarios into a predictive model for the region in order to predict the effects on the oxygen concentrations and the biological system, including the effects on economically and ecologically important species. CSCOR's intent is to provide timely and high-quality scientific results that can be used in an adaptive management program to restore and protect the Louisiana continental shelf ecosystem.

For more information on current CSCOR funded research in Northern Gulf of Mexico, visit our website at http://www.cop.noaa.gov/projects/GoMex/

Hypoxia Information

CSCOR published seven reports in the Decision Analysis Series about the problem of hypoxia in the Gulf of Mexico. Decision Analysis Series Number 14 is a summary of the NECOP study while Number 15 through Number 20 are a part of the Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. A listing of the reports can be found at http://www.cop.noaa.gov/pubs/das.html and are available to the public through CSCOR.

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circulation, Acoustic Doppler Velocity Profilers and Acoustic Doppler Velocimeters were launched to monitor circulation within the estuary, and a bottom mounted CTD and fluorometer were installed. This instrument array was augmented by the launch of the radio-telemetered CBOS buoy pictured on page 5. Telemetry, with web access, has been established with the CBOS buoy (www.cbos.org). What is the advantage to local managers of this state of the art system? Every nuance of water condition is recorded in this continuous and automated system. This will allow river users possible early warning of conditions that may cause a toxic *Pfiesteria* outbreak.

New ECOHAB Projects

In October 2001, ECOHAB funded thirteen new projects. Funded projects are:

1. *Toxin composition variability as an indicator of nutritional status of Alexandrium field populations*. Woods Hole Oceanographic Institute: D. Anderson
2. *The role of zooplankton grazing in harmful algal bloom dynamics and trophic transfer of toxins*. University of Texas: E. Buskey
3. *A molecular basis for differential susceptibility and accumulation of paralytic shellfish poisoning toxins in commercial bivalves*. University of Maine, Northwest Fisheries Science Center: L. Connell and V. Trainer
4. *Ecological and evolutionary consequences of the spreading of Alexandrium to grazers, and implications for bloom formation and maintenance*. University of Connecticut: H. Dam
5. *Algicidal bacteria targeting Gymnodinium breve: Population dynamics and killing activity.* Center for Coastal Environmental Health and Biomolecular Research: G. Doucette
6. *The role of zooplankton grazers in harmful algal bloom dynamics.* University of Rhode Island: E.G. Durbin
7. *Laboratory and numerical modeling studies of Gymnodinium breve behavior to aid in predicting natural bloom events.* North Carolina State University: D. Kamykowski
8. *Diarrhetic toxins and Prorocentrum lima in New England coastal waters*. University of Rhode Island: L. Miranda
9. *Factors promoting growth and dominance of harmful algal species in estuarine ecosystems: The role of dissolved organic material and its mobilization.* Old Dominion University: M.E. Mulholland
10. *Quantitative detection of transcriptionally active carbon fixation genes in the Florida red tide organism, G. breve.* University of South Florida: J.P.Paul
11. *Cellular mechanisms mediating bloom longevity and bloom termination in a toxic dinoflagellate, Gymnodinium breve.* Center for Coastal Environmental Health and Biomolecular Research: F. Van Dolah
12. *Life history and pathogenicity of Pfiesteria shumwayae.* College of William and Mary: W.L.Vogelbein
13. *The role of trace metals in regulating domoic acid production and release by toxigenic diatoms.* University of California, Santa Cruz: M. Wells.

Future Directions

Center for Sponsored Coastal Ocean Research is preparing for a busy and exciting time in the near future. New announcements for 2002 include:

Multiple Stressors
Synthesis and Ecological Forecasting
Monitoring and Event Response for Harmful Algal Blooms (MERHAB)
Coral Reef Ecosystem Studies

Check out our webpage for more information: http://www.cop.noaa.gov/