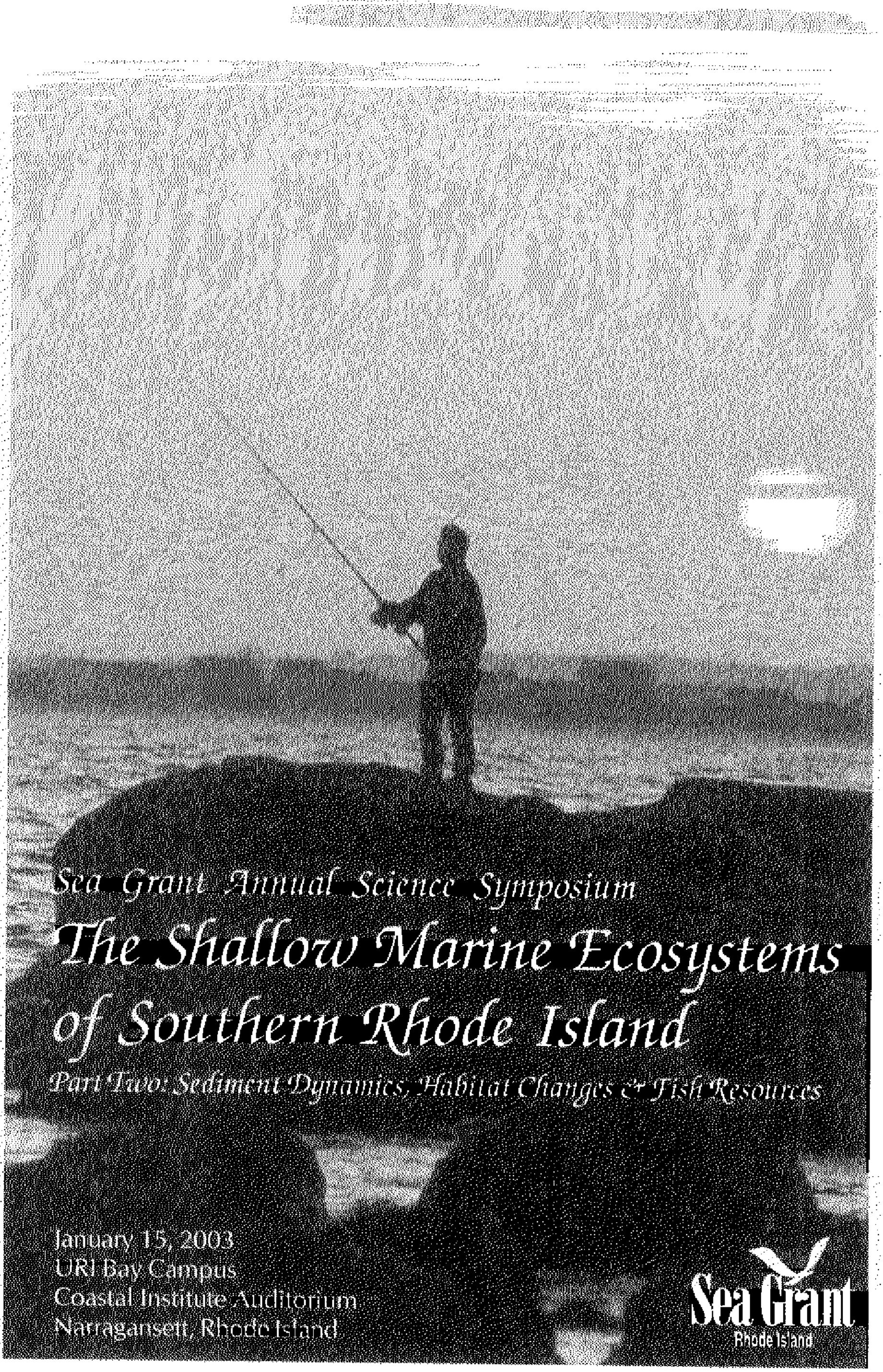

*Sea Grant Annual Science Symposium*

# *The Shallow Marine Ecosystems of Southern Rhode Island*

## *Part Two: Sediment Dynamics, Habitat Changes & Fish Resources*

January 15, 2003
URI Bay Campus
Coastal Institute Auditorium
Narragansett, Rhode Island

Sea Grant
Rhode Island

# Sea Grant Annual Science Symposium

## The Shallow Marine Ecosystems of Southern Rhode Island

Part Two: Sediment Dynamics, Habitat Changes & Fish Resources

This symposium highlights research on Rhode Island's south shore shallow marine ecosystems including Little Narragansett Bay, the Pawcatuck estuary, the salt ponds, and Narrow River. For information on the south shore projects funded by the Rhode Island Sea Grant College Program as part of its Omnibus Proposal for 2001 to 2003, please visit the Rhode Island South Shore Sea Grant Project Web site at http://seagrant.gso.uri.edu/coasts.

