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STAR RESEARCH

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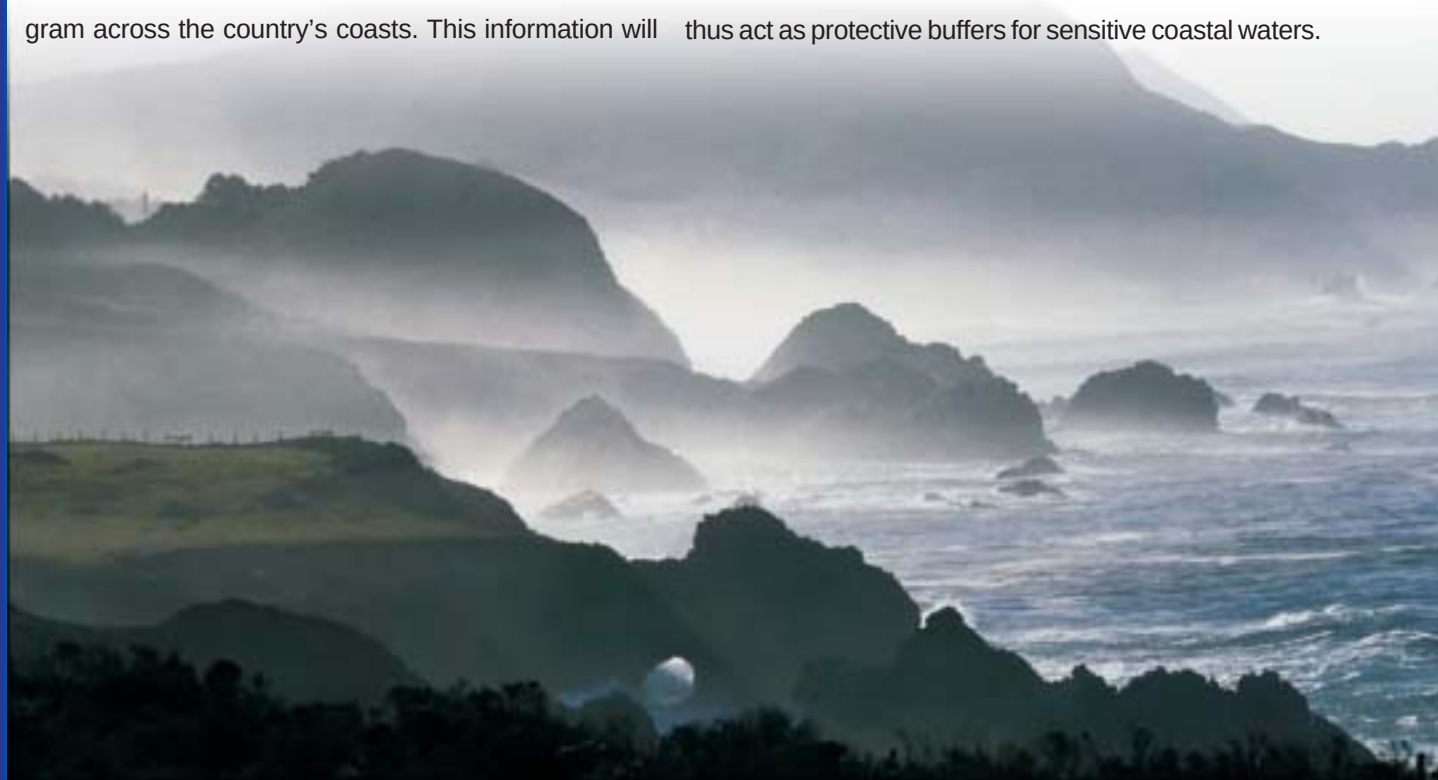
ESTUARINE AND GREAT LAKES (EaGLe) RESEARCH

Estuaries - the transitional zones where salt water from the sea mixes with fresh water flowing from the land – are one of our most valuable and stressed resources. Through Science to Achieve Results (STAR), an Environmental Protection Agency program, five Estuarine and Great Lakes (EaGLe) research programs were recently established to help us understand how to better protect these resources. The EaGLe Programs will work on developing the next generation of ecological indicators that can be used in a comprehensive coastal monitoring program across the country's coasts. This information will feed into a strategy that will enable us to understand the condition of our estuarine and coastal waters. To support remote sensing research related to the coasts, the National Aeronautics and Space Administration has provided additional funding for three of the programs.

