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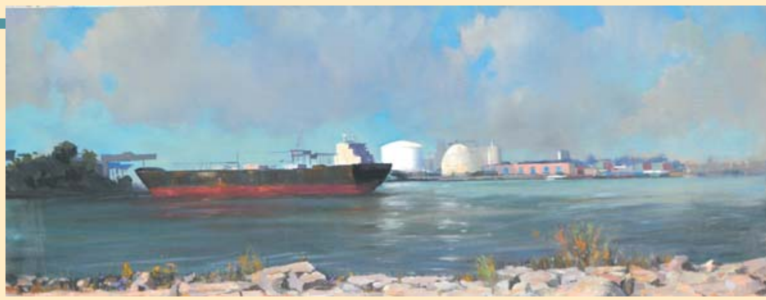

PROVIDENCE HARBOR AS SEEN THROUGH THE EYES OF PAINTER MARK FREEDMAN

41°N

A PUBLICATION OF RHODE ISLAND SEA GRANT
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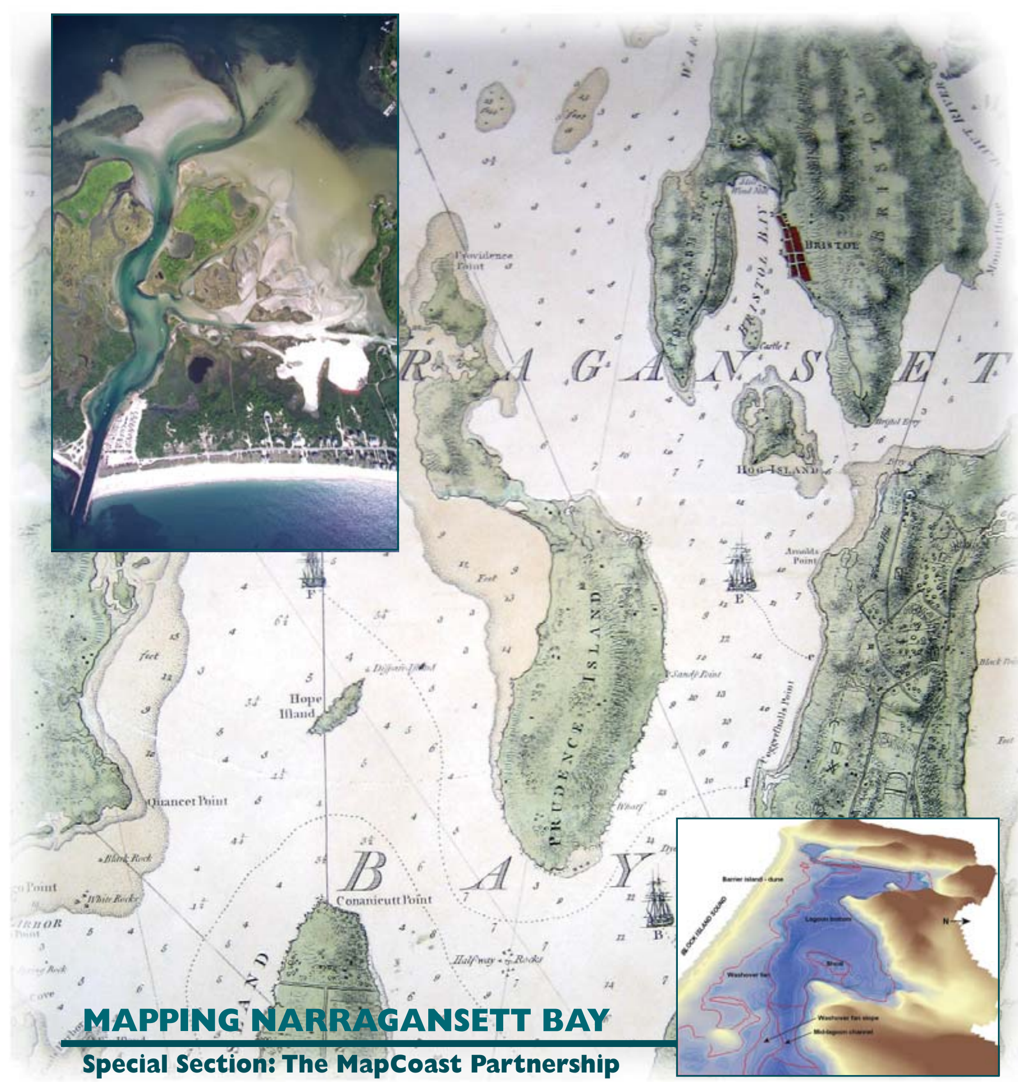
COASTAL INSTITUTE
VOL 4 NO 1 2007



MAPPING NARRAGANSETT BAY

Special Section: The MapCoast Partnership

Sea Grant Rhode Island

COASTAL INSTITUTE

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41°N is published twice per year by Rhode Island Sea Grant and the Coastal Institute at the University of Rhode Island (URI). Its title, *41°N*, refers to the degree of latitude in which Rhode Island lies. Although the full geographic "address" of Rhode island is 41°N, 71°W, we chose to focus on the latitude to emphasize Rhode Island's position in the Northeast region and to draw attention to the many commonalities the state shares with other locales along the 41°N parallel.

The Rhode Island Sea Grant College Program, part of the NOAA National Sea Grant Program, was established in 1966 to promote the conservation and sustainable development of marine resources for the public benefit through research, outreach, and education. Funding for the Sea Grant Program comes primarily from federal sources, with matching funds provided by states and private-sector groups.

The URI Coastal Institute works in partnership with local, state, federal, and international agencies to provide a neutral setting where knowledge is advanced, issues discussed, information synthesized, and solutions developed for the sustainable use and management of coastal ecosystems. The Coastal Institute works across and beyond traditional structures to encourage new approaches to problem solving.

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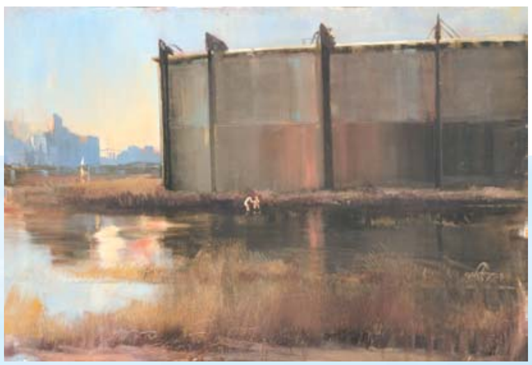
COVER CREDITS

Front cover background image "A Chart of The Harbour of Rhode Island and Narragansett Bay (1776)" originally published by J.F.W. Des Barres, reproduced by Barre Publishers, 1966. Top inset: *Photo courtesy Warwick Planning Department.* Bottom inset: *Bathymetric image courtesy the MapCoast Partnership.* Back cover: *Paintings (2) by Mark Freedman.* Inside front cover: *Interstate 195 bridge photo by Amber Neville; inset painting by Mark Freedman.* Inside backcover: *Aerial photo courtesy Narragansett Bay National Estuarine Research Reserve.*



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A Guide to Rhode Island's Natural Places

Elizabeth Gibbs, Tony Corey, Malia Schwartz, Deborah Grossman-Garber, Carole Jaworski, and Margaret Bucheit

This classic guide to Rhode Island's parks, refuges, trails, conservation areas, woodlands, waterfronts, and other natural places is designed to help state residents and visitors discover, appreciate, and enjoy the outdoor environment. This illustrated guide includes sites in every city and town, with animals and plants to look for, as well as brief articles on the history and ecology of various areas. A foldout map is included to help you find your way. *208 pages. RIU-B-94-001. $15.*

Urban Coastal Greenway Design Manual

Jennifer McCann, Sunshine Menezes, Grover Fugate, Caitlin Chaffee, James Boyd, and Monica Allard Cox (eds.)

The R.I. Coastal Resources Management Council's Urban Coastal Greenway policy allows redevelopment of the Metro Bay waterfront (that of Cranston, East Providence, Pawtucket, and Providence) in a manner that integrates economic development with expanded public access along and to the shoreline, and provides for the management, protection, and restoration of valuable coastal habitats. Those applying to CRMC for permits under the policy are encouraged to refer to this guide for assistance in following the policy's stormwater management, sustainable landscaping, and public access regulations. *70 pages. RIU-H-07-003. $3. Available free on-line at seagrant.gso.uri.edu/metrosamp/.*

Bycatch Reduction in the Directed Haddock Bottom Trawl Fishery

David Beutel, Laura Skrobe, and Kathleen Castro

The Sustainable Fisheries Extension Program evaluated an experimental net, the "Eliminator Trawl," designed to target haddock while reducing bycatch of declining stocks of cod and flounder. Results showed the new gear catches just as much haddock as the existing gear, but without catching the stocks of concern. The net configuration exploits the different behaviors exhibited by groundfish when a net is dragged toward them. Haddock typically swim upward, while cod and flounder swim downward when a net approaches. The report from this project is now available. *39 pages. RIU-T-06-002. Available on-line at* seagrant.gso.uri.edu/fisheries/haddock *or on loan from the National Sea Grant Library. Contact Joyce Winn at (401) 874-6114 or visit* nsgl.gso.uri.edu.

The Conceptual Approach to Lobster Shell Disease Revisited

Kathleen Castro, Jan Factor, Thomas Angell, and Donald Landers, Jr.

This paper presents a conceptual model for examination of shell disease that links environmental stressors to physiological upsets and disease to population level impacts, and can serve as a general model of disease in the marine environment. Reprinted from *Journal of Crustacean Biology* **26(4)**:646–660. *14 pages. RIU-T-06-002. Available on loan from the National Sea Grant Library. Contact Joyce Winn at (401) 874-6114 or visit* nsgl.gso.uri.edu.

Rhode Island Sea Grant Program Guide 2006–2008

This booklet describes Rhode Island Sea Grant's over $6 million investment in research, outreach, legal, education, and communications programs based in Rhode Island in 2006–2008. *28 pages. RIU-Q-06-002. Free. Available on-line at* seagrant.gso.uri.edu/about.

Coming Up

The Estuarine Research Federation is holding its annual conference on **November 4 to 8** at the Providence Convention Center. The theme of the conference is "Science and Management: Observations/Syntheses/Solutions." For conference information, visit *www.erf.org/erf2007/*.

On **November 30, 2007**, Rhode Island Sea Grant and the R.I. Department of Environmental Management Division of Fish and Wildlife will sponsor a "Menhaden Science and Policy Symposium." The allocation of the menhaden resource is a recurring contentious issue in Rhode Island. Rhode Islanders deserve the opportunity to explore the current information available about the menhaden resource. Visit *seagrant.gso.uri.edu/fisheries/menhaden/index.html* for more information.

The New England Regional Water Program will hold the "2007 New England Private Well Water Symposium" on **December 3 and 4** at the Hyatt Regency on Goat Island in Newport. This year's symposium will integrate research, outreach, and regulatory efforts within the field of private well protection in an effort to protect groundwater quality, drinking water wells, and the health of those who depend on these resources. Symposium details can be found at: *www.usawaterquality.org/newengland/wellsymposium/*.

The Rhode Island Natural History Survey will present "Birds and New England Native People: The Traditional Relationship" with Shepard Krech, III, Brown Unniversity anthropology professor and Haffenreffer Museum of Anthropology director, on **December 5** from 7:30 to 9:00 p.m. at the URI Coastal Institute's Weaver Auditorium in Kingston. This lecture is part of the Mark D. Gould Memorial Lecture Series. All lectures are free and open to the public.

Mark your calendars for the 13th Annual Rhode Island Natural History Survey Conference on **March 20, 2008**. Visit *www.uri.edu/ce/rinhs* for upcoming information.

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Visit *41°N* on-line at: *seagrant.gso.uri.edu/41N*

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WRITE US

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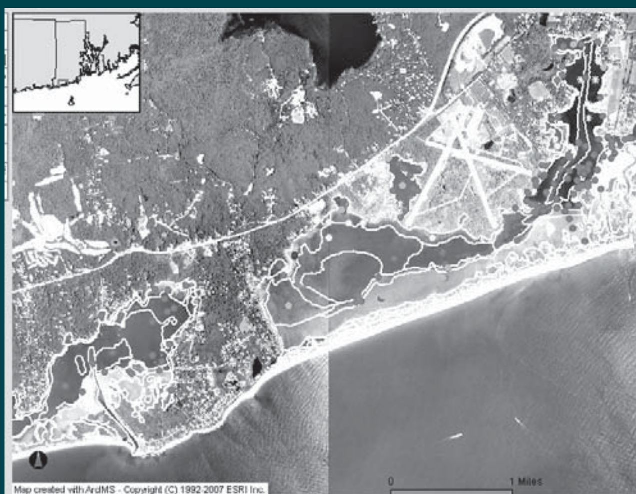
The MapCoast Partnership



MapCoast: Extending soil surveys to submerged environments.

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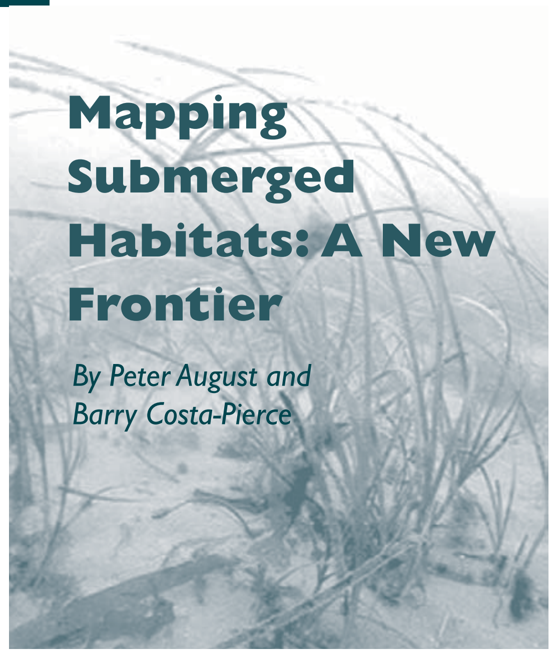
Photos this page and opposite courtesy MapCoast.



Mapping Submerged Habitats: A New Frontier

By Peter August and Barry Costa-Pierce

The MapCoast Partnership is a cooperative alliance of institutions interested in mapping submerged habitats in shallow (less than 5 meters (m) depth) coastal waters. It is a rich assortment of disciplines, interests, and technologies. The National Cooperative Soil Survey program of the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) has recently made the bold move to extend the nation's soil survey into shallow, submerged areas of our coasts. The USDA has declared this their "Coastal Zone Soil Survey Initiative." Subaqueous soils are the underwater counterparts to terrestrial soils. Like terrestrial soils, subaqueous soils are substrates for rooted plants that use photosynthesis to derive energy and are habitats for ecologically important epifauna and infauna (organisms growing on or in the sediments). Submerged aquatic vegetation, such as eelgrass, grows best in certain types of subaqueous soils and provides essential habitat for fish, shellfish, and other marine life. In the process of mapping the nation's terrestrial soils over the past century, the NRCS has developed methods, protocols, and nomenclature that are rigidly followed. This has produced a national database called the Soil Survey that is one of the most important datasets for land-use planners, natural resource managers, farmers, environmentalists, scientists, and engineers. But mapping submerged soils is a new frontier for the NRCS, and the MapCoast team is on the cutting edge of developing the methods and naming conventions that can be used in delineating underwater soils.