The Sea Grant Annual Science Symposium brings researchers and the public together to share information about coastal science of importance to Rhode Island and beyond. Rhode Island Sea Grant is a federal-state partnership that promotes the conservation and sustainable development of marine resources for the public benefit through research, outreach, and education.

**Rhode Island Sea Grant College Program**
*Barry Costa-Pierce*
Director

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*Cover photo courtesy of the Salt Ponds Coalition.*

## AGENDA

**8:30** Welcome, introduction to symposium
*Barry Costa-Pierce*

**8:45** Overview and background
*Virginia Lee*

**9:00** Processes, depositional environments, and geologic history of the southern Rhode Island shoreline
*Jon C. Boothroyd*

**9:45** What do you mean by mean high tide?
*Janet Freedman/Megan Higgins*

**10:15** Break

**10:30** Examining paleoenvironment and the impact of major storms in Rhode Island coastal lagoons
*John W. King*

**11:00** Baseline distribution of contaminants in a shallow lagoon, Quonochontaug Pond
*Kathryn H. Ford*

**12:00** Lunch on your own

**1:00** Shellfish resources of the coastal salt ponds, past and present
*Arthur R. Ganz*

**1:30** Juvenile fish in Rhode Island's coastal lagoons: seasonal changes over an eight-year period
*Jenifer Temple*

**2:00** U.S. Environmental Protection Agency winter flounder projects and other work in Rhode Island salt ponds
*Giancarlo Cicchetti*

**2:30** Break

**2:45** Overview of Rhode Island's Shellfish Restoration Program in response to the *North Cape* oil spill
*Karin Tammi*

**3:15** Discussion of research needs and management implications

**4:00** Adjourn

## Processes, depositional environments, and geologic history of the southern Rhode Island shoreline

*Jon C. Boothroyd*
*Professor of Quaternary Geology*
*University of Rhode Island*

*State Geologist*
*Rhode Island Geological Survey*

Deglacial deposits of the last Laurentide Ice Sheet form the substrate for the current barrier/headland/coastal lagoon shoreline of southern Rhode Island. A series of fan deltas were deposited into Glacial Lake Block Island about 17-18,000 BP when the ice margin stood at the Charlestown Moraine. Subsequent lake drainage and sea-level rise established a probable barrier shoreline some 10 km south of the present shoreline by 5,000 BP; northward migration of the barrier/lagoon system to near present lagoon positions occurred by 2,500 BP. Present processes, outlined below, continue the evolution of the system.

The 30 km long southern Rhode Island shoreline, Watch Hill east to Pt. Judith, can be treated as a coastal compartment with a mostly closed sediment transport system. There is little to no sediment "leakage" alongshore; leakage offshore remains a complex issue. Sediment is transported shoreward by overwash across the barriers and low headlands and into coastal lagoons by tidal-current and storm-surge augmented flow. The alternating microtidal barrier and glacial headland shoreline has an instantaneous berm volume of 1 million $m^3$, making it a relatively sediment-starved beach system. A long-term shoreline monitoring program (25 years of weekly beach profiles), compilation of dredging records, extensive vibracoring and mapping of flood-tidal deltas in the coastal lagoons, and side-scan sonar surveys of the upper and lower shoreface allow a semi-quantification of sediment transport rates and volumes.

The entire system is storm driven; therefore, size and intensity, forward speed, path, tidal phase, and time between storms (Hayes and Boothroyd, 1969) control the resulting changes. A rapid, short-term exchange (days to weeks) of sediment occurs between the berm and upper shoreface sand sheet on the order of 50-100,000 $m^3$; longer-term exchanges (months) may be up to 100,000 $m^3$. An average of 5,000 $m^3 \cdot yr^{-1}$ of sediment enters each of four tidal inlets, to be deposited as flood- tidal delta lobes. An excess of 5-20,000 $m^3 \cdot yr^{-1}$ of sand is transported eastward past any given point toward Pt. Judith. Another 25-100,000 $m^3$ is transported landward by overwash processes during 10-year and greater storms.

