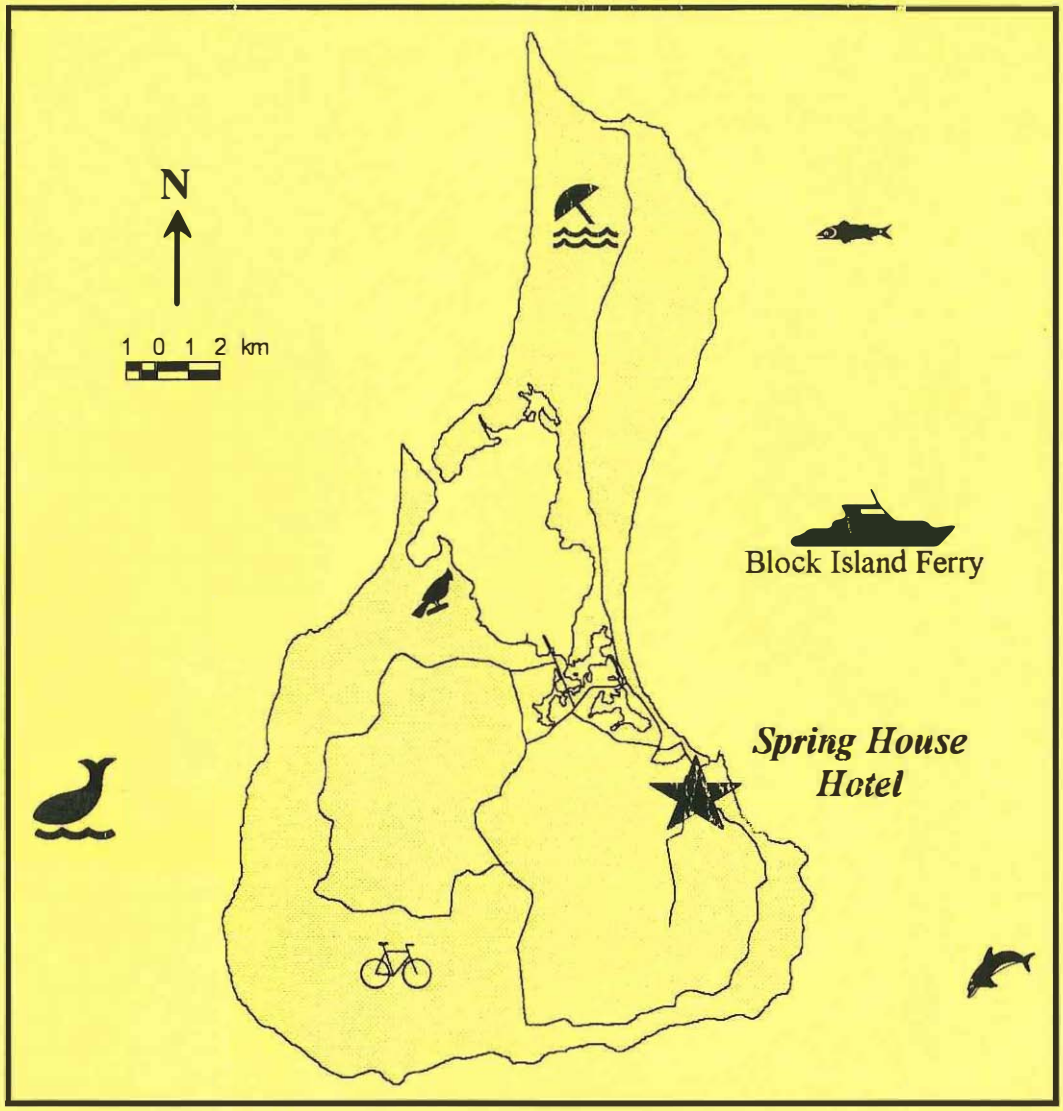
New England Estuarine Research Society

PROGRAM and ABSTRACTS



FALL 2000 MEETING

November 2 – 4, 2000

Spring House Hotel

Block Island, RI

New England Estuarine Research Society

ABSTRACTS AND PROGRAM OF THE FALL 2000 MEETING

2-4 NOVEMBER 2000
SPRING HOUSE HOTEL
BLOCK ISLAND, RHODE ISLAND

JOINTLY HOSTED
BY
THE GRADUATE SCHOOL OF OCEANOGRAPHY
UNIVERSITY OF RHODE ISLAND
AND
US ENVIRONMENTAL PROTECTION AGENCY, NHEERL,
ATLANTIC ECOLOGY DIVISION, NARRAGANSETT, RI
AND
US GEOLOGICAL SURVEY COASTAL FIELD STATION
UNIVERSITY OF RHODE ISLAND
AND
RHODE ISLAND SEA GRANT
UNIVERSITY OF RHODE ISLAND