Mapping submerged habitats has been the traditional bailiwick of coastal and marine geologists. Some of the instruments they use to map underwater habitats are not used in terrestrial environments, such as side-scan imagery and sediment profile camera systems. In some cases, however, terrestrial soil scientists and coastal geologists use similar methods: Both, for example, extract core samples—sometimes many meters long—and study the different layers of material in the core. Cores contain information that allows scientists to determine what changes have occurred at a given location over hundreds and sometimes thousands of years. One of the important goals of the MapCoast Partnership is to determine which of the tools in the toolboxes of coastal geologists and terrestrial soil scientists are most effective in characterizing and mapping shallow-water habitats.

This is not just an academic exercise. The first question the MapCoast team set out to answer was, what do the users of our coast need to know about submerged habitats? A number of datasets were at the top of the user community's list—bathymetry and imagery of the sea floor, chemical pollutants in the sediments, submerged vegetation, shellfish beds, and benthic communities (organisms living in the sediment). These requests by shellfishermen, marina operators, natural resource managers, and environmental scientists have played an important role in directing the MapCoast workplan. MapCoast is committed to making the data it collects useful to the coastal community and readily available over the Internet.

So where is MapCoast now? Current mapping activities are centered in the coastal lagoons on the south shore of Rhode Island, Wickford Harbor, and Greenwich Bay. Our south shore coastal lagoons, locally called salt ponds, offer many unique challenges and opportunities: They are heavily used shallow-water ecosystems, they are biologically rich and contain critically important habitats for fish and shellfish, groundwater pollutants from dense development along the shores create water quality problems, and legacy pollutants from past land uses are sometimes found in pond soils.

Seafloor mapping does not end at the 5 m depth mark. Mapping the deeper waters of Narragansett Bay and coastal Rhode Island is where the Rhode Island Sea Grant–funded BayMap project takes over. The BayMap project is a large team of multidisciplinary scientists led by John King, URI oceanography professor, and they work to map all of Rhode Island's coastal waters. The processes that form subaqueous soils (sediments) in deeper waters having no sunlight are very different from shallow-water ones. Nevertheless, the different geological substrates (e.g., rocks, cobble, sand, silt) that define the bottom of Narragansett Bay and our coastal waters are critical habitats for a wide range of fish, shellfish, and crustaceans.

Not only does it "take a village" worth of disciplines to map submerged habitats, it takes a multitude of funding agencies to pay for it. MapCoast/BayMap projects have been generously supported by a variety of agencies. Prominent among them are the NRCS, Rhode Island Sea Grant, the URI Agricultural Experiment Station, NOAA Coastal Services Center, the National Science Foundation, and the Champlin Foundations. Sen. Jack Reed and former Sen. Lincoln Chafee have also been exceptionally helpful in identifying possible sources of funding for the MapCoast and BayMap initiatives.

This special section of *41°N* summarizes what mapping submerged soils and sediment is all about, the different methods we use, and the exciting products we are developing. If we have whetted your appetite and you want to learn more, come visit us at *www.mapcoast.org*.

—Peter August is Director of the URI Coastal Institute. Barry Costa-Pierce is Director of the Rhode Island Sea Grant College Program.

From Land to Shallow Water: The Evolution of Soil Mapping

Contributors: Mark Stolt and Michael Bradley, URI; James Turenne, Eric Scherer, and Maggie Payne, NRCS

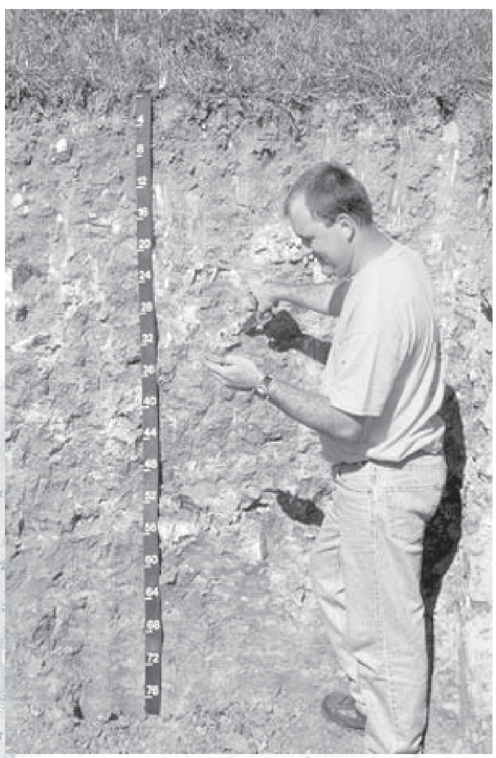


Photo courtesy MapCoast.

Soil scientists working under the National Cooperative Soil Survey (NCSS) have been conducting detailed inventories of the nation's soil resources for over 100 years. The importance of soil maps and data—collectively known as soil surveys—became critically clear early in the history of the NCSS following the catastrophic dust storms of the 1930s caused by poor land management and conservation practices. As a result, the Soil Conservation Service (now Natural Resources Conservation Service (NRCS)) was created by President Franklin D. Roosevelt to be the lead federal agency of the NCSS.

Soil mapping is conducted by a field soil scientist trained to understand the interaction of soil forming processes and soil-landscape relations. By understanding how soil properties and characteristics change across the landscape, a soil scientist can map out the various soil types in an area quickly, usually mapping several hundred acres in one field day. This requires extensive field work, with the soil mapper traversing the landscape and digging many holes (sometimes 2 meters (m) deep) to observe soil properties (e.g., color, texture, and horizonation) and conditions (e.g., wet versus dry). The boundaries of the soil map units are then delineated on an aerial photograph. The final product of such efforts is a soil survey that includes maps showing the distribution of different soil types and a series of tables that explain the classification, use, and management of the various soils types. These tables identify attributes of the soil types; for example, soil suitability for septic systems, houses, wildlife habitat, wetlands, forestry, and agricultural uses.

Soil survey data are requested by a wide variety users, including land developers, realtors, environmental consultants, individual land-owners, farmers, and scientists. Numerous state and federal regulations rely on soil survey information in their efforts to identify and protect critical fish and wildlife habitat, wetlands, and prime agricultural lands. These data are used by towns for implementation of land-use planning and zoning ordinances. Soil survey information is one of the most highly requested resource datasets by GIS data users. Thus, soil surveys are not only a critical data layer for wise land-use planning, but also for development of natural resource conservation plans, global climate change, and natural disaster mitigation.

MapCoast scientists Jim Turene (left) and Mark Stolt (right) flank WJAR-TV reporter R.J. Heim during a feature on MapCoast work on the weekly Channel 10 News "URI Watershed Report." *Photo courtesy MapCoast.*

Recognizing the value of soil survey data for various use and management issues, scientists working in coastal environments began to develop methods and approaches to create soil survey information for benthic habitats in shallow estuarine environments (typically less than 5 m of water). As on land, similar techniques and tools were used by these scientists to map permanently submerged, shallow-water soils (subaqueous soils). The earliest work was done in Maryland, with similar research following shortly afterwards in Rhode Island. Over the last 10 years, subaqueous soil inventories have been made in Maine, Rhode Island, Connecticut, New York, Delaware, Maryland, Florida, and Texas. These subaqueous soil surveys are being used to make management decisions related to restoration of aquatic vegetation such as eelgrass, locating areas suitable for aquaculture, deciding whether an area should be dredged and the fate of the dredged materials once they are applied to the land, and determining locations for shellfish restoration.

Understanding the need for such information in the Ocean State, the Rhode Island office of the NRCS took the lead in establishing the institutional framework necessary to begin mapping coastal and subaqueous soils and coastal and marine habitats in Rhode Island. This institutional framework, now known as the MapCoast Partnership, is made up of the Rhode Island NRCS, URI researchers and scientists, as well as other state and federal agencies.

NEW TECHNOLOGIES ARE MAPPING MARINE ENVIRONMENTS

In 2006, federal funding for coastal restoration projects in Rhode Island exceeded $10 million. The success or failure of these projects relies, in part, on good scientific data about the soils and geology of restoration sites. Currently, little data exist for shallow-water areas. The most recent map of sediment types occurring in Narragansett Bay was published in 1961—over 45 years ago, prior to the development of much our modern mapping technology.

Resource inventory maps, such as the type that the MapCoast and BayMap projects are creating, form the basis for wise resource planning and stewardship. These information products support scientifically sound decision making.

MapCoast uses a variety of procedures and technologies, some extremely technical, which together create a clear picture of our underwater environments. These include:

- Sediment Profiling Imagery (SPI)
- Coring
- Bathymetric Mapping
- Geographic Information Systems (GIS)
- Aerial Photography
- Underwater Imagery
- Side-scan Imagery

The data collected in a MapCoast inventory fully complement and build on each other, providing unique insights into shallow coastal ecosystems. For example, bathymetry and aerial photography are used to delineate shallow-water landscapes and determine sampling locations; sonar and SPI images are used to determine the surface composition and condition of benthic habitats; and core and auger samples provide subsurface data including grain size and organic matter content. In addition, lab samples are analyzed to determine the physical (color, grain size, percent gravel, percent shells, and magnetic potential) and chemical (salinity, pH, organic carbon, and metal content) properties of subaqueous soils. All the data are brought together in a comprehensive GIS database for analysis and map production. By collecting data at various scales (lab to landscape), the individual information products integrate to provide a resource inventory that is a complete and accurate description of shallow-water habitats.

SIDEBAR

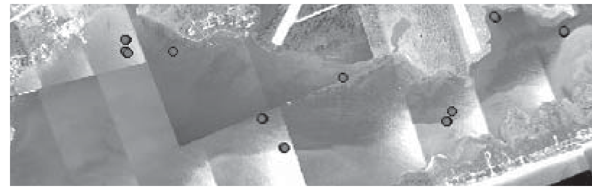
The Underwater Garden

Imagine you are looking to select the best location for your vegetable garden. You might want to examine the soil before you start digging. Is it rich, dark earth that would promote good rooting and productive beds? Or is it hard-crusted gravel, left over from construction that would challenge even the best gardener?

This type of assessment is now under way by the scientists involved in the MapCoast and BayMap projects. They are using state-of-the-art science to examine the composition of the submerged soils and sediment that lie beneath Narragansett Bay and the south shore salt ponds. The soils that support verdant gardens and flower beds on terra firma also provide a rich foundation for underwater plants. These areas of submerged aquatic vegetation, such as eelgrass and macroalgae, are critical areas used by many species of fish and shellfish. By examining the underwater soils in our coastal ponds and estuaries, scientists can gauge the health of these ecosystems.

By combining the methods used by soil scientists on land for the past century with state-of-the-art remote sensing technologies developed by marine scientists, we are creating a new set of tools to map our underwater habitats. The need to increase scientific understanding of submerged (or subaqueous) soils is of vital importance in the management of coastal activities. Fishing, habitat protection, dredging, and eelgrass restoration depend on accurate information on submerged soils. These are the baseline data that guide the protection, conservation, and management of our near coastal waters.

An aerial view of South County salt ponds, sites of MapCoast surveys. *Photo courtesy URI Graduate School of Oceanography.*



Spying on the Ecosystem

Contributors: John King and Emily Shumchenia, URI Graduate School of Oceanography (GSO)

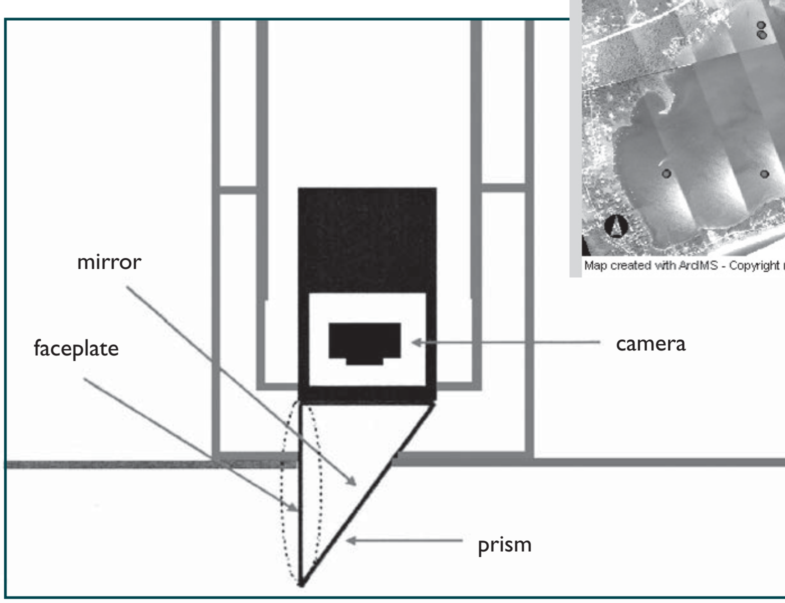
If you ever played with the kiddie toy that uses a mirror to let you look around corners, or been to a golf tournament and used the same sort of device to watch the action from far back in the gallery over other spectators' heads, you have a rough idea of the workings of sediment profile imagery (SPI). SPI (pronounced "spy") cameras are lowered to the Bay floor, where a prism containing a mirror is forced into the mud. Through the prism window, a digital camera takes a picture of a slice of the sediment. The most useful images capture the sediment-water interface and any creatures living on or in the mud.

SPI allows MapCoast researchers to obtain high-resolution digital images of the soil surface layers, provides data on the amount of sand, gravel, and clay (grain size) to determine bottom type, is used to identify bottom-dwelling marine life and plants (e.g., eelgrass), and can capture evidence of low oxygen (hypoxic) conditions.

One of the key value-added traits of SPI is that it brings together geological and biological information in a rapid and quantitative way, which can aid in the overall assessment of environmental conditions. Historically, the difficulty of simultaneously collecting data on the geological, physical, and biological characteristics of the seafloor made it difficult to quickly characterize benthic habitats. SPI is able to rapidly capture a representation of bottom conditions, including indicators of nutrient pollution, chemical pollution, and other disturbances from human activities.

SPI also provides a visual tool to identify areas in which ecosystem function has been altered, information that can be used to guide future management and/or protection. For example, SPI has been used to monitor the biological recovery of recently dredged areas on both coasts of the United States and in Europe, providing accountability for financing of such initiatives and allowing for adaptive management since the scenario may change. SPI has also been used in the United States and in Europe for studies involving low oxygen, fish farms, trawling, dumping, and mapping of drill cuttings around oil platforms, as well as for benthic monitoring programs.

The ability to evaluate ecosystem health quantitatively not only contributes to scientific research, but also effectively informs management decisions. Information on Bay ecosystem status is being gleaned from sediment profile images in numerous areas in Rhode Island and contributes to the overall understanding of the interaction between physical, chemical, geological, and biological conditions throughout the Bay.



Above: Map of locations of SPI imagery available for download on the *www.mapcoast.org* website. *Left:* Schematic drawing showing how a SPI camera works.

CUTTING TO THE CORE

Contributors: Mark Stolt, URI Natural Resources Science; Michael Bradley, URI Environmental Data Center (EDC); James Turenne and Maggie Payne, USDA Natural Resources Conservation Service (NRCS); John King, GSO

A specially designed pontoon boat is used to extract core samples. *Photo courtesy MapCoast.*

It is not exactly like drilling for oil and hoping for a gusher, but there is much to be revealed by digging down and taking core samples from the shallow seafloor to help guide how we manage our coastal ecosystems. Taking core samples is labor intensive, and analyzing them requires even more time and attention to detail. The information hidden in the cores, however, is essential to marine and soil scientists in understanding the history of a site and the composition of benthic habitats.