Estuaries are biologically diverse, highly productive ecosystems that act as important nurseries and refuges for numerous freshwater and marine finfish and shellfish. They provide habitat for terrestrial wildlife. Estuaries process nutrients and toxic substances that originate on land and thus act as protective buffers for sensitive coastal waters.



They also are used by many people as areas for public enjoyment. With coastal populations increasing at a dramatic rate, there is a strong need to find ways to maintain healthy ecosystems in these areas.

Indicators are tools that can be used to assess the current and future health of the environment by relaying complex messages from numerous sources in a simplified and useful manner. The EaGLe Programs will identify and develop a new suite of ecological and socioeconomic indicators that focus on ecosystem processes in coastal areas. Some of these ecological indicators — such as total species diversity, biomass, land cover and land use, net primary productivity, and water and nutrient discharge — describe ecosystem health in terms of important variables including functionality, integrity, and sustainability. Functionality is the ability of an ecosystem to capture solar energy via photosynthesis and store it as carbon-based molecules. Integrity is the degree to which an ecosystem supports a balanced and resilient community of organisms with processes similar to natural habitats in the same region. Sustainability is the ability of an ecosystem to maintain the functionality and integrity of its processes over time. Socioeconomic indicators, such as expenditures on wastewater treatment, can be useful in interpreting stakeholders' attitudes on environmental risks, understanding institutional and jurisdictional obstacles to change, and communicating environmental information in a meaningful way. Ecosystem managers will use these new ecological and socioeconomic indicators to better assess the health of the environment, set priorities, implement appropriate actions, and evaluate outcomes.

For additional information on the STAR EaGLe Program, visit: http://www.epa.gov/ncer/centers/eagles/.

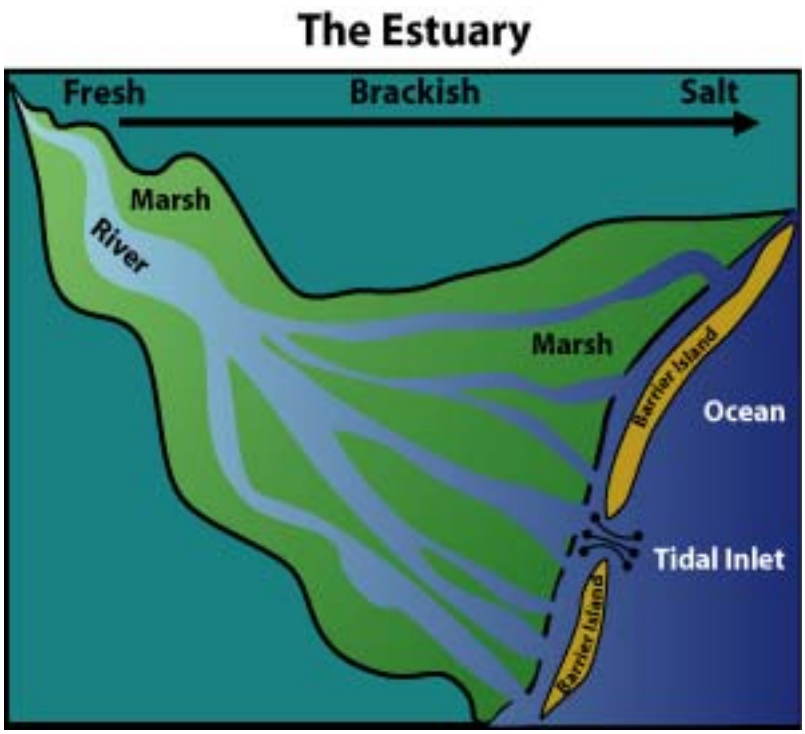
RELATIONSHIP TO OTHER PROGRAMS

The STAR EaGLe Program is the extramural component of EPA's Environmental Monitoring and Assessment Program (EMAP). EMAP's goal is to develop the scientific understanding needed to translate environmental monitoring data from multiple spatial and temporal scales into assessments of ecological condition. It uses these data to forecast future risks to the sustainability of our natural resources. EMAP will transfer the approaches and technology to states, which are responsible for water-quality monitoring under the Clean Water Act. The EaGLe Program will support EMAP's goal by developing the next generation of ecological indicators for these monitoring programs. To learn more about EMAP, visit: http://www.epa.gov/emap/.