One can consider onshore and alongshore transport volumes to be conserved, but sediment transported to the lower shoreface and not returned can be considered lost to the system and to have "leaked." The retreat of the high-water line (HWL) has averaged 0.4 $m \cdot yr^{-1}$ over a 60-year time span, a highly speculative number. It could be inferred that linear distance, recomputed to a berm volume, represents the sediment leaving the system via storm-driven combined flows to the lower shoreface.

Future evolution of the barrier/headland/lagoon system will allow for lagoon filling by barrier migration and flood-tidal delta growth that will outstrip the present rate of sea-level rise that is providing accommodation space. An evolutionary "snapshot" can be gained by viewing the progression of lagoon filling east from Maschaug to Ninigret.

## What do you mean by mean high tide?

*Janet Freedman*
*Coastal Geologist*
*Coastal Resources Management Council (CRMC)*

*Megan Higgins*
*Coastal Policy Analyst*
*CRMC*

One of the persistent problems CRMC encounters is the conflict over beach use. Article 1 Section 17 of the Rhode Island Constitution guarantees shoreline privileges that include, but are not limited to, "fishing from the shore, the gathering of seaweed, leaving the shore to swim in the sea and passage along the shore." The Rhode Island Supreme Court in *State v. Ibbison*, 448 A.2d 728 (1982), determined that the boundary between private and public lands is the mean high tide line defined as the "the line formed by the intersection of the tidal plane of mean high tide with the shore." *Id.* at 730. Mean high tide is the "arithmetic average of high water heights observed over an 18.6 year Metonic cycle." *Id.* This measure was considered synonymous to the "land over which the daily tides ebb and flow" referred to in *Borax Consolidated Ltd. v. City of Los Angeles*, 296 U.S. 10, 22-23, 56 S. Ct. 23, 29 (citing *Attorney General v. Chambers,* citations omitted). The general perception is that the seaweed line on the beach, or at very least, the wetted portion of the beach, can be used as a proxy for the mean high tide line.

The University of Rhode Island's department of geosciences, under the direction of Jon Boothroyd, has been measuring beach profiles along the Rhode Island south shore for the past 25 years. Data from the Cha-EZ profile in Charlestown, R.I., is used to examine the relationship between the last high tide swash line (LHTS) and the intersection of the plane of mean high tide (MHW) with the beach. On wave dominated shorelines the LHTS will always be landward of the MHW line. This distance between the two measures can be tens to hundreds of feet depending on the slope of the beach and wave height. The Cha-EZ data raises the question of the suitability of MHW as the appropriate measure to guarantee shoreline privileges for the people in the state of Rhode Island.

## Examining paleoenvironment and the impact of major storms in Rhode Island coastal lagoons

*John W. King*
*Professor of Oceanography*
*URI Graduate School of Oceanography*

*Kathryn H. Ford*
*URI Graduate School of Oceanography*

The sheltered waters of the coastal lagoons (salt ponds) in Rhode Island provide prime habitat for finfish, shellfish, birds, and people. The ponds have been subjected to significant human population increase over the last 50 years. In order to maintain the productivity of this ecosystem, understanding its response to stressors is critical. Of greatest interest is the ponds' ability to sustain alterations in nutrient inputs, temperature, and tidal flushing. Toward this end, seven sediment cores are being studied to examine the ecological history of this region. Lithology, grain size, density, and magnetic susceptibility measurements are being coupled with measurements of paleoindicators such as diatoms and eelgrass seeds. These parameters will give information regarding salinity and temperature regimes over time. Fossil pigments and organic carbon concentration will also be utilized to investigate paleoproductivity. Additionally, the impact of major storms will be assessed. Since major storms can dramatically modify the coastal environment, understanding the impact of such storms is important in investigating the evolution of coastal areas and in predicting impacts of future storms. Three storms have been identified and were dated radiometrically with $^{210}Pb$, with pollen (e.g. *Ambrosia*), and with contaminants with known introduction dates (e.g. PCBs and DDT). The sedimentation rate was calculated as 0.135 cm/yr. This rate was used to correlate the storm layers with known storms (1938, 1815, and 1450). The diatom community appears to be fairly constant with depth in the core, but significant short-term changes are evident. These are likely attributable to the storm events.