Synopsis:

Wednesday, November 3 (optional)
Arrive on Block Island, activities on your own

Thursday, 2 November: 12:30 PM – 10 PM
Others arrive on Block Island, Registration, Lunch,
21st Century Symposium, Social, Dinner, Shallow Water Discussion Group

Friday, 3 November: 8:00AM – 10 PM
Contributed Oral Presentations, Lunch, Shallow Water Nutrient Presentations,
Poster Session, More Talks, Social, Banquet, Student Awards, Festivities

Saturday, 4 November: 8:00 AM – 12:30 PM, (to 5 PM = Optional)
Contributed Oral Presentations, More Shallow Water Nutrient Presentations, Box Lunch,
Optional Field Trip, Depart Block Island

Meeting Program and abstract on following pages
All talks take place in Victoria's Parlor and all posters are in the Sunroom Wing

Wednesday, 3 November 2000 (optional)

2:00 PM Ferry departs Pt. Judith for Block Island
3:00 PM Arrive on island. Check into Hotel and help put up poster boards. Then on your own to tour the island, swim, practice your talk, etc.
6:00 PM Meet in Hotel foyer to go out to dinner.

Thursday, 2 November 2000

7:00 –9:00 AM Continental Breakfast, Spring House Hotel, ***or***
6:00 AM Be at Block Island Ferry dock in Pt. Judith, RI, for ferry that departs at 6:30, ***or***
10:30 AM Be at Block Island Ferry dock in Pt. Judith, RI, for ferry that departs 11:00 or as soon as filled.
Look for Pam Arnofsky and the NEERS table on this ferry so you can register there.
12:15 – 1:15 PM Buffet Lunch in the Oceanfront Dining Room, Spring House Hotel
(must either be staying at the Spring House Hotel Thursday night or have pre-registered for lunch)
12:30 – 3:30 PM NEERS meeting registration, foyer, Spring House Hotel
1: 30 PM – 5:00 PM 21st Century Symposium, Victoria's Parlor, Spring House Hotel

SPECIAL SYMPOSIUM

Estuaries: How Smoothly Will They Flow into the 21st Century?

Session Chair = Walter Berry, US Environmental Protection Agency

1:30PM Introduction and welcome, Walter Berry, Symposium organizer

1:45 Michael S. Connor, Vice President, Programs and Exhibits, New England Aquarium, Boston, MA
WHAT WILL THE PUBLIC WANT FROM COASTAL RESEARCH IN THE NEXT CENTURY?

2:15 Anne E. Giblin, Associate Scientist, The Ecosystem Center, Marine Biological Laboratory, Woods Hole, MA and President of the Estuarine Research Federation (ERF)
ESTUARINE SCIENCE AND MANAGEMENT IN THE 21ST CENTURY — WILL WE EVER GET OUR HEADS OUT OF THE SEWER?

2:45 Jan Reitsma, Director, Rhode Island Department of Environmental Management, Providence, RI
KEY ESTUARINE ISSUES IN NARRAGANSETT BAY: A RESOURCE MANAGER'S PERSPECTIVES

3:15 BREAK

3:30 Scott W. Nixon, Professor of Oceanography, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI
NEW ENGLAND ESTUARIES —THE FUTURE REMEMBERED.

4:00 Peter Lord, Science Writer, Providence Journal and Associate Director of Metcalf Institute for Marine and Environmental Reporting, Narragansett, RI
THE AHUPUA`A CONCEPT OF WATERSHED MANAGEMENT IN HAWAII.

4:30 PANEL DISCUSSION - Estuaries: How Smoothly Will They Flow into the 21st Century?

5:00 PM Symposium Social, Victoria's Parlor, Spring House Hotel
5:30 – 7:30 PM NEERS meeting registration
6:00 PM ferry back to Pt. Judith for those who have been voted off the island
6:00 PM ferry arrives from Pt. Judith with NEERS newcomers
7:00 PM – 9:00PM Dinner served, Dining Room, Spring House Hotel (Pick your own time)
6:00 PM – 10:00 PM Poster set up, Sunroom Wing, Spring House Hotel
9:00 PM Discussion Group on Nutrient Enrichment in Shallow Water Systems,
Providence (The guesthouse, not the site of ERF'97 nor the TV show), Spring House Hotel

Friday, 3 November 2000

(note: if you want to attend this morning's session & you come by ferry, you MUST arrive on Thursday.)
6:45 AM – 7:45 AM Continental Breakfast, Dining Room, Spring House Hotel
6:45 AM – 7:45 AM More poster set-up, Sunroom Wing, Spring House Hotel
7:45AM – 12:00 PM Meeting Registration, Foyer, Spring House Hotel

MORNING CONTRIBUTED PAPERS SESSION

Session Chair = Scott Warren, Connecticut College

(**K** indicates denotes Ketchum