While a SPI image (see page 6) provides a detailed look at the water column-soil interface, it provides little information regarding the deeper soil and sediment. To investigate the deeper materials, cores are collected. A core is a cylindrical sample of soil and sediment that can be many meters long. The top part of a core sample contains material that was recently deposited. As you go down the core, the material is older and older. Cores provide a detailed history, sometimes over thousands of years, of a specific site. They can show evidence of extreme climatic events, changes in the hydrology of an area, changes in the ecology of a specific location, and they can even document when areas were first covered by marine waters. The SPI camera is rapid and is helpful for covering larger areas, but coring delivers much greater detail of information than does SPI.

MapCoast coring is done from a pontoon boat. A vibra-core is inserted through a "moon pool" (or hole) in the deck of the boat and into the soils and sediments at the bottom of the estuary. A vibra-core, as the name implies, uses vibration as the force to drive an aluminum or PVC core barrel into the lagoon or Bay bottom. The weight of the device along with the high-speed vibration allows soil, sediment, and small rock fragments less than 8 centimeters (cm) (3 inches) to enter the core. Once the vibra-core reaches the desired depth (typically 2 meters), the core is pulled out using a winch or chain-fall. Numerous cores are collected for an area and examined. The sampling locations are recorded with a GPS. Cores are labeled on the boat and taken back to the University of Rhode Island (URI) where they are stored in a refrigerator until being described and sampled.

MapCoast scientists Maggie Payne and Jim Turenne taking a core sample. *Photo courtesy MapCoast.*

Prior to this analysis, cores are cut in half in a laboratory and photographed using a high-resolution digital camera. One half of the core is measured every 1.3 cm (0.5 inch) for physical properties (e.g., density) and archived in a repository for future use. The other half of the core is studied by horizon (soil layers having the same properties). The scientist records such properties as color; amount of sand, silt, and clay; rock and shell fragments; presence of hydrogen sulfide; pH; and numerous other properties that allow MapCoast researchers to accurately characterize, classify, and map the shallow-water landscape. These data are stored in a database program designed for soil surveys. Samples of each of the layers are placed in bags and sent to the soil lab at URI or to the National Soil Survey Laboratory (the largest soil lab in the world) in Lincoln, Neb., where a full analysis of the chemistry and physical properties is completed.

The physical, chemical, and morphologic information is used to create a database of the soil types that occur in shallow-water estuarine environments. This information allows scientists to develop soil map units and build use and management interpretations for the various soil types that occur within an estuary.

Bathymetry: An In-depth Study

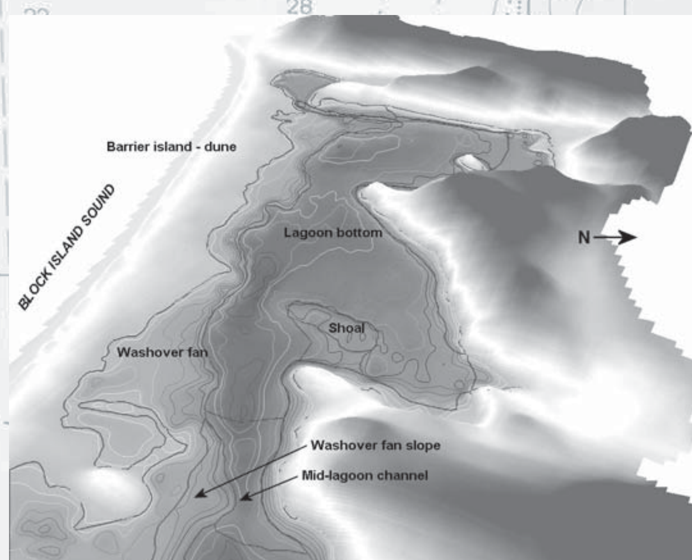
Contributors: Peter August, URI Coastal Institute and URI Natural Resources Science; Michael Bradley, EDC; James Turenne, NRCS; Kathryn Ford, Massachusetts Office of Coastal Zone Management

How deep is the water? How many times has a swimmer or boater asked this question? Whether you are canoeing on a salt pond or fishing in a quiet cove, knowing the bathymetry (the depth of the water) of Narragansett Bay and other coastal waters is essential information. Like all users of the state's coastal waters, MapCoast scientists need accurate and up-to-date bathymetric data to help them get a picture of the seafloor.

During the MapCoast User Conference in November 2004, detailed and accurate shallow-water (less than 5 meters) bathymetry data was one of the most requested data sets. Bathymetry data for MapCoast is primarily collected using fathometer soundings. In areas too shallow for a deeper water fathometer, researchers use high-accuracy GPS to collect measurements of depth by wading into shallow waters from shore.

Using GIS technology, MapCoast scientists merge existing coastal elevation data with shallow-water bathymetry to create a seamless elevation model. Careful testing and statistical analyses are performed to ensure the resulting topographic and bathymetric data set is accurate. Using different GIS procedures, MapCoast scientists then create contour maps and other representations of elevation and depth used in resource management.

While MapCoast bathymetric data sets are not intended for navigation, there are many scientific uses for these data. Bathymetry and the resulting contour lines give MapCoast researchers valuable information on the shallow-water landscape and allow them to define the boundaries of soil map units and underwater habitats. Detailed bathymetric data can be used for a variety of marine studies, including mapping eelgrass beds and identifying essential fish habitat. Bathymetry is also an important component for hydrographic modeling for examining current flow, and it is used for habitat restoration design (e.g., restoration of salt marshes) and analysis of sediment and contaminant transport. Detailed bathymetry has been developed for Ninigret and Quonochontaug ponds on the south shore of Rhode Island and for Greenwich Bay and Wickford Harbor.



Above: Depth contours for Ninigret Pond. *Below:* 3-D representation of depth contours and submerged landscape units. *Images courtesy MapCoast.*

Into the Deep: Mapping the Bay

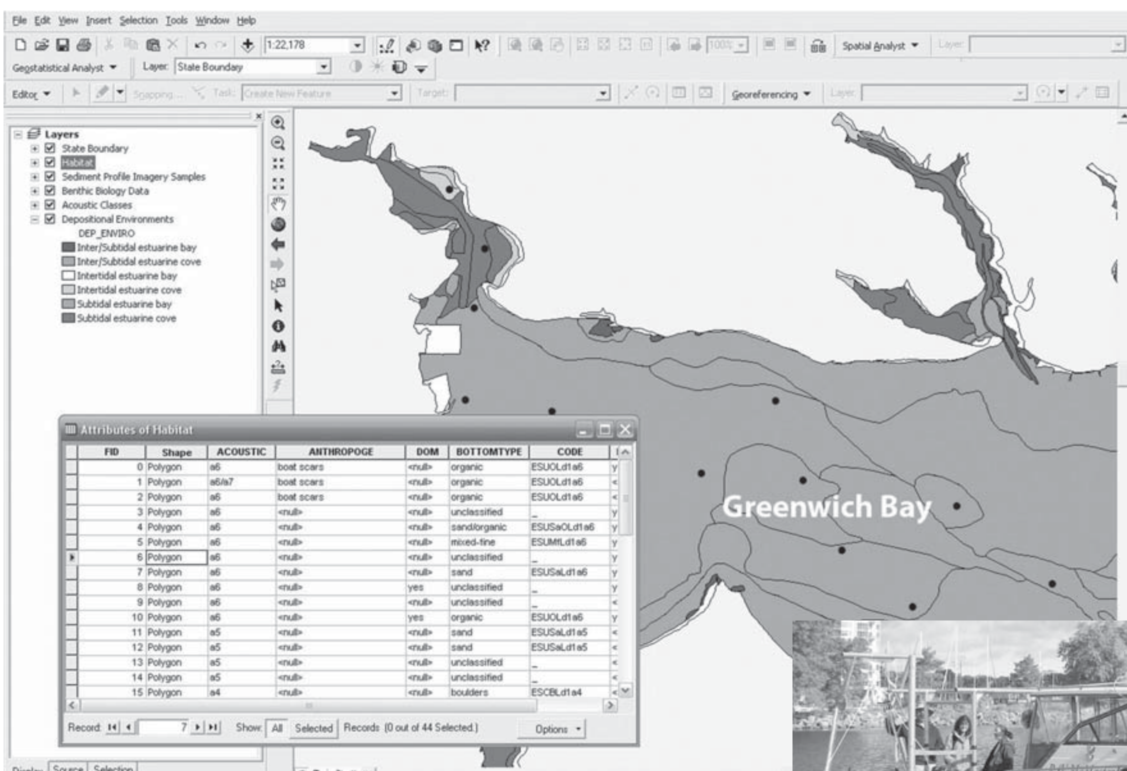
Contributor: John King, GSO

As a complement to MapCoast's focus on soils in coastal lands and in shallower waters, the main focus of BayMap is on sediment in deeper waters. The BayMap project will produce a comprehensive series of high-resolution seafloor maps for coastal environments deeper than 5 m (16.5 feet). Those maps will describe the geology, habitats, biological communities, and archaeology of the deeper areas of Narragansett Bay and the south shore.

BayMap uses sophisticated imaging technologies to map the seafloor and the organisms that live there. This information will be assembled into an inventory of sediment types, habitats, biological communities, and underwater archaeological sites in a readily accessible GIS format. An interdisciplinary team of geologists, biologists, archaeologists, and GIS experts from URI are collaborating on the BayMap study, which receives funding from Rhode Island Sea Grant.

BayMap is designed to provide much-needed insights into the factors that control the presence/absence and abundance of bottom-dwelling plants and animals. When the waters of our marine environment are healthy, these organisms thrive and are the basis for Narragansett Bay's rich ecosystem. However, they are the first organisms to show signs of stress when the water becomes polluted. When these bottom-dwelling communities are diminished or fail entirely, the entire Bay environment is impacted. For example, if blue mussel communities are killed by low oxygen events, then they no longer filter particles from large volumes of water, and coastal waters become more turbid and less hospitable to eelgrass communities that require penetration of sunlight to thrive.

Above: BayMap researchers deploy the Sub-Chem Systems nutrient analyzer. This instrument measures nitrate, nitrite, ammonia, phosphate, iron, dissolved oxygen, salinity, and temperature at various depths in the water column. *Photo courtesy BayMap field team.*



Above: Computer screen image showing various data layers being synthesized into a preliminary habitat map for Greenwich Bay, using ArcMap GIS software. *Right:* The *R/V McMaster* is used primarily for deeper water surveying. *Photo courtesy BayMap field team.*

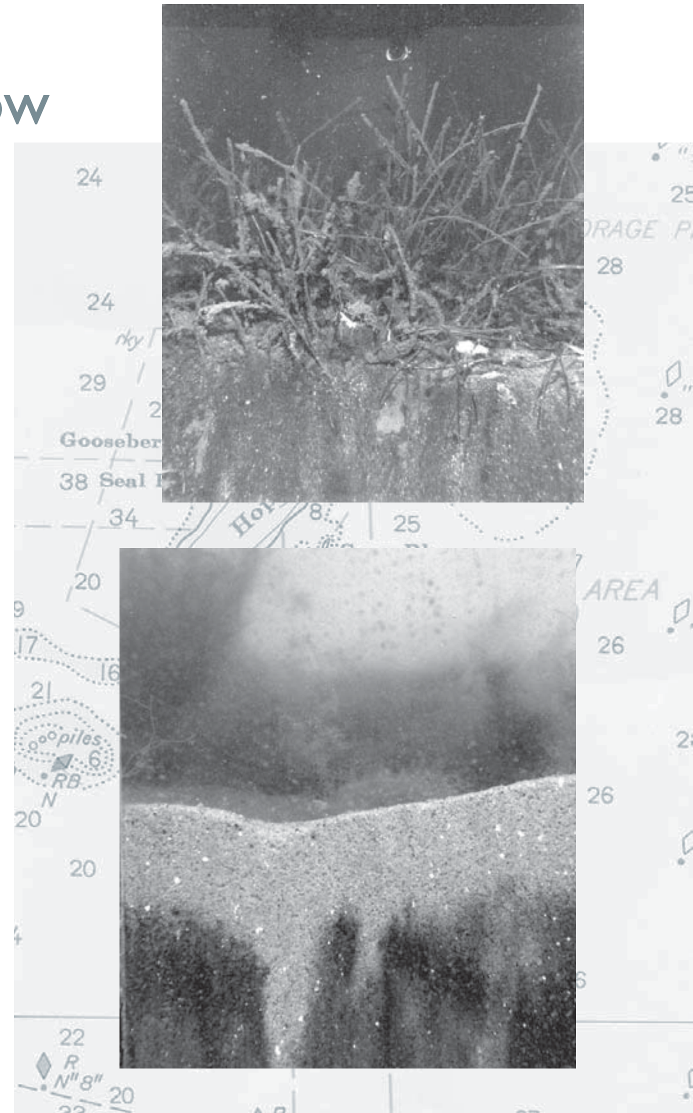
The Sky Above, the Mud Below

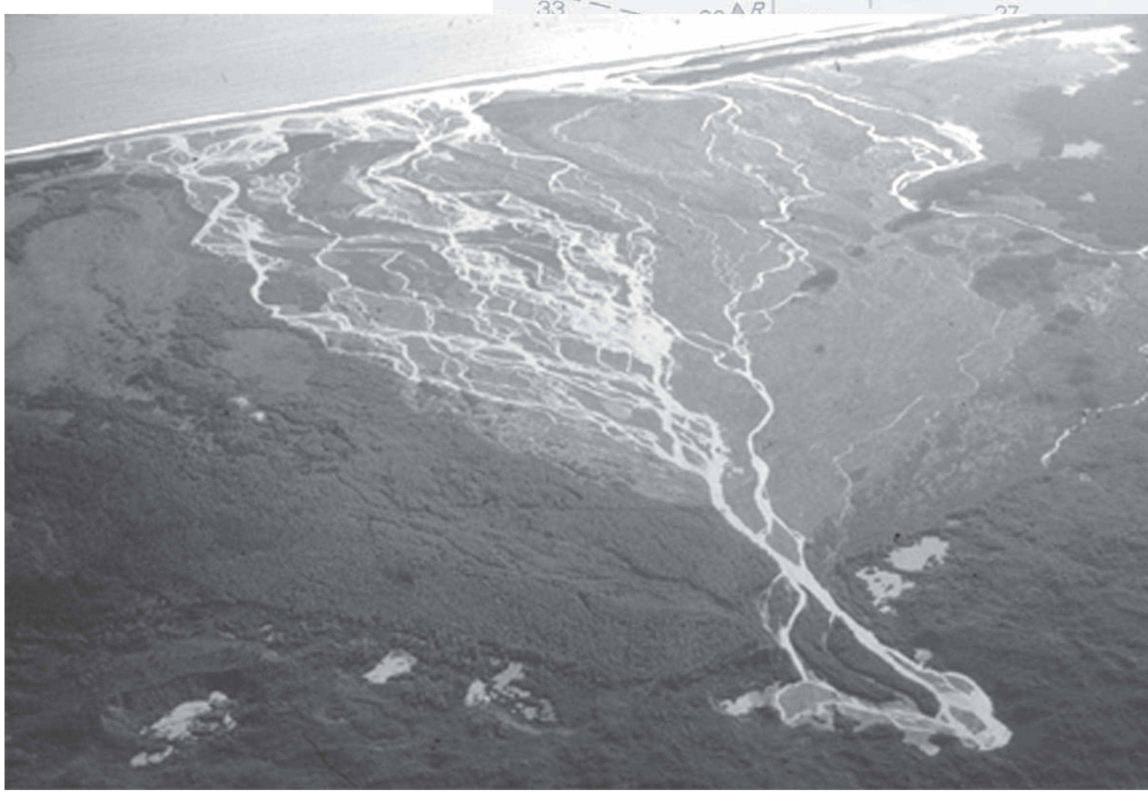
Contributors: John King and Emily Shumchenia, GSO; Michael Bradley, EDC; Cheryl Hapke, U.S. Geological Service (USGS)

Photographic imaging is an effective scientific tool for exploring and characterizing the environment because it provides a lasting record of the plants, animals, and physical conditions that are present. Images can vary in scale depending on how broadly one wants to examine the environment. MapCoast scientists have collected images of coastal areas from aircraft and from cameras lowered from boats. These and other MapCoast techniques are designed to provide a comprehensive characterization of the seafloor so as to promote informed management of Rhode Island's coastal waters.

Aerial photography, where the camera is hundreds of meters above the water surface, can characterize habitats such as seagrass beds, salt marshes, and intertidal flats in shallow water areas. Aerial images cover a large area and can help determine how much of each habitat is present. Aerial images can also help detect changes in area of habitats from year to year. Additionally, they provide a background for making and displaying maps.

Underwater photography, where the camera is usually less than a meter from the seafloor, can image living things including clams, worm tubes, snails, shrimp burrows, seagrass, and algae. MapCoast has used several types of underwater imaging. These include still cameras and video cameras that look at the surface of the seafloor, as well as sediment profile (SPI) cameras that see a cross-section or "slice" of the sediment (see page 6). These images can tell us something about the condition of living resources and verify the habitats that are being mapped. Furthermore, images of the same location can tell us how the environment is changing over time.





Top and middle: Sediment profile imagery of the seafloor showing biological and physical properties of the site.
Bottom: The complex geography of land, water, and sea as seen in an aerial photograph. *Photos courtesy MapCoast.*

Finding More Than Fish

Contributors: John King, GSO; Jon Boothroyd and Brian Oakley, URI Geosciences

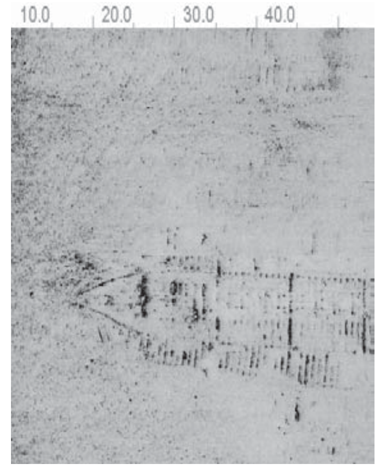
Many fishermen consider their fish-finders to be an invaluable tool. These instruments use sonar to detect the seafloor and schools of fish in the water column.

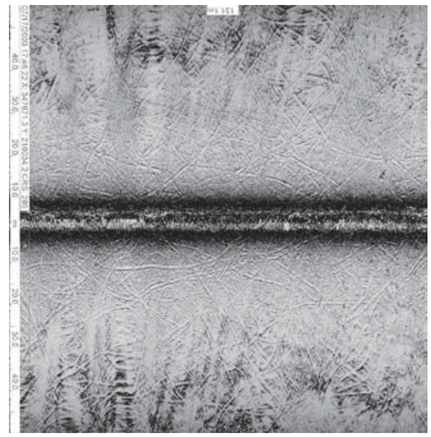
The side-scan sonar technology used by MapCoast is a high-end version of a fish-finder that also uses sound waves to collect an acoustic image of a lagoon or bay floor to determine benthic (bottom) type. Because the acoustic data are collected simultaneously off each side of the survey vessel (hence the name "side-scan"), the boat can drive back and forth over the area—much like mowing a lawn—to get a full acoustic picture of the ocean bottom.

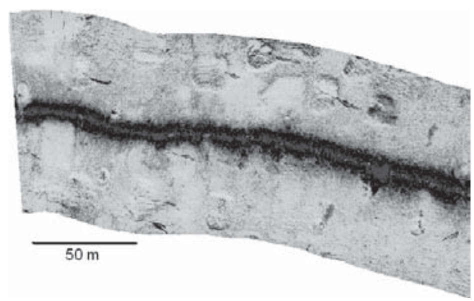
Benthic habitats have features that make them acoustically distinct. A benthic habitat will respond to sound waves differently depending on surface hardness and complexity, and these responses, or backscatter intensities, can be used to identify habitat boundaries. For example, a rocky bottom will have high backscatter intensity, and a muddy bottom will have very low backscatter intensity. Organisms, such as eelgrass or oyster beds, living on the Bay bottom can also affect the backscatter intensity. Habitat restoration specialists can use these acoustic maps to guide their restoration efforts.

In order to determine if the acoustically distinct areas really are different habitats, it is important to ground-truth the acoustic map. Ground-truthing is an essential step in creating benthic habitat maps using remotely sensed data. Factors like water depth, bottom slope, and vegetation can change the acoustic signature from place to place. Underwater imagery techniques such as video and sediment profile imagery (see page 6) along with traditional grab samples are used to interpret the acoustic signals and get a closer look at the bottom of the Bay. Because of the excellent spatial coverage generated by side-scan sonar, the acoustic data act as a guide, and ground-truthing surveys can maximize our understanding of different habitat types.

Just as aerial photography is an essential source of information when mapping terrestrial soils, side-scan sonar is equally important for mapping ocean bottom conditions. The imagery collected by the MapCoast research team is the basis for geological mapping of the seafloor, benthic habitat mapping, and subaqueous soil delineation.



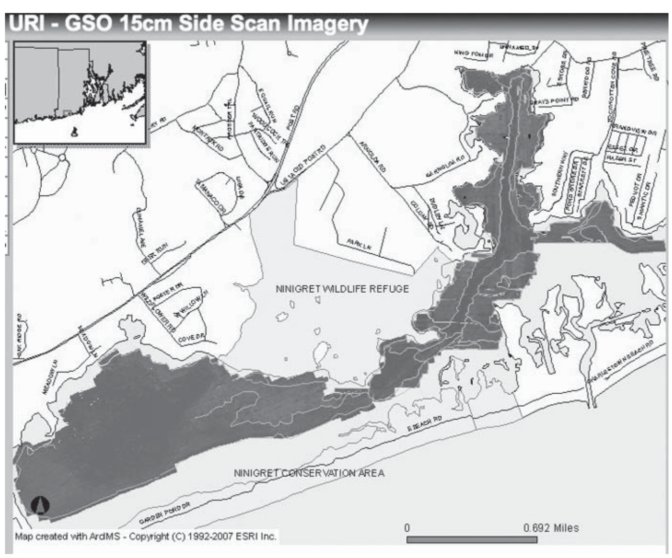




Top: Side-scan sonar image of a sandy depositional platform near Oakland Beach, R.I., showing a wrecked barge. The ribs from the port side are laying on the sand adjacent to the barge. *Image provided by Jon Boothroyd, URI Geosciences.*

Middle: Side-scan image of the central western basin of Narragansett Bay, R.I. The Bay-floor basin fine silt is crisscrossed by trails formed by quahog rakes dragged across the bottom during the harvesting of the shellfish. The quahoggers drift with the wind and tidal current as they harvest the clams. *Image provided by Jon Boothroyd, URI Geosciences.*

Bottom: Side-scan image of a cove south of Chepiwanoxet, R.I. Bay-floor basin fine silt shows circular features caused by the chains from moorings. The 10- to 20-meter circular features are formed as the moored boats rotate around the mooring in response to wind and tidal current. *Image provided by Jon Boothroyd, URI Geosciences.*



Right: Map showing side-scan imagery for the Ninigret area.

Acoustic maps guide restoration efforts.

MapCoast: Bringing Together Scientists, Technology, and Users

Contributor: Eric Scherer, USDA Natural Resources Conservation Service

One major goal of the MapCoast partnership is to develop protocols and procedures for the synthesis and interpretation of subaqueous soils, with an objective of providing widely accessible information to a variety of users. The ultimate goal is to create a seamless soils-sediments database of our coastal waters.

The partnership has brought together a diverse group of scientists, stakeholders, and data consumers who recognize the need to collect detailed soil and sediment data for coastal ecosystems. Their work consists of:

- Gathering detailed data on water depth (bathymetry) for the coast
- Characterizing (classifying) bottom composition
- Using sonar imaging to map geological formations and submerged habitats
- Describing benthic (bottom) community composition and condition using sediment profile imagery (SPI) technology
- Mapping and characterizing subaqueous soil types

These data make it possible to integrate the information to produce underwater soil maps, benthic geological maps, and submerged habitat maps. These maps will help meet the informational needs of shellfishermen, coastal management agencies and managers, citizens, fisheries managers, scientists, and a host of other agencies, organizations, and individuals who use Rhode Island's coastal zone.

The collaborative effort of the MapCoast Partnership brings together the diverse talents, skills, and resources of researchers to produce data sets that will address a broad spectrum of users. Physical scientists (geologists, soils experts) are working in concert with biologists and technocrats (GIS, remote sensing specialists) to produce data sets that, taken together, provide a resource inventory that is a complete and accurate description of shallow-water habitats. The partners are sharing equipment, data collection, laboratories, and sampling procedures to fine-tune the protocols that will be used by others in mapping and classifying subaqueous soils around the world.

In the end, this protocol for synthesis and interpretation allows the MapCoast data, and associated metadata (information about the data), to be available to users via a number of Internet technologies such as Internet Map Service, downloadable GIS data, imagery servers, and the MapCoast portal. For more information about MapCoast, visit *www.mapcoast.org*.

Soil mapping results are drawing more and more media and public attention. *Photo courtesy MapCoast.*

MapCoast data gathering is often hands-on, dirty, and wet. *Photo courtesy MapCoast.*

MapCoast supporter and former Senator Lincoln Chafee with NRCS state conservationist, Roylene Rides at the Door. *Photo courtesy MapCoast.*

Coastal Ecosystem Management in Rhode Island: The Role of MapCoast

Contributors: Janet Freedman and James Boyd, R.I. Coastal Resources Management Council

Millions of dollars are spent each year by state and federal agencies on restoration projects, habitat enhancement, coastal erosion, dredging, and other projects.

Most of these projects are along the shoreline or adjacent to it, in the realm of MapCoast's target area, where there are little, if any, existing up-to-date data available from resource inventory maps such as bathymetry, soil chemical and physical properties, or geological data.

As the federally designated policy and regulatory agency for Rhode Island's coastal zone, the Coastal Resources Management Council (CRMC) has particular interest in a standardized soil-habitat mapping protocol to improve coastal ecosystem management decisions. Using more detailed soil and sediment data, bathymetry, and side-scan sonar imagery developed through the MapCoast Partnership, the CRMC can be much more effective in assessing suitable habitat restoration sites for coastal wetlands, eelgrass, and shellfish. The MapCoast data will offer a much higher level of detail to determine priority restoration sites and will result in more successful and cost-effective restoration efforts.

These detailed data sets can also provide valuable information for the assessment of dredging needs and management of dredged materials in the coastal environment. They will allow for better selection of areas for new dredging, limiting the amount of material that has no reuse potential and avoiding sensitive habitats. For example, the U.S. Army Corps of Engineers (COE) employed MapCoast protocols for beneficial re-use of the dredged sediment in the Point Judith Pond dredging project—protocols that were fairly new for the COE. The sediment "welded" onto the beaches, as predicted, which proved critical a few months later in mitigating some of the damages in the 2007 Patriot's Day storm.

The mapping and characterization of benthic habitat will permit much better assessment of ecological conditions and allow coastal managers to evaluate the success (or failure) of habitat restoration efforts and permit-required pollution abatement controls. Additionally, the integration of the MapCoast data will enhance the effectiveness of the CRMC special area management plans (SAMPs) by linking important underwater soil and benthic habitat data with development and implementation of floodplain, hazard mitigation, habitat protection and restoration, and coastal buffer management tools.

Examples of the uses of MapCoast data include:

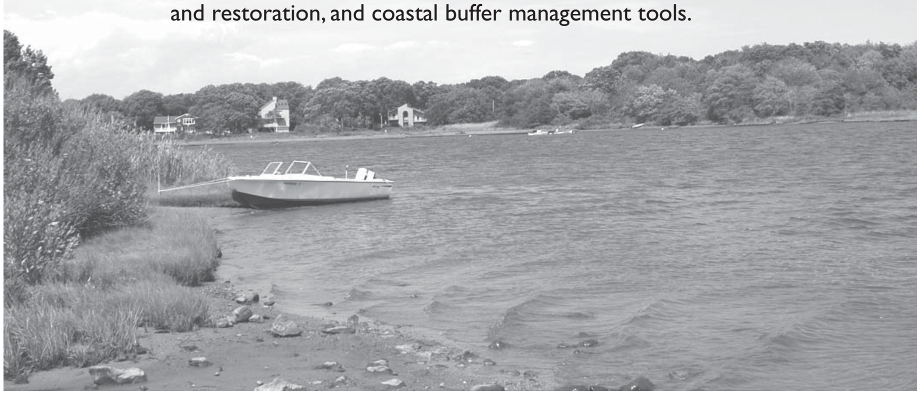
Floodplain Management in Redevelopment Zones
- Modeling flood inundation zones
- Analyzing impacts of floodplain development on a regional level
- Identifying pre-disaster mitigation strategies
- Mapping safest evacuation routes and shelter locations

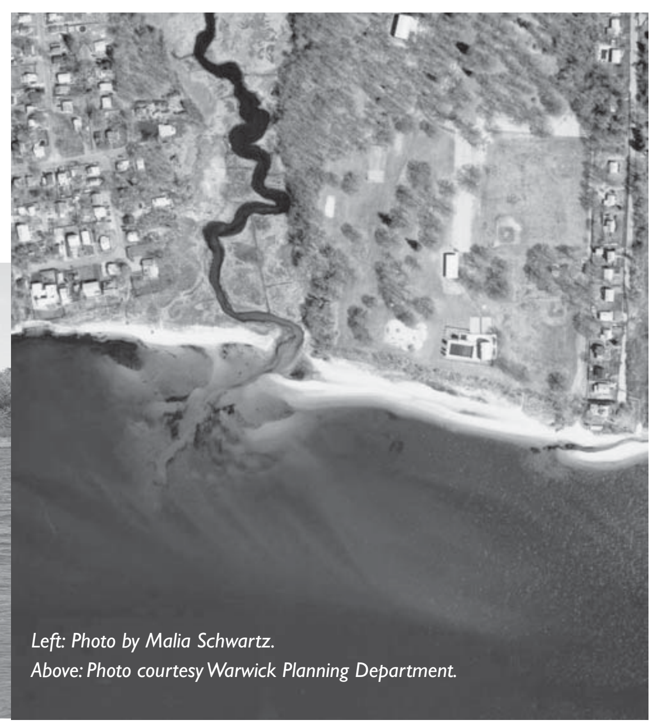
Urban Coastal Greenway
- Identifying habitat preservation, restoration, and linkages between important conservation or recreational lands

Greenwich Bay SAMP
- Using sediment profile imagery and bottom imagery, tracking changes in the biota and areas of low dissolved oxygen following mandatory sewer tie-ins, and in the Narragansett Bay Commission's combined sewer overflow project
- Mapping subaqueous soils for habitat management using side-scan sonar.
- Performing habitat and bathymetric mapping for marina activities and identifying habitat restoration sites

South Shore Coastline and Salt Ponds
- Characterizing detailed habitat and restoration potential
- Beneficially reusing dredge materials

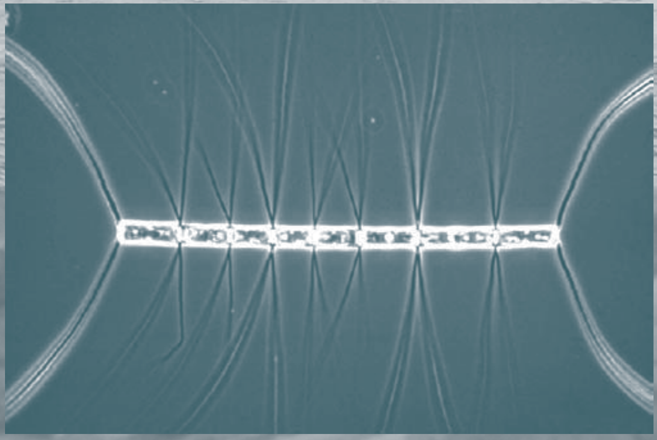
Rhode Island is a leader in cutting-edge technology for mapping coastal and submerged soils and sediments. The hope is that MapCoast will pave the way for a new center of excellence in mapping technology and research in Rhode Island and serve as a model for mapping coastal areas elsewhere.





Left: Photo by Malia Schwartz.
Above: Photo courtesy Warwick Planning Department.

A few degrees' increase in annual surface water temperature is significant in shallow water systems such as Narragansett Bay,



Background photo by Monica Allard Cox; comb jelly photo (inset, right) courtesy NOAA Photo Library; phytoplankton photo (inset, left) by Paul Hargraves, GSO.

A CLIMATE-CHANGED BAY

By Barry A. Costa-Pierce and Alan Desbonnet

There is consensus among scientists who study the Bay that the climate change signal is distinct and strong in Narragansett Bay, with broad implications for altering the ecology and circulation of the ecosystem.

Bay water temperatures have risen about 2°C in winter and 1°C in summer over the past few decades, and it is predicted that Rhode Island air temperatures could increase 5°C in the coming years. If so, it is projected that the Narragansett Bay ecosystem will approximate coastal ecosystems currently found in South Carolina.

Over the last 50 years, the ecosystem of Narragansett Bay has been changed by nutrient loading and overfishing. Nutrients "fertilize" the water, which promotes algal growth and can lead to decreased dissolved oxygen for other aquatic plants and animals. Increases in average annual sea surface temperatures amplify these effects to exert major new forces of change on the ecosystem.

Nutrient loading to the upper Bay is beyond the threshold considered acceptable for eelgrass. Increased algal growth can block sunlight from reaching the eelgrass and diminish water quality. When warming waters due to climate change are added, eelgrass restoration efforts in the upper Bay are less than successful. Nuisance algae, common in upper Bay areas historically, now predominate in the urban reaches, but hard data are not available to track trends over time. The R.I. Department of Environmental Management fisheries trawl surveys provide a convincing story of macroalgal increase in the upper Bay in recent decades: In the mid-1980s, trawls in waters less than 6 meters deep were halted after the trawl nets were rapidly filled and choked with algae upon being set. In 2004, all trawl survey stations in the upper Bay were abandoned for this reason. Warming temperatures due to climate change, combined with high nutrient loadings in the upper Bay, are at least partially responsible for this increase in algae.

Shifts in precipitation are also a major element of climate change, and the indication is that precipitation volume is increasing over time in the Bay region. The Narragansett Bay watershed is witnessing as much as a 30 percent increase in precipitation since 1900. Precipitation is critically important to the behavior and flow of nutrients into Narragansett Bay.

Nutrients arrive in Narragansett Bay in pulses, driven by rainstorms that move large quantities of nitrogen from river and sewage treatment facilities with storm-water overflows to Bay waters. Impervious surfaces in the watershed, such as paved roads or parking lots, continue to increase as urbanization and landscape development proceed; and with increased precipitation, nutrients from runoff of these surfaces will increase.

Climate change may be a key to predicting the effects of nutrients on shallow, well-mixed ecosystems such as Narragansett Bay. A few degrees' increase in annual surface water temperature is significant in shallow water systems such as Narragansett Bay, exacerbating nutrient impacts to plankton, shellfish, and other bottom-dwelling organisms, macroalgae, eelgrass, and fish. How climate change will fully impact the Bay ecosystem is nearly impossible to accurately predict, but certainly change will occur at various, if not all, ecosystem levels, and these changes can be unexpected and sometimes startling.

For instance, the 2°C to 3°C warming currently affecting the Bay has drastically reduced the magnitude of its fundamental food production process—the annual winter-spring phytoplankton (notably diatoms) bloom—the ecological bedrock of the Narragansett Bay ecosystem. Copepods, the minute crustaceans that eat diatoms and are an important food source for other animals, are declining. Researchers are now finding an almost complete lack of copepods during summer months in Narragansett Bay. With this link in the food web removed, impacts on other components of the ecosystem, including species declines, are not yet known.

There is speculation that if nutrient levels decline because of reduced discharges from wastewater treatment facilities, the magnitude of winter-spring blooms may be further suppressed, resulting in an even more reduced supply of nitrogen available during the summer period when there is already evidence of food limitation in the ecosystem of the mid- and lower Bay.

Fulweiler et al. (2007) found shifts in grazing and/or increased cloudiness that have caused a 40 percent decrease in primary production in Narragansett Bay over the past three decades. For the first time anywhere in the world, these authors found that the sediments of a rich, shallow-water estuary during summer months switched from their traditional role as nitrogen sinks to being a source of nitrogen. They calculated that the Bay's sediments now release a huge amount of nitrogen to the Bay's water column, equal to as much as 60 percent of all of the nitrogen being added by sewage to the Bay! This massive output from the sediments has many potential ramifications for the ecology of the Bay and of nearby Rhode Island Sound.

The warming of the Bay has also increased the abundance of a ctenophore (comb jelly) that has extended its range as well as its seasonal cycle of abundance. Because of warming, the comb jellies become abundant earlier in the season. Ctenophores are voracious predators that lower the population densities of Bay zooplankton during summer months, allowing a summer phytoplankton bloom to occur in the upper Bay. Late summer blooms might heighten the problem of low oxygen (hypoxia) by providing more organic matter to bottom waters for decomposition—a process that consumes oxygen—during that period of the summer season when the upper Bay is most susceptible to hypoxia.

An additional concern is that the warming of Narragansett Bay may allow southern species, including invasive species, to expand their range northward and infiltrate the Bay ecosystem, further impacting its rapidly changing ecology. In recent memory, the lowly mussel fishery. And the lionfish, a voracious, invasive predator from more tropical waters, has been noted in waters near Jamestown.

The questions that arise and the problems posed to coastal ecosystem managers due to climate change are numerous, significant, and surprising. There is every indication that the warming trend will continue, and it appears New England will continue to get wetter as well, at least over the near term. Any ecosystem-based management schemes must incorporate and consider climate change, which is impacting our ecosystems even as mitigation measures are being drafted and studies conducted. Management strategies will need to be flexible, able to respond to changing climate and the shifts it brings to the Narragansett Bay ecosystem. To do otherwise will be neither productive nor prudent.

Further Reading

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Fulweiler, R.W., S.W. Nixon, B.A. Buckley, and S.L. Granger. 2007. Reversal of the net dinitrogen gas flux in coastal marine sediments. *Nature* 448:180–182.

—Barry A. Costa-Pierce is Rhode Island Sea Grant Director. Alan Desbonnet is Rhode Island Sea Grant Assistant Director.

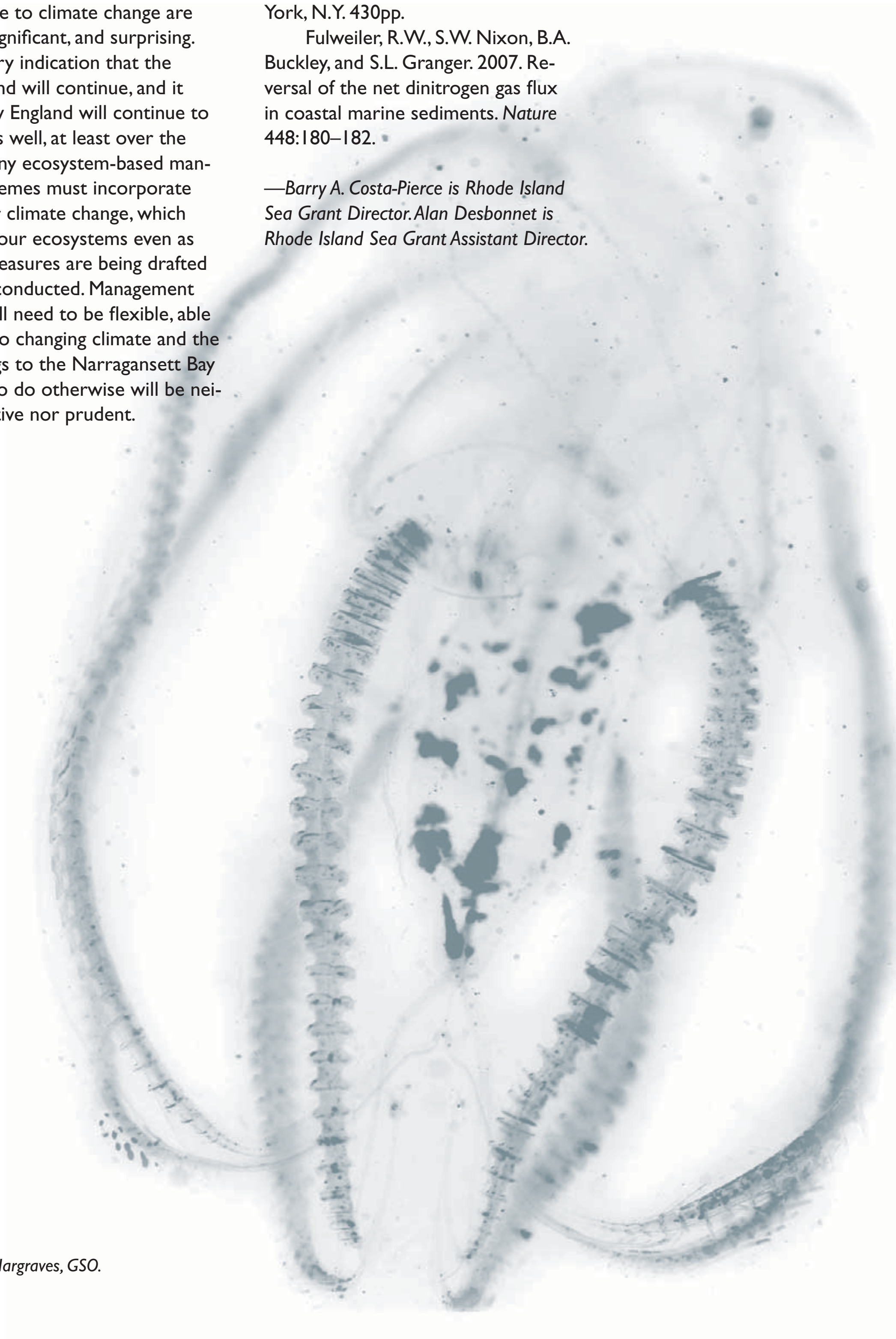


Photo by Paul Hargraves, GSO.

up to the **MINUTE**

What Does the Future Hold for Rhode Island's Hidden Highway?

Stakeholders discuss burdens, benefits of Providence Harbor and Port of Providence

By Monica Allard Cox

As you drive along Interstate 95 in Providence, south of the state house, the hotels, and the mall, cast your eye towards Allens Avenue and Providence Harbor. When you look at the smoke stacks, industrial buildings, salt pile, and fuel tanks, are you seeing an eyesore, an unfair burden on the city of Providence, or an economic engine that is vital to the city, state, and region?

At a spring workshop addressing development of Providence Harbor, participants from a variety of sectors—port industries, city and state officials, nonprofit organizations, and speakers from academia and other area ports—agreed that all of those characterizations might be true. The workshop sought to address conflicts over projected plans for the harbor, primarily between water-dependent businesses that require access to the deep-water channel of Providence Harbor and the city that receives little in the way of property taxes from industrial uses, making residential and other commercial development more attractive to city officials.

Top: Photo by Jennifer Lennon, URI Coastal Resources Center.
Bottom: Photo by Amber Neville.

David Cohen, owner of Promet Marine Services, helps guide the Providence Harbor tour. *Photo by Amber Neville*.

A Plea for the Port

Several speakers implored the city and the state to preserve, even grow, the port.

Joseph Riccio, executive director of the Bridgeport Port Authority, said that ports are vital to importing fuel.

"If we have an energy policy in this country, I don't know about it," he said, adding that the United States imports "massive" amounts of fuel through its ports, and no new facilities are being built. He added that the country is also importing more of its food in refrigerated vessels.

Speaking of the Port of Providence specifically, he said, "You're in the top 50 ports in the United States. It's not insignificant the amount of materials you bring in." Without the port to import oil and gas, "your costs are going to go up. It's going to affect you long-term."

He predicted that more cruise ships might also make their way to Rhode Island. "The cruise ship industry is growing by leaps and bounds," he said. "It's a huge growth industry that needs deep-water ports." For those unconvinced that the urban upper Bay may be a prime candidate for attracting cruise ships, Riccio pointed to Galveston, Texas: "If someone told you 20 years ago that Galveston would be one of the leaders in the cruise industry, you'd think they were crazy."

In his final plea for preservation of the port's traditional uses, Riccio addressed the fundamental pressure on ports to evolve into mixed-use areas: taxes.

"Maritime jobs pay good wages," he said. "Yes, housing and development generate more taxes, but ports generate more payroll, and I think payroll is important to the health of the community."

Cities Looking at Revenues, Redevelopment

Thomas Deller, Providence planning director, put the issue facing the city succinctly: "We survive on tax base." While Providence is technically 96 percent developed, he said, its high number of colleges, universities, hospitals, and other such tax-exempt institutions represent 40 percent of the tax base. In addition, Providence's challenges include dealing with poverty and a huge school population, many of whom don't speak English. However, he said, "We've always been a strong port city."

Jeanne Boyle, East Providence planning director, echoed Deller's concerns about building the city's tax base. While East Providence has active oil terminals along the Providence River, it also has 300 acres of vacant or underutilized waterfront brownfields.

"Redevelopment of these properties costs tens of millions of dollars just to clean them up," she said.

Other challenges include a lack of high-quality architectural design, high traffic volume, and a dearth of public access to the waterfront. In a bid to change all that, East Providence has established a waterfront commission that is development-friendly, expediting permitting, but gives projects a "rigorous but fair" review.

Boyle cited several brownfields redevelopment projects the city has attracted, and pointed out that the mixed uses that developers envision include more than residences and retail space.

Making Mixed-Use Development Work

Exactly what mix mixed-use redevelopment plans entailed was indeed a concern of the port proponents at the workshop. Capt. Don Church, owner of Seaboats, a tug-and-barge company that moved from Providence to Fall River several years ago, said that by imposing residential sites next to oil terminals "you're going to generate untold amounts of money for lawyers" with resident complaints about the noise and lights associated with the industry.

This issue is one that Portland, Maine, grappled with in the 1980s, when condos began to displace industry along the city's working waterfront. The city placed a five-year moratorium on non-marine development on the waterfront. Since then, said William Needelman, Portland planning director, the city has embraced a true mix of uses, including ferries, a container port, a dry bulk port, a fishing fleet, and waterfront trails—but even with amenities like the trails, he said, "we are absolutely a working waterfront."

He said that "new incompatible uses," such as a recent condo complex next to an existing bait shack, "know they're uninvited guests," the implication being that new residents are welcome to stay, but not to complain about the noises, smells, and lights of their commercial neighbors.

Portland has even found some innovative ways to bring varying uses together. Some industrial buildings with tall first floors allow certain marine industries the types of space they require below, while providing office space above for other businesses. Needelman pointed out that zoning must allow for this type of mix, and encouraged "a fine-grain approach" to encourage different types of waterfront uses.