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**Baseline distribution of contaminants in a shallow lagoon, Quonochontaug Pond**

*Kathryn H. Ford*
*Graduate Student*
*URI Graduate School of Oceanography*

*John W. King, and James G. Quinn*
*URI Graduate School of Oceanography*

In the summers of 1999 and 2000, inorganic and organic contaminants were examined in 39 surface sediment samples from Winnapaug, Quonochontaug, and Ninigret ponds in Charlestown and Westerly, R.I. These micro-tidal coastal lagoons are flushed only through a breachway—a single, narrow connection to the open ocean. Because of this limited flushing, the ponds can serve as sinks for contaminants from atmospheric, surface-water, and groundwater sources. The surface sediments were analyzed for grain size; organic carbon content; organic contaminants including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and DDT compounds; and inorganic contaminants Al, As, Cd, Cr, Cu, Hg, Fe, Mn, Ni, Pb, Ag, and Zn. Contaminant concentrations are generally below sediment quality guidelines. However, PCBs, DDTs, Hg, Ni, and Cd are present in concentrations above sediment quality guidelines in some samples. The contaminant concentrations decrease closer to the breachways, as expected due to better flushing and dilution by sediment deposited in the flood tidal delta. Fort Neck Cove in Ninigret Pond and the west end of Quonochontaug Pond have consistently higher concentrations of contaminants. Higher contaminant concentrations are also close to streams entering the ponds, suggesting a focusing of surface runoff contaminants. This contaminant distribution pattern illustrates incomplete mixing within the ponds. Oxygen data from the summers of 2001 and 2002, which will be presented, also suggest limited mixing.

## Shellfish resources of the coastal salt ponds, past and present

*Arthur R. Ganz*
*Supervising Marine Biologist*
*R.I. Department of Environmental Management, Marine Fisheries Section*

This report is a collection of survey information and field observations taken over 30 years. The variations of shellfish abundance in Ninigret Pond, Quonochontaug Pond, and Winnapaug Pond are traced. Efforts by the Marine Fisheries Section to restock and restore depleted resources, as well as reduce fishing pressure, are presented.

The bay quahaug, *Mercenaria mercenaria*, was the most stable harvestable resource in all ponds. The resource supports a recreational fishery, which inflicts heavy fishing mortality every summer. Natural recruitment appears to sustain the quahaug population in Ninigret Pond. Reduced recruitment was observed in Quonochontaug, which was addressed by establishment of a spawner sanctuary. Periodic transplant stocking of adult quahaugs into that closed sanctuary has resulted in an increase of quahaug density throughout the pond. Shellfish density in Winnapaug Pond has declined. Restoration efforts including spawner sanctuaries have not been successful there.

Oysters, *Crassostrea virginica,* once the prime molluscan treasure, have vanished from the three ponds. The suspected cause of the demise of Ninigret oysters was MSX disease. Habitat degradation is suspected as the cause of the decline in other ponds.

Soft-shell clams, *Mya arenaria,* continue to be a presence in all ponds. Strong year classes have provided stock for short durations to support opportunistic fisheries. Strong sets have supported localized commercial harvests in the early 1970s followed by a decline, then a strong resurgence in the late 1990s.

Bay scallops, *Argopecten irradians,* responded sporadically to stocking efforts by the section. Stock enhancement using transplanted juvenile scallops from Westport, Mass., resulted in resurgence of the fall tradition of scalloping in the 1970s. More recent restocking efforts using hatchery-reared seed have resulted in some sporadic successes.

The major concern for the future of shellfisheries in the salt ponds is habitat quality. The impact of eutrophication and water stagnation in Winnapaug is dramatic, and less so in the other ponds. We wait anxiously for the completion of the South Coast Restoration Project, which hopefully will improve habitat conditions and slow the degradation process.

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## Juvenile fish in Rhode Island's coastal lagoons: seasonal changes over an eight-year period

*Jenifer Temple*
*Senior Marine Biologist*
*R.I. Department of Environmental Management, Marine Fisheries Section*

*Lesa Meng*
*U.S. Environmental Protection Agency, Atlantic Ecology Division*

Multidimensional scaling (MDS) was used to look at eight years of finfish data collected at 16 estuarine beach seine stations in Rhode Island's coastal lagoons, known locally as salt ponds. Fish were collected bimonthly from May through October from 1994 to 2001 in Winnapaug, Quonochontaug, Ninigret, and Point Judith ponds and Narrow River. Fish data were standardized by effort. Analysis by year and location showed no patterns. Therefore, data were further broken down into seasons. A MDS analysis of fish catches in spring showed no patterns. However, when a MDS analysis was run on fall data, a pattern emerged. The years 2000 and 2001 were distinctly different from the other years. Graphs of spring and fall fish numbers showed increases in some populations and declines in others.