INFORMATION ON INDIVIDUAL GRANTS

The Atlantic Slope Consortium

The Atlantic Slope Consortium (ASC) is led by Pennsylvania State University. Other institutions in the consortium are the Smithsonian Environmental Research Center, Virginia Institute of Marine Sciences, East Carolina University, Environmental Law Institute, and FTN Associates. Researchers will study the Atlantic slope region, extending from the Appalachian Mountains to the Atlantic Ocean. This area consists of three major drainage basins: the Delaware, Susquehanna-Chesapeake, and Albemarle-Pamlico.



Emphasis is being placed on developing and testing indicators, and constructing models, that link conditions in upstream watersheds to downstream estuaries. Upstream components of a watershed encompass stream reaches, riparian corridors, wetlands, and waterbodies and their contributing drainage basins. This approach is based on the premise that coasts, estuaries, rivers, streams, lakes, and wetlands must be viewed as an integrated system. The consortium is researching the applicability of aquatic indicators, such as nutrient and sediment discharges, and the spatial distribution of engineered structures and optical properties of estuarine waters, across the spectrum of environments from best attainable to severely degraded.

A suite of socioeconomic indicators, including education level and membership in environmentally active associations, also will be evaluated. The development of these socioeconomic indicators builds on work already done in the Mid-Atlantic Region under other EPA programs such as the STAR Program on Decision-Making and Valuation, the EPA/State Mid-Atlantic Integrated Assessment, and the EPA Regional Vulnerability Assessment (ReVA) Program. The socioeconomic data available to the consortium includes income, employment, health, education level, crime, water supplies, and wastewater treatment facilities.

Atlantic Coast Environmental Indicators Consortium (ACE-INC)

The Atlantic Coast Environmental Indicators Consortium (ACE-INC) is led by the University of North Carolina (UNC) at Chapel Hill. Other institutions in the consortium are the University of Maryland Center for Environmental Science, the University of South Carolina, Marine Biological Laboratory at Woods Hole, Massachusetts, and in a federal collaboration role, the National Oceanic and Atmospheric Administration (NOAA) Beaufort Laboratory.

The consortium selected four ecologically and hydrologically diverse estuarine ecosystems as study areas. The four estuarine systems include the Nation's two largest estuarine complexes: the Chesapeake Bay and Albemarle-Pamlico Sound, as well as a small riverine estuary in Massachusetts and a small bar-built estuary in South Carolina. The key indicators of interest are those that reflect attributes of estuarine systems including primary production, phytoplankton and higher plant (marsh and seagrass) biomass and composition, zooplankton and fish community structure, dissolved oxygen, and estuarine circulation.

The indicators will be tested for their applicability to estuaries with different primary producer bases, different biogeographic provinces, and similar and contrasting chemistry, circulation, and different freshwater flows and flushing times. In addition, each of the systems has been impacted in varying degrees by humans, thus affording the opportunity to test the indicators' ability to detect and differentiate between human and natural stresses, including hurricanes, flooding, and changes in sea level.

Researchers also will use calibrated and ground-truthed remote sensing and real-time observing system data to provide a regional or coast-wide ecosystem picture. Even more importantly, these data will allow for rapid detection and quantification of trends in coastal health.

The Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium

The Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium is led by the Bodega Marine Laboratory of the University of California at Davis, in partnership with the University of California at Santa Barbara. Collaborators include the University of Georgia, The Bay Institute, and the San Francisco Estuary Institute.

The overarching goal of PEEIR is to develop indicators of wetland ecosystem integrity and propose an approach for

synthesizing indicators in assessments of wetland health along the Pacific coast. Traditional ecosystem sampling, chemical analyses, and toxicity testing are not adequate to address responses to multiple stressors in wetland ecosystems. For this reason, researchers will develop new indicators for specific plant, fish, and invertebrate population health, as well as indicators of toxicant-induced stress and bioavailability for wetland biota. Specific local problems, including wetland degradation and declining fish populations in San Francisco Bay and in Southern California, mercury contamination in Tomales Bay, invasions by exotic species, and pesticide contamination in Northern and Southern California watersheds, will be addressed using these biological indicators.

Scientists will use the remote sensing component of this research to establish landscape-level indicators of environmental stresses that can be routinely measured from the air or space. This approach will take advantage of high-spatial/spectral resolution instruments to better assess spatiotemporal aspects of ecosystem functioning.

Other programs that can benefit from this research include the CALFED Program that manages water resources in the San Francisco Bay and the upstream Sacramento/San Joaquin systems, and the western component of EMAP.