The Case for Marine Industry, Infrastructure

A tour of the harbor aboard the vessel *Providence Piers* gave participants a first-hand look at the area under discussion. David Cohen, owner of Promet Marine Services, spoke about the importance of the port to his business. Promet, which repairs and services vessels from fishing boats to ferries to tankers, relies on the depth of the channel, Cohen said, describing it as "one of the most important avenues to the state of Rhode Island and Narragansett Bay."

Cohen said that 98 percent of Promet's revenues come from customers outside the state from Maine to the Mid-Atlantic and beyond. "We're not recycling Rhode Island money inside Rhode Island," he said.

Moving his business from Providence to, say, Quonset Point, would be

Pictured left to right: Thomas Deller, Providence planning director, Jared Rhodes, chief of the R.I. Statewide Planning Program, and Jeanne Boyle, East Providence planning director, discuss waterfront issues. *Photo by Monica Allard Cox. Bottom photo by Amber Neville.*

nearly impossible. In addition to the 40-foot federal channel, which Quonset doesn't have, Promet's infrastructure is expensive and difficult to move. Also, obtaining permits presents another challenge, as does dealing with a different "environmental complexion," he said. He explained that Providence Harbor has a soft bottom, which Promet has dealt with by using many deep pilings, while other areas are rocky and would require different tactics.

"People just don't understand the infrastructure that operates from this port," Cohen said.

What Goes Where: Policy, Planning Address Needs, Constraints

Grover Fugate, R.I. Coastal Resources Management Council (CRMC) executive director, later pointed out that because Quonset is not a federally recognized channel, the state would have to pay for any dredging needed at the facility. Providence River dredging, on the other hand, was recently completed at an estimated cost of $63 million, including monitoring and other costs, most of which were paid for by the federal government, with less than 20 percent contributed by the state.

CRMC, which has jurisdiction over state waters and areas 200 feet inland from the coast, has, uniquely among all states, designated Rhode Island waters into six types based on their primary uses. These type designations limit what may be done along the shores as well. Fugate said that Providence and East Providence have over $4 billion in redevelopment projects under permit consideration, and for some of the projects to move forward, some waters may have to be "released" from their Type 6 designation, which gives priority to water-dependent and industrial uses such as ports and transportation.

While CRMC's new Urban Coastal Greenway Policy, which pertains to the northern Narragansett Bay area, is designed to streamline permitting for redevelopment, CRMC is required by its federal authority to consider national interests, such as energy needs, Fugate said.

Public Access to Urban Shorelines in Demand

The policy includes provisions for increasing public shoreline access as well—another issue that was discussed at the workshop. Patrick Conley, owner of Providence Piers, where the workshop was held, said that growing up in south Providence in the 1940s and '50s, the only way he could get to the waterfront was to trespass. Fugate said that under the greenway policy, over a mile of public access has been opened up. Deller said that Providence is also looking to expand public access to the shore, in part thanks to 19 acres of land made available by the relocation of I-195.

Rosemary Wakeman, Fordham University associate professor of urban studies, told participants that ports and public space do not have to be at odds, "Ports are sexy. Working waterfronts are sensational. People adore them."

She gave examples of revitalized ports from Brooklyn to Melbourne, and said that nurturing public support for ports, such as through "port days" festivals, was one of the keys to their success.

"You have a wonderful industrial port here," she said, "Embrace your waters."

Next Steps

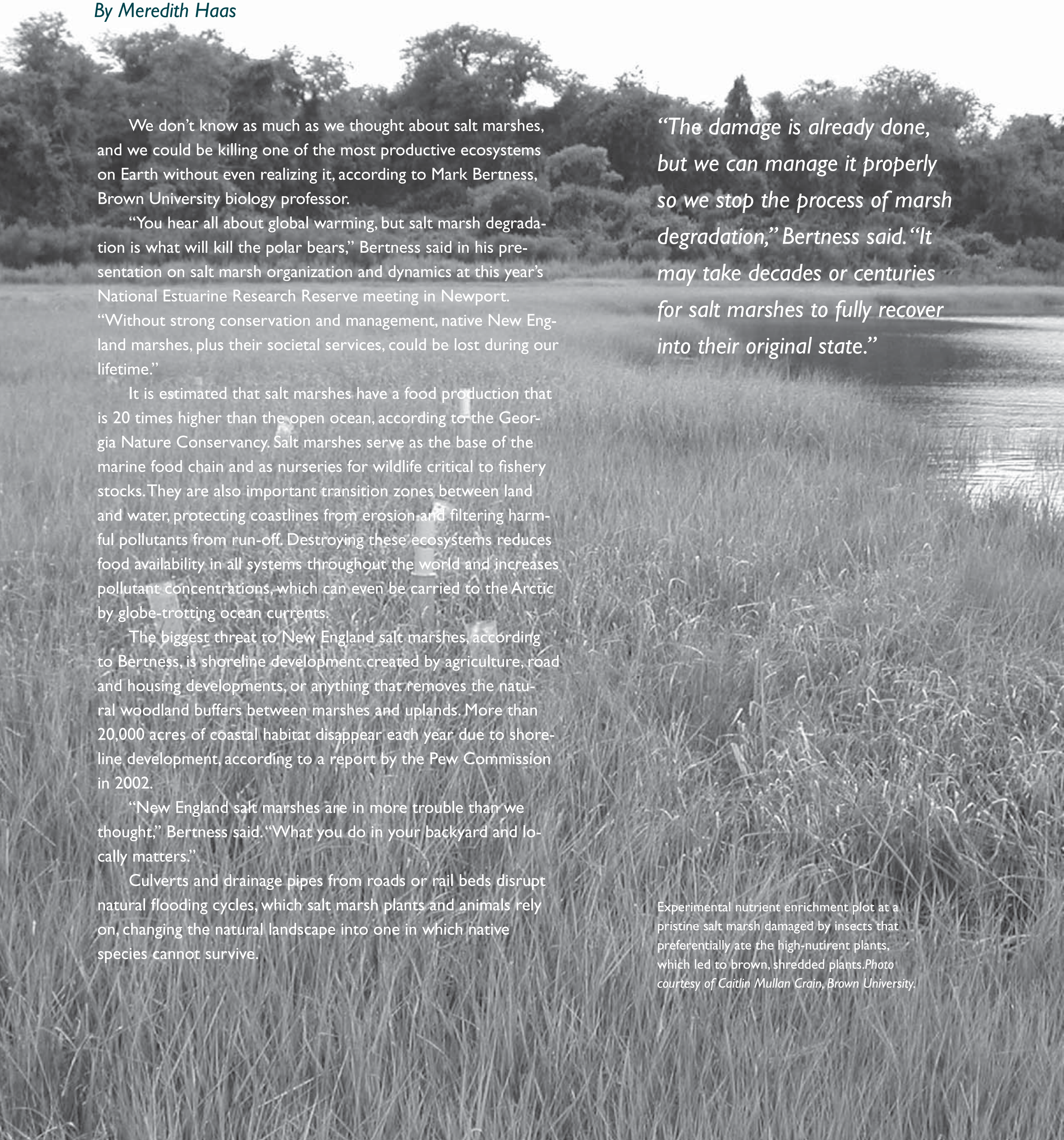
At the end of the workshop, participants identified action items to pursue. Ideas included developing financial agreements between the municipalities and the state to ease the strain on municipalities hosting industrial uses, and looking at the marine economy from a statewide perspective through the R.I. Division of Statewide Planning. Several participants noted that many local officials had not been to the port or been out on the water in the upper Bay, and representatives from maritime businesses in the port discussed developing an industry collaboration to provide outreach to local officials about port activities. The Providence Working Waterfront Alliance, which includes companies represented at the workshop along with other waterfront industries, debuted in September "to educate officials and the public about the critical role of Providence's working waterfront." For information on the organization, visit *providenceworkingwaterfront.org/*.

The "MetroBay SAMP Workshop: Identifying Innovative Solutions to Guide Development Along the Providence River" was sponsored by CRMC, Rhode Island Sea Grant, the URI Coastal Resources Center, NOAA, the Rhode Island Foundation, the R.I. Economic Policy Council, Providence Piers, Promet Marine Services, and Sprague Energy Corp. More information on the workshop can be found on-line at: *seagrant.gso.uri.edu/metrosamp/prov_harbor_wkshp.html.*

—Monica Allard Cox is a Communicator for Rhode Island Sea Grant.

Where Have All the Salt Marshes Gone?

By Meredith Haas



We don't know as much as we thought about salt marshes, and we could be killing one of the most productive ecosystems on Earth without even realizing it, according to Mark Bertness, Brown University biology professor.

"You hear all about global warming, but salt marsh degradation is what will kill the polar bears," Bertness said in his presentation on salt marsh organization and dynamics at this year's National Estuarine Research Reserve meeting in Newport. "Without strong conservation and management, native New England marshes, plus their societal services, could be lost during our lifetime."

It is estimated that salt marshes have a food production that is 20 times higher than the open ocean, according to the Georgia Nature Conservancy. Salt marshes serve as the base of the marine food chain and as nurseries for wildlife critical to fishery stocks. They are also important transition zones between land and water, protecting coastlines from erosion and filtering harmful pollutants from run-off. Destroying these ecosystems reduces food availability in all systems throughout the world and increases pollutant concentrations, which can even be carried to the Arctic by globe-trotting ocean currents.

The biggest threat to New England salt marshes, according to Bertness, is shoreline development created by agriculture, road and housing developments, or anything that removes the natural woodland buffers between marshes and uplands. More than 20,000 acres of coastal habitat disappear each year due to shoreline development, according to a report by the Pew Commission in 2002.

"New England salt marshes are in more trouble than we thought," Bertness said. "What you do in your backyard and locally matters."

Culverts and drainage pipes from roads or rail beds disrupt natural flooding cycles, which salt marsh plants and animals rely on, changing the natural landscape into one in which native species cannot survive.

"The damage is already done, but we can manage it properly so we stop the process of marsh degradation," Bertness said. "It may take decades or centuries for salt marshes to fully recover into their original state."

Experimental nutrient enrichment plot at a pristine salt marsh damaged by insects that preferentially ate the high-nutirent plants, which led to brown, shredded plants. *Photo courtesy of Caitlin Mullan Crain, Brown University.*

The largest impact from shoreline development, however, is the removal of woody vegetation, Bertness said. These areas of woody vegetation, also referred to as buffer zones, prevent erosion and aid marsh systems in filtering harmful terrestrial run-off from roads, fertilized lawns, or agricultural areas. Removing these buffer zones increases the amount of freshwater and pollution from run-off that enter salt marsh systems. The amount of oil equivalent to the *Exxon Valdez* spill enters coastal waters every eight months due to excess runoff, according the Pew Commission.

In response to such physical changes, native vegetation and its natural distribution are disrupted. This may have severe effects on food web relations by altering consumer and vegetation (primary production) dynamics in salt marsh communities, which Bertness said may force ecologists to reevaluate how they look at community ecology.

"Much of what we learned as undergrads may be wrong," he said.

According to Bertness, scientists have historically thought that salt marsh systems are structured by physical conditions, or bottom-up factors such as salinity and nutrient levels. Human disturbances through overharvesting and eutrophication, however, are changing marsh systems into systems controlled by top-down factors such as consumer control by insects, crabs, geese, and other species that feed on marsh vegetation.

"The old paradigm was that consumers played a small role in the regulation of primary production," Bertness said. "Now we are seeing that top-down pressures from consumer control are having a greater effect on marsh organization."

Salt marshes are constructed with a vertical zonation, or spatial segregation of vegetation based on plant competition and physical conditions. The distribution of plants in lower marsh zones is influenced more by the physical stresses of frequent exposure to tidal fluctuations, whereas plants in the higher marsh zones are influenced more by competition for nutrients. Eutrophication, however, has relieved the below-ground competition for nutrients, evolving the system to above-ground competition for light. The invasive common reed, *Phragmites australis*, now dominates New England marshes because it is better adapted to low salinity and high nutrient conditions. Shoreline development accelerates the invasion of *Phragmites*, which in turn drives most of the native plant community to local extinction.

For the past two decades, Bertness has been researching the dynamics and organization of New England salt marsh plant communities in order to implement better management and conservation. His current research, which is funded by Rhode Island Sea Grant, examines 30 different sites throughout the Bay. Experimental fertilized plots were compared to unfertilized control plots to determine if increased nutrients triggered consumer control in marsh systems. Bertness and his colleagues found that *Phragmites* flourished more readily in fertilized plots than in plots without fertilization. Increases in plant biomass resulting from fertilization increased the rate of herbivory. Rhode Island salt marshes, in particular, are under increasing consumer pressure from insects, such as grasshoppers, leafhoppers, and beetles, as well as from marsh crabs. These animals reproduce and consume in response to increases in marsh vegetation. Marsh vegetation, however, cannot be replenished as quickly as it is consumed, resulting in patches of marsh left bare like mudflats.

Bertness is also currently investigating the effects of a relatively unknown nocturnal marsh crab, *Sesarma reticulatum,* found in southern New England marsh systems.

"They're not even in the common field guide," he said.

This species, according to Bertness, may be largely responsible for leaving barren mudflats in Cape Cod's salt marsh communities, which was one of the first areas in New England to report marsh dieback in 2002, according to the U.S. National Park Service.

"It's a potential disaster in the beginning stages at our doorstep," Bertness said.

In other research along the East Coast and in northern regions around the Hudson Bay, as well as in Chile and Argentina, Bertness has found that these marsh systems have also experienced increases in herbivory due to nutrient increases and higher consumer densities, resulting in various degrees of marsh dieback.

Nearly 50 percent of Rhode Island salt marshes have been lost to human development since the colonial period and, of those remaining, over 90 percent have been heavily affected by human activity, according to Bertness. He feels that a better understanding of the organization and dynamics of natural communities will lead to better conservation of salt marshes.

"The damage is already done, but we can manage it properly so we stop the process of marsh degradation," Bertness said. "It may take decades or centuries for salt marshes to fully recover into their original state."

—Meredith Haas is a 2007 URI Marine Biology and Journalism graduate and served as a Rhode Island Sea Grant Communications Intern.

This salt marsh receives high nutrient inputs from a neighboring country club that helps *Phragmites* to invade. *Photo courtesy of Caitlin Mullan Crain, Brown University.*

Photo courtesy Narragansett Bay National Estuarine Research Reserve.

Conserving Our Submerged Lands

By Ronan Roche and Jay Udelhoven

How might underwater mapping techniques, which identify important habitats, lead to true conservation action? Underwater land, often referred to as "submerged land," has special legal characteristics that distinguish it from terrestrial land. It is common to hear that "you can't own the bottom" when referring to lands submerged by marine waters. However, lands lying beneath coastal waters have been leased for commercial purposes for centuries and have also been bought and sold in some instances. Worldwide, nations generally hold their submerged lands and coastal waters to be the property of the state. As a result, the majority of marine conservation programs are government-driven and managed. This contrasts with the terrestrial situation, where there is a longer history of private conservation initiatives and considerable private land ownership. However, there are examples worldwide of private conservation initiatives operating in the marine environment. In the United Kingdom, where the Crown Estate associated with the monarchy owns most submerged lands, a private organization, the National Trust, leases or owns over 700 miles of intertidal and coastal lands. This means that in the United Kingdom, excluding Scotland, 10 percent of coastline is protected by a private organization.

In Rhode Island, almost all submerged land is publicly owned. Land beneath the high-tide line is subject to the Public Trust Doctrine, a set of rules whose lineage can be traced through Roman to English law. As one of the original colonies, Rhode Island received title to its lands initially as a charter from King Charles II. In 1663, Roger Williams secured from the king a charter for "Rhode Island and Providence Plantations," which held a land grant and included title to tidal lands. This was based upon English common law, in which the title and the dominion in lands flowed by the tide were held by the king for the benefit of the nation.

The Public Trust Doctrine protects the rights of the public to use submerged lands in certain ways, even if those lands are sold to a private entity. These protected uses generally include fishing, fowling, and navigation. In the Rhode Island Constitution, protected activities include fishing from the shore, leaving the shore to swim in the sea, passage along the shore, and the now somewhat anachronistic activity of gathering seaweed from the shore. However, the constitution also provides that it shall be the duty of the General Assembly to provide for the preservation, regeneration, and restoration of the natural environment of the state. Thus there is a need for balance in the uses of the submerged lands of the state to fulfill all of these requirements. In Rhode Island, it is the General Assembly that is the ultimate arbitrator between competing uses of submerged lands.

Recent work undertaken at the University of Rhode Island (URI) Coastal Institute has been looking into how nongovernmental organizations could conserve submerged land. For example, in some states, The Nature Conservancy—an environmental organization perhaps best known for its use of acquisition and easements for land protection—has already applied its strategies to the underwater environment. It has acquired over 25,000 acres of submerged marine lands for conservation and restoration in North Carolina, Virginia, New York, Texas, and Washington State. One of the first steps in the process, just as on land, is to identify critical habitats and sites in need of protection and restoration. It is here that underwater mapping technologies, such as those being used by the BayMap and MapCoast projects, could help conservation leasing and ownership efforts to determine what areas should be prioritized or which areas contain habitats required for marine species, such as shellfish, to survive.

Submerged land in Rhode Island is currently leased by the Coastal Resources Management Council mainly for shellfish aquaculture purposes. There is a long tradition of aquaculture leasing in Rhode Island. In 1844, a shellfish commission was established that had authority to lease submerged lands for oyster growing—by 1880 there were already over 1,000 acres of leased bottom in Narragansett Bay. Production reached a pronounced peak in 1910, when 20,000 acres of submerged lands were leased, and oysters made up more than half of the value of all the fisheries in Rhode Island.

More recently, there has been substantial research carried out highlighting the beneficial filtering effects that oysters have on estuarine ecosystems. Chesapeake Bay is one area in which the enormous oyster populations once present are suggested to have had a crucial role in maintaining the clarity and quality of Chesapeake Bay water. There are now major efforts under way to restore these oyster reefs and help improve the ecological quality of Chesapeake Bay. More locally, the R.I. Department of Environmental Management and NOAA have used the settlement from the *North Cape* oil spill of 1996 to initiate the R.I. Shellfish Restoration Program, which aims to restore scallop, oyster, and quahog populations in Narragansett Bay.

However, it is widely acknowledged that much work remains to be done in both conserving submerged resources and restoring shellfish populations, and as we look to the future, private conservation of submerged lands, carried out in partnership with state agencies and informed by underwater mapping efforts, could have an important role to play. Whilst mapping of ecological and oceanographic features is essential to expand current knowledge, an understanding of the ownership and human-use aspects of submerged lands is also needed to determine where appropriate actions such as development or conservation can be carried out.

—Ronan Roche is a URI Coastal Institute IGERT (Integrative Graduate Education and Research Traineeship) Project Trainee and a URI Marine Affairs Graduate Student. Jay Udelhoven is Senior Policy Advisor for The Nature Conservancy's Global Marine Initiative.

WATER FROM STONE: The Groundwater Journey From Bedrock to Coastal Ponds and Beyond

By Monica Allard Cox

If a drop of pond water could be said to have a life history, S. Bradley Moran knows what it is.

For several years, Rhode Island Sea Grant funding has aided Moran, University of Rhode Island oceanography professor, in his studies of where the water in southern Rhode Island's coastal ponds—locally called salt ponds—comes from, how long it circulates around these ponds, and where it goes. Because coastal pond water is a mixture of salt and fresh water and carries nutrients and contaminants with it, this research has also been of interest to, and funded by, the R.I. Coastal Resources Management Council. His research has shown that groundwater—as opposed to surface water, such as from rivers and streams—contributes significantly to these coastal ponds, and that the supply of groundwater changes with the seasons. These new findings have important implications regarding watershed land use and how contamination sources might affect coastal water quality.

"There is no question that the problem of understanding and managing the ecological and economic impact of groundwater and associated chemicals and microbial contaminants on our coastal waters is still a big one," Moran says. However, he adds, it is too soon to tell what the longer-term impacts associated with increased building and urbanization on the watershed will be on groundwater—and thus the coastal ponds and Narragansett Bay.

Moran's scientific approach involves the use of naturally occurring radium isotopes (^{223}Ra, ^{224}Ra, ^{226}Ra, and ^{228}Ra) as tracers. As sediment and bedrock weather, they release radium isotopes to groundwater, which retains a radium "fingerprint" that results from the constant radioactive production of the isotopes. Depending on the type of bedrock—for example, in the Pettaquamscutt watershed, the bedrock is composed of Rhode Island Formation metasediments, Narragansett Pier granite, Esmond granite gneiss, and Esmond augen granite gneiss—the characteristics of the radium isotopes differ in known ways. Therefore, measuring these isotopes can tell scientists where groundwater is coming from as well as the amount of groundwater flowing into coastal waters.

In addition, because ^{223}Ra and ^{224}Ra have short half-lives, on the order of several days, they can be used to determine the average length of time that water remains in a coastal pond before circulating out to Narragansett Bay and further offshore. For example, Moran and his graduate students estimate that surface water in the Pettaquamscutt river-estuary spends an average of about eight days before being flushed out. The waters of Ninigret, Winnapaug, and Point Judith ponds remain between four and 10 days, while water in Green Hill and Quonochontaug ponds remains between five and six days. Knowing these time scales is important because the quality and health of a coastal water body is controlled in part by the water's residence time.

His group has sampled water at various locations in the water column and in groundwater to determine how radium isotopes are distributed throughout the ponds. Factored into the analysis are measurements of precipitation and evapotranspiration, and the results have been compared to results from modeling techniques, in collaboration with John Masterson,

Point Judith Pond. *Photo by Meredith Haas.*

Robert Breault, and other colleagues from the U.S. Geological Survey. For all their cutting-edge technology and promising results, however, Moran feels that "these radium isotope tracers are not yet a tool in the toolbox" for coastal management.

"The application of these radium isotopes to coastal studies has really taken off in the last 10 years, and these tracers have certainly provided new and interesting results," he adds. "However, when using these tracers, a key question is: What are we really measuring? We still don't fully understand what these tracers are telling us; there is certainly more work that needs to be done."

One of the difficulties with conducting this research is that scientists are often limited by the number of samples they can collect. For example, due to weather conditions, a lack of equipment, or other such logistical constraints, some previous investigations have sampled groundwater only from shore, or taken water column samples from a limited number of locations. Because of the complexity of groundwater water movement and the potential for multiple sites of origin, the accuracy and hence usefulness of data from such studies could be compromised. One study Moran supervised showed a wide variability not observed in other studies. Moran's recent studies have involved a detailed collection of samples from both groundwater and the water column; however, he says that he would prefer to collect more data.

"We have succeeded in establishing new limits for the amount of groundwater and associated nutrients that flow into these ponds, as well as the average time water remains in the ponds," he says. Observing the variability in our results has been "interesting and useful—you appreciate the complexity of these important ecosystems—however, for coastal managers, they want answers."

Moran notes that using radium isotopes as tracers in coastal ponds has uncovered some important information about how the ponds work. Future studies of coastal groundwater will focus both on basic and applied research questions. In turn, results from such studies will have direct implications for the environmental management of coastal waters.

Moran is proposing to build on this research with David Smith, URI oceanography associate professor, using new techniques to track microbial source contamination in groundwater and surface waters of Rhode Island's coastal ponds, which has direct, practical implications. Such studies of the salt ponds, he says, provide information pertinent to other water bodies.

"The same concerns regarding the ecology and health of coastal groundwater and embayments in Rhode Island exist for many places around the world. It turns out that the salt ponds of southern Rhode Island are useful natural laboratories for studying these problems, and the results from this research have broad implications that are applicable to other regions."

For further reading:

Cute, K. 2004. CRMC Funds Groundwater Research in the Salt Ponds Region Watershed. *Coastal Features* 12(1):1–6.

Kelly, R.P. and S.B. Moran. 2002. Seasonal changes in groundwater input to a well-mixed estuary estimated using radium isotopes and implications for coastal nutrient budgets. *Limnol. Oceanogr.* 47(6):1796–1807.

—Monica Allard Cox is a Communicator for Rhode Island Sea Grant.

Background image of a cunner fish captured with sediment profile imagery (SPI) on Narragansett Bay bottom (see page 6). *Photo courtesy BayMap field team.*

IN BRIEF

Ecosystem-based management: From theory to practice

WalMart has agreed to sell seafood products from sustainably managed species. Boaters willingly pay more for slips at clean marinas. There is public support for saving Chesapeake Bay, buying dolphin-safe tuna, and protecting coral reefs. But good ecosystem-based management faces a myriad of challenges and has suffered a host of failures.

The successes, failures, and challenges of ecosystem-based management were the subject of the joint 6th Annual Marine Law Symposium and 5th Annual Ronald C. Baird Sea Grant Science Symposium that took place last October.

Ronald Baird speaks at the 5th Baird Sea Grant Science Symposium. *Photo courtesy Roger Williams University.*

Keynote speaker Dorinda Dallmeyer, director of the Environmental Ethics Certificate Program at the University of Georgia, called humans a "profoundly terrestrial species" who have only recently begun to see oceans as more than a "cornucopia" of fish and other resources and a "conveniently flushing toilet." She said that even with the growing acceptance of the view that humans are a part of natural systems, the ability to protect or restore ecosystems, particularly marine ones, may be limited. She pointed out that terrestrial species are much more protected than marine species, for example, with many more terrestrial species on the endangered species list. She also spoke of the need to shift from protecting individual species to protecting habitats.

In addition, people's perception of the environment depends largely on its condition during their lifetime. "We forget, if we ever knew, what our marine environments were like historically." Dallmeyer said. "The Stellar sea cow could have been mythological if we didn't have a skeleton. What do we mean when we talk about 'restoration'? It makes a lot of difference where you start as to where you end up."

Nevertheless, Dallmeyer sees a growing public awareness of ocean issues, an awareness enhanced by a physical connection to the ocean: "We're sort of getting people to wade into the water a little bit. We have a lot of benefits of technology, but there's no substitute between watching something on a television screen versus being out there in it, and it doesn't have to be some great once-in-a-lifetime experience."

Other speakers touched on a variety of examples where management has begun to consider an ecosystem perspective—sometimes successfully, sometimes not.

Cathy Roheim, URI environmental and natural resource economics professor, spoke about the momentum behind eco-labeled seafood. Sales of seafood labeled sustainable by the Marine Stewardship Council, which she advises, increased 16.5 percent from 2004–05 to 2005–06, and WalMart has committed to selling Marine Stewardship Council–labeled fish.

While many market-based attempts to promote sustainble fisheries—including boycotts of overfished species and wallet cards of seafood to buy or avoid—have been controversial, Roheim says that the council effort, while "not perfect," is transparent, includes stakeholder involvement and objections procedures, and follows consistent standards.

Michael Keyworth, vice president and general manager of Brewer Cove Haven Marina in Barrington, R.I., was introduced by Dennis Nixon, URI College of the Environment and Life Sciences associate dean, as "representing the face of the new marina"—much cleaner than its predecessor.

Keyworth said that an environmentally friendly approach to marina management can be financially rewarding. "Our prices are higher, and we're completely full," he said. "Clean water is something we need to protect, because without it, we won't have a business," he added.

Brewer Marina charges an environmental fee, Keyworth said, adding, "the interesting thing is there's really no negative reaction to it." He also feels that green marinas are spawning green clients: "They recycle at home because we do it at the marina." He said that a shrink wrap recycling program, initiated in 2005 by the Rhode Island Marine Trades Association, had collected and recycled 94,000 pounds of shrink wrap.

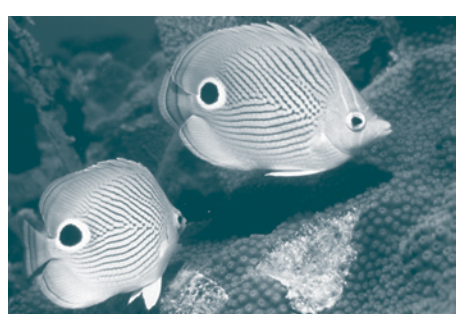


Photo courtesy NOAA Photo Library.

Not every undertaking discussed at the symposium has been a success. The management of Chesapeake Bay has been "a splendid failure, but we're doing it with style," said William Dennison, professor of marine science and vice president for science applications at the University of Maryland Center for Environmental Science.

"It's intensively managed, everybody around the bay knows about it, we get a lot of money—we're close to D.C., that helps—but Chesapeake Bay continues to degrade," he said.

He said that over 8 million data points are collected each year, but determining what the data mean remains elusive. "It's like a fire-hose of data, but we can't get a drink," he said. Effective actions are also needed, he added, noting that the seagrass and oysters that had been reintroduced in restoration attempts have died.

He said that while Chesapeake Bay efforts have produced solid science, good partnerships, public awareness, and political support, the health of the bay continues to suffer from the pressures of a high population in its watershed as well as from nutrient pollution originating outside Maryland's border—namely from Pennsylvania farms. He said that to address the latter problem, efforts must be made to make the issue relevant to Pennsylvania farmers, telling them "not that they are affecting crabs in Maryland, but that they are affecting their own streams and their kids' ability to fish in them."

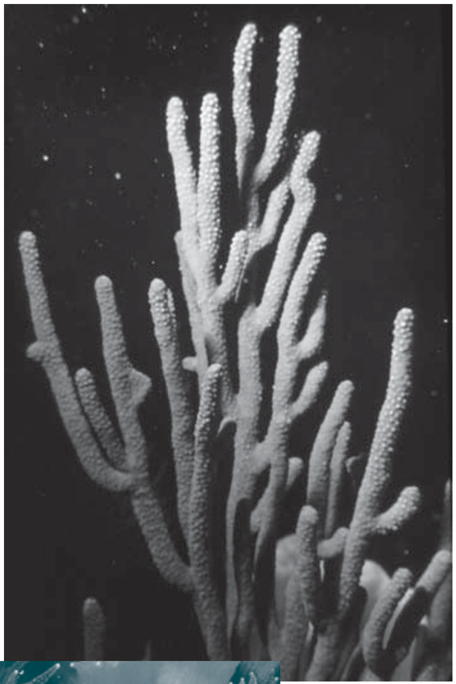
Ronald Baird, former National Sea Grant director in whose honor the symposium was named, gave a keynote address about using the best available science to support ecosystem-based management. He said that scientific literacy among the public is needed to support such approaches. He also stressed the need for outreach and extension specialists to translate and disseminate scientific information to policymakers.

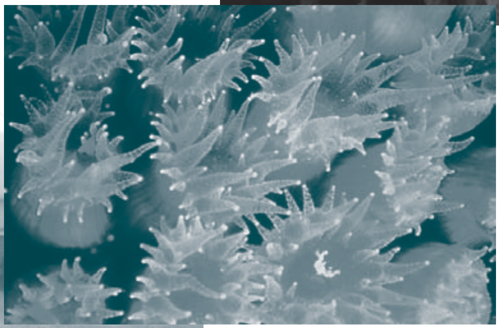
"Ecosystem-based management has our attention at high levels of government and academe," he said, noting that one of the key issues, particularly in the face of rapid population growth, is whether institutions can respond to challenges quickly enough. "They've never had to evolve at this pace before."

Integrating the best available science into management is essential, he said. "We're facing the century of the environment."

More information about the 5th Annual Ronald C. Baird Sea Grant Science Symposium is on-line at *seagrant.gso.uri.edu/research/science_symposium.html.*

—Monica Allard Cox





Photos clockwise from top: Chesapeake Bay satellite image, knobby purple sea rod, star coral, and Chesapeake Bay sunrise. *Photos courtesy NOAA Photo Library.*

New England Lobster Research Initiative awards $2.3 million in research and monitoring grants

The New England Lobster Research Initiative has pulled together some of the most prominent lobster researchers in the country to address lobster shell disease.

Shell disease disfigures shells, prompts egg-bearing lobsters to molt prematurely, and can make it difficult for lobsters to shed their shells. The initiative, funded with a Congressional appropriation obtained through the efforts of Sen. Jack Reed (D-RI) and Sen. Olympia Snowe (R-ME), has allocated $2.3 million for nine research and two monitoring projects that will examine lobsters and their habitats to determine how the disease affects lobsters and what makes them susceptible to it. The initiative's executive committee chair said the projects will enhance scientists' fundamental understanding of lobster biology and disease and provide insights for fishery managers to improve the health of New England's most valuable catch.

"These researchers are using cutting-edge technologies to identify the pathogen that causes shell disease; to determine how external stressors, such as increasing water temperature or environmental contaminants, affect lobsters; to see how the disease damages the lobster's shell; and to develop a rapid screening technique to see if a lobster has the disease," said Kathleen Castro, Rhode Island Sea Grant Sustainable Fisheries Extension coleader and chair of the initiative's executive committee.

"We've got to protect our lobster fisheries," said Sen. Reed. "This is a major environmental concern, but it is also an important economic concern. The lobster industry is important to Rhode Island and New England and is a crucial link to our regional history and culture. I hope these research teams can identify and mitigate the problem."

"Industry, researchers, and fishery managers will hopefully understand more about the origin of shell disease and then be able to inform others to help minimize any impacts on the lobster fishery, therefore optimizing the industry's health far into the future," said Elizabeth Kordowski, then executive director of the Rhode Island Lobstermen's Association.

For more information on the funded proposals, see below, or visit the New England Lobster Research Initiative website: *seagrant.gso.uri.edu/fisheries/lobster_initiative*. New England Lobster Research Initiative Funded Proposals:

Two state surveys—one in Rhode Island and one in Maine—were funded to monitor lobsters to see if small lobsters are also affected by the disease. Working with fishermen and using ventless traps, which, unlike traditional traps, will prevent sub-legal lobsters from escaping, state fishery managers will be able to provide real-time data to researchers in a project requested by lobster fishermen.

Three groups will use different techniques and approaches to look at the microbiology on lobster shells to identify the pathogen causing shell disease, and whether or not affected lobsters have suppressed immune systems.

One project will seek to determine whether different lobster populations have different susceptibility to the disease, and whether or not there is a relationship between that susceptibility and genetic and/or behavioral differences between the populations.

Four projects will examine how environmental stressors—such as increasing water temperature or environmental contaminants—affect lobsters, whether through interfering with shell formation or hardening or impacting lobster genetic expression.

One project will use new techniques to compare shells of healthy and sick lobsters to see what is changing in the shells of lobsters with the disease.

—Monica Allard Cox

Photos by Puffin Enterprises.

Rhode Island Sea Grant comings and goings

Alan Desbonnet has been named Rhode Island Sea Grant assistant director. Desbonnet has a long history with Rhode Island Sea Grant, working in the Sustainable Coastal Communities and Ecosystems (SUCCESS) Extension Program from 1989 to 2002, where he was instrumental in designing an interstate management plan with Connecticut and Rhode Island, and with Massachusetts and Rhode Island. He was also active in launching the nine-town Washington County Regional Planning Council, a group that collaborates on resource and economic planning and management issues. Previously, Desbonnet worked at the Mystic Marinelife Aquarium as an aquarist, researcher, and educator. Desbonnet also designed and implemented the college intern program for the aquarium during his tenure there. Since 1992, he has taught ecology as an adjunct at Eastern Connecticut State University.

Desbonnet became managing editor for the Husbandry & Management Section of the international journal *Aquaculture* in 2002, and joined program management as program manager, where he oversaw Rhode Island Sea Grant's education portfolio. Desbonnet has also served as secretary of the Stonington Shellfish Commission since 1991.

"The Rhode Island Sea Grant program is a truly great program, and I feel honored to be selected to work with both staff and funded researchers at this new level. I look forward to a future with Rhode Island Sea Grant that builds upon existing excellence, but also soars to new heights," Desbonnet says.

"Alan's extensive and diverse background in research, outreach, education, and administration has well qualified him to be assistant director," says Barry Costa-Pierce, Rhode Island Sea Grant director. "He truly understands the goals and concerns of both our extension programs and our funded researchers and is working to make their jobs easier so they can focus on results for our constituents."

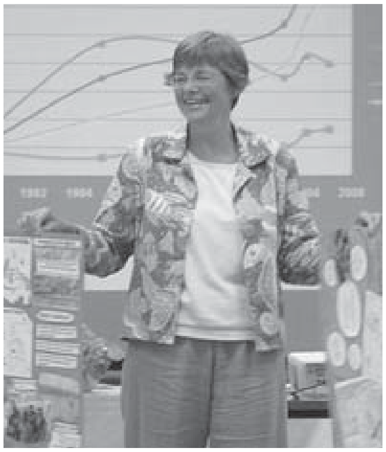
Austin Becker has joined the SUCCESS Extension Program as a coastal management extension specialist who is focusing on urban coastal issues. Becker, who recently received a master's degree in marine affairs at URI, has a long history on the water, once owning and operating a yacht charter business, managing a marina, and serving on the municipal harbor management committee in Provincetown, Mass. He was also captain for five years of Rhode Island's state flagship, the *Continental Sloop Providence*.

"In my last job as a ship captain and teacher of marine education programs, I had a unique chance to provide environmental and leadership training to students—from kids to adults—in New England's coastal communities. I enjoyed giving people the opportunity to learn from a new perspective—that of looking at the land from the water rather than vice versa," Becker says.

"Austin's perspective as someone who has worked on the water and understands the issues will add tremendous value to meeting the needs of the people that we serve," says **Jennifer McCann,** who has recently become leader of the SUCCESS Extension Program.

McCann began her career in Washington, D.C., at the Center for Marine Conservation, now The Ocean Conservancy, building a constituency for the creation and management of the Stellwagen Bank National Marine Sanctuary, among other projects. She joined the URI Coastal Resources Center (CRC) in 1995 and worked on projects to build local capacity for coastal management first in Mexico and later on Aquidneck Island.

"Jennifer's experience here in Rhode Island and internationally is a tremendous asset to Rhode Island Sea Grant as we work to create programs that serve our local constituents while having broader impacts. Her ability to bring diverse constituents together has proved successful in Mexico, on Aquidneck Island, and in the urban communities of northern Narragansett Bay as we see the progress of the Metro Bay Special Area Management Plan," Costa-Pierce says.



Virginia Lee recently moved from leading Rhode Island Sea Grant's SUCCESS Extension Program to assuming the leadership of CRC's training efforts worldwide in nurturing the next generation of coastal managers. Lee joined Rhode Island Sea Grant in 1980, and led the development of coastal management policies and plans, hazard risk assessment and mitigation efforts, and one of the first programs for volunteer monitoring of coastal waters in Rhode Island—an innovative program that captured the interest of the U.S. Environmental Protection Agency (EPA) and led to the promotion of volunteer monitoring nationwide.

In her new role, Lee is focusing on designing and developing a training institute program this year in Thailand, where CRC has been working since the 2004 tsunami, and is also developing a certification program for Marine Protected Area professionals.

"Virginia has done an extraordinary job of building the Rhode Island Sea Grant coastal outreach program into what is recognized as one of the best in the nation. Her combination of passion and wisdom in ensuring that our coastal resources will be available for future generations has made her a well-respected and inspiring leader in our program and throughout the national coastal management community," Costa-Pierce says.

Heather Rhodes is Rhode Island Sea Grant's new fiscal officer. Prior to joining Rhode Island Sea Grant in 2004, Rhodes served as financial assistant for The Family Life Project in the College of Health and Human Development at Pennsylvania State University. Rhodes oversaw all financial aspects of this federally funded five-year collaboration with the University of North Carolina-Chapel Hill, and brings that experience to Rhode Island Sea Grant, where she is responsible for all aspects of fiscal management, human resources, overseeing the program's Knauss, Industry, and Coastal fellowship programs, and managing student help. Most recently, Rhodes has become more actively involved with Rhode Island Sea Grant's Diversity Initiative, coordinating educational learning programs for the Nuweetooun School. "As much as I enjoy the fiscal management, I am grateful for the opportunity and encouragement to explore other aspects of Rhode Island Sea Grant in working with the Knauss Fellows and the students from the Nuweetooun School," Rhodes says.

"Heather not only keeps us in the black, but balances managing our many fiscal accounts and human resources, along with our educational programs, with a great deal of finesse. She truly cares about the students our programs serve, and helps to make their experience with Rhode Island Sea Grant a positive one," Costa-Pierce says.

Tracy Kennedy is the new program administrator. Prior to joining Sea Grant, Kennedy worked for 12 years in the Department of Family Medicine at Brown University/Memorial Hospital of Rhode Island before leaving in 1997 to be home with her children. "I really enjoy working at Rhode Island Sea Grant. Everyone has made me feel very welcomed," Kennedy says.

"Tracy is the new face and voice of the Rhode Island Sea Grant program administration office, and we are very pleased to have her join our growing family," Costa-Pierce says.

—Monica Allard Cox

George Klein, OMP educator, shows Nuweetooun School students sea stars found in Narragansett Bay. *Photos by Heather Rhodes.*

Nuweetooun School students learn about Narragansett Bay as part of Sea Grant Diversity Initiative

This spring, Rhode Island Sea Grant hosted students from The Nuweetooun School at the Tomaquag Indian Memorial Museum in Exeter, as part of its Diversity Initiative. Padma Venkatraman, URI coordinator for graduate diversity, arranged for the students to attend the NOAA broadcast that the URI Graduate School of Oceanography's Office of Marine Programs (OMP) makes available to Rhode Island schools and the public. The students were able to participate in a live broadcast hosted by Robert Ballard, URI oceanographer, featuring the undersea exploration of the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. The students also enjoyed an interpretive program, "Rhode Island Seashores," by George Klein, OMP marine educator.

Klein brought buckets with a variety of Bay creatures, including lobsters, stone crabs, and sea stars. He described plankton and its vital role in the ecosystem.

"The stuff you can't even see plays one of the biggest roles that sustains the marine environment and consequently us," Klein said. He discussed one of the more common and visible types of fisheries in the state—lobstering—and demonstrated how a lobster trap works and some of the tools of the trade. Next, Klein delved into the natural history and biology of the animals themselves, focusing on conservation with the live animals.

Students also examined many different types of shellfish from local waters, from mussels to steamers, which interested many of the students who liked to eat shellfish.

Klein also showed the students a variety of crabs, beginning with the invasive species, the Japanese shore crab. This is a natural bridge that allows students to see an invasive species first hand, and gets them to start wondering how a crab traveled half way around the world to end up in Narragansett Bay.

"The asian crab was really, really, really awesome because it walked sideways. I also like the colors on it," said Laurel Spears, a student at Nuweetooun School.

Klein also showed the students a rock crab, which is a native species and important in the commercial fishing industry.

Periwinkles are the most common snail locally, and Klein showed the students how to have them emerge from their shells by holding them gently. This brought a lot of giggles from the students.

The grand finale was none other than the lobster, which the students particularly enjoyed seeing.

"What I always like to stress is how important it is to conserve these animals, and consequently, the environment in which they live. Concepts of stewardship, respect, reverence. Stuff like that. I think it provides for a more enriching experience, more than just a funky show and tell, if the kids can come away with a deeper understanding and appreciation of the natural world around them," Klein said.

In May, Venkatraman hosted some of the older students for a workshop on the chemistry of the oceans, with an interactive question and answer session and experiments in separating chemicals. And in June, Rhode Island Sea Grant sponsored another visit from the Nuweetooun School in which students visied the rocky shore of Jamestown at Fort Getty with Klein.

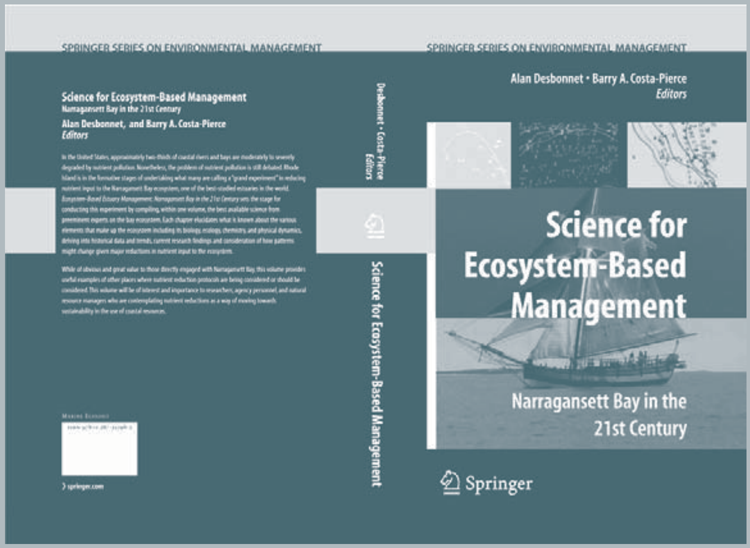
"We are interested in examining new relationships with the Narragansett Indian Tribal Nation in research, outreach, extension, and education," said Barry Costa-Pierce, Rhode Island Sea Grant director, who added that Rhode Island Sea Grant is committed to promoting diversity.

For more information on the education programs offered by the OMP, visit their website at *omp.gso.uri.edu.*

—Heather Rhodes

IN BRIEF...

Prepublication discount available for Narragansett Bay book



Science for Ecosystem-Based Management: Narragansett Bay in the 21st Century addresses the broad problem of coastal nutrient pollution. In the United States, approximately two-thirds of the coastal rivers and bays are moderately to severely degraded from nutrient pollution. However, debates continue about how large a problem nutrient pollution is and what actions to take, and since effective management requires decisions at a local scale, an in-depth case study can provide valuable guidance.

Narragansett Bay is one of the best-studied estuaries in the world. Rhode Island has been developing regulatory and management actions to reduce nutrient inputs, particularly those of nitrogen, to the waters of Narragansett Bay. This book was developed in response to a symposium addressing this mandate with coastal/estuarine scientists and environmental management agency personnel. The contributors use long-term data sets to discuss the interactions among biological, ecological, chemical, and physical processes, and discuss what is known about nutrient inputs to the Bay ecosystem, the impacts related to nutrient inputs, and how the ecosystem might respond to a sudden reduction in these inputs.

In the United States, approximately two-thirds of the coastal rivers and bays are moderately to severely degraded from nutrient pollution.

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The book will retail for ca. $89.95. Order for the prepublication price of $71.96, available until December 31 (use code BIM060731). To order, visit the Springer website at *www.springer.com* and search for "Narragansett Bay," or download the order form at: *seagrant.gso.uri.edu/news/2007/narr_bay_book_order.pdf*.