## U.S. Environmental Protection Agency winter flounder projects and other work in Rhode Island salt ponds

*Giancarlo Cicchetti*
*Ecologist*
*U.S. Environmental Protection Agency (EPA), Atlantic Ecology Division*

*Marty Chintala, Rich Pruell, Lesa Meng, and Bryan Taplin*
*EPA Atlantic Ecology Division*

We will briefly summarize selected EPA research in Rhode Island's salt ponds from 2000 into the near future. In one project, during the summer of 2000, we used a 1.75 $m^2$ drop sampler to quantify populations of juvenile flatfishes and other small nekton in Ninigret Pond. Mean abundance of all fishes in the sampled habitats was high, at 21.8 $\pm$ 2.1 (SE) inds/$m^2$. The mean abundance of juvenile winter flounder (15 - 95 mm) in all habitats was also high at 11.0 $\pm$ 2.2 (SE) inds/$m^2$. These data, and the work of others, point to the importance of Rhode Island's coastal lagoons as valuable fish nursery habitat. Motivated by these findings, we are planning a larger winter flounder study in 2003 to investigate juvenile flounder/habitat relationships in several of the salt ponds, in the West Passage of Narragansett Bay, and in the Providence River. The major goal of this study will be to develop empirical relationships between habitat characteristics at several scales and fish densities, as part of an EPA effort to characterize habitats for development of habitat protection criteria. Habitat characteristics will be assessed in 2003 with an instrument sled equipped with digital and analog video cameras and a continuously recording YSI instrument logging T, S, DO, depth, optical Chl-a and turbidity. The sled also includes a beam trawl to simultaneously estimate fish densities along with these habitat characteristics. We will also acquire aerial photographs of our sampling sites to correlate underwater and shoreline habitat arrangements to fish densities at larger spatial scales. Work with this gear in Narragansett Bay proved successful in 2002; we look forward to using these techniques in the salt ponds. Other flounder work planned for the salt ponds in 2003 includes an otolith signature project to look at the relative contributions of juvenile habitats to fished adult flounder populations. We are attempting to identify distinct chemical signatures in juvenile flounder otoliths from macroalgal, seagrass, and unvegetated habitats in the salt ponds, in lower Narragansett Bay, and in upper Narragansett Bay. Preliminary work showed that otolith signatures of juvenile flounder taken from three of the salt ponds can be clearly distinguished from signatures of flounders taken from similar habitats in Narragansett Bay. If habitat/location combinations can be successfully identified in juvenile otoliths, we will then examine the central cores of otoliths from fished adult populations for these same signatures, so as to assess the relative contributions of distinguishable juvenile habitats to the adult populations. In addition to these projects, EPA is also involved with National Coastal Assessment work in the salt ponds, and we will describe this as well.

## Overview of Rhode Island's Shellfish Restoration Program in Response to the *North Cape* Oil Spill

*Karin A. Tammi*
*Coordinator for the North Cape Shellfish Restoration Project*
*R.I. Department of Environmental Management (RIDEM)*

*Najih Lazar and Arthur R. Ganz*
*RIDEM*

*James G. Turek and John G. Catena*
*National Oceanic and Atmospheric Administration*

On the evening of January 19, 1996, the tank barge *North Cape* struck ground off Point Judith, R.I., and began leaking oil in the vicinity of two National Wildlife refuges, several salt ponds, and public and private beaches. Wind and wave action dispersed the oil into the atmosphere, throughout the water column, and into the benthic sediment. Approximately 828,000 gallons of heating oil were released into the surrounding offshore and inshore environment, affecting large numbers of crustaceans, mollusks, birds, amphipods, and fish.

It was determined that the spill was responsible for the loss of about 150.6 million surfclams (*Spisula solidissima*) with a total biomass of 379,000 kg for a value of $1.5 million. The spill resulted in the formation of a natural resource trustee group composed staff from the R.I. Department of Environmental Management, the National Oceanic and Atmospheric Administration, and the U.S. Fish and Wildlife Service to evaluate the injury to the natural resources and to plan the resulting restoration activities. Since the surfclam population should recover to natural baseline levels within three to five years, a compensatory shellfish restoration program for alternate species will be launched in Narragansett Bay and in the coastal salt ponds.

Beginning in June 2002, the trustees initiated a multifaceted and multispecies approach to shellfish restoration with programs for the eastern oyster, *Crassostrea virginica*, northern quahog, *Mercenaria mercenaria* and the northern bay scallop, *Argopecten irradians irradians*. The shellfish restoration strategy will utilize many techniques, including a remote setting program for oysters, seeding, spawning sanctuaries and spat collection for bay scallops, and shellfish upweller nurseries for quahog seed. These shellfish restoration initiatives offer tremendous opportunities for Rhode Island's shellfish resources.