Consortium for Estuarine Ecoindicator Research for the Gulf of Mexico

The College of Marine Sciences at the University of Southern Mississippi is leading the Consortium for Estuarine Ecoindicator Research for the Gulf of Mexico (CEER-GOM). Other members of the consortium are the University of West Florida, Florida State University, University of Florida, University of Alabama, Louisiana State University, Southeastern Louisiana University, University of Texas Marine Sciences Institute, and University of Washington. The CEER-GOM team will be working with coastal managers from the five Gulf states to ensure that their research is relevant and assist in incorporating the research results into state monitoring programs.

The primary objective of CEER-GOM is to study and validate indicators of estuarine condition at four levels of biological complexity: organism, population, community, and ecosystem/watershed. For example, at the organism level, scientists will develop molecular indicators of dissolved oxygen (DO) stress as predictive indicators of reduced animal fitness related to molting and reproduction. At the community level, they will study microbial biofilms and macrobenthic communities as indicators of ecosystem integrity, resilience, and function. At the ecosystem/watershed scale, remote sensing will be used to analyze the spatio-temporal patterns of ecosystem parameters such as landscape metrics, chlorophyll, surface-water temperature, and turbidity. Ultimately, an Index of Estuarine Ecosystem Integrity (IEEI) will be developed, validated, and transferred to the states to monitor estuarine conditions over the long term.

Great Lakes Environmental Indicators (GLEI) Consortium

The Great Lakes Environmental Indicators (GLEI) Consortium is led by the Center for Water and the Environment in the Natural Resources Research Institute at the University of Minnesota-Duluth. Other cooperators include the University of Minnesota-Twin Cities, Minnesota Sea Grant; University of Wisconsin-Green Bay; the University of Wisconsin-Madison; Cornell University; John Carroll University; University of Michigan; and the University of Windsor, Ontario.

GLEI researchers will be developing and testing a suite of indicators across the range of habitats that form the Great Lakes coastal region. To provide an understanding of coastal ecosystems within the larger basin, indicators will be developed that reflect the special characteristics of the entire basin, coast, and land margins. For the basin as a whole, scientists will work with climate measures, land uses, and landscape characteristics. Water-quality contaminant levels and the relative abundances of amphibian, bird, diatom, fish, macroinvertebrate, and plant species and communities will be used as indicators for estuaries, bays, and nearshore coastal waters. For the land margins, scientists will measure the community structure of birds. Each of these subcategories will be linked to measures of habitat condition and other stressors in the Great Lakes coastal region.

This work will be coordinated with specific resource management and assessment programs including the binational State of the Lakes Ecosystem Conference (SOLEC) and individual state programs under the Clean Water Act. To promote effective communication and interaction with management agencies, scientists will coordinate with appropriate EPA research laboratories working in the region. They also will work closely with the Great Lakes Sea Grant network.

For more information, visit our web site at www.epa.gov/ncer

2000 STAR Recipients (Environmental Indicators in the Estuarine Environment Research Program)

The Great Lakes Environmental Indicators (GLEI) Consortium *Lead Institution:* University of Minnesota Duluth; *Co-Institutions:* University of Minnesota Sea Grant Program; University of Minnesota Twin Cities; University of Wisconsin-Green Bay; the University of Wisconsin-Madison; Cornell University; John Carroll University; and the University of Windsor, Ontario.

The Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium *Lead Institution:* University of California; *Co-Institutions:* University of California-Santa Barbara; University of Georgia; The Bay Institute; San Francisco Estuary Institute

Atlantic Coast Environmental Indicators Consortium (ACE INC) *Lead Institution:* University of North Carolina at Chapel Hill; *Co-Institutions:* University of Maryland; University of South Carolina, Marine Biological Laboratory of Woods Hole; and the NOAA-NOS Beaufort Laboratory.

The Atlantic Slope Consortium *Lead Institution:* Pennsylvania State University; *Co-Institutions:* Smithsonian Environmental Research Center; Virginia Institute of Marine Sciences; East Carolina University; Environmental Law Institute, and FTN Associates.

Consortium for Estuarine Ecoindicator Research for the Gulf of Mexico (CEER-GOM). *Lead Institution:* University Southern Mississippi; *Co-Institutions:* Florida State University; University West Florida; University Florida-Gainesville; University Alabama; Southern Lousiana University; The University Texas Marine Science Institute; and the University Washington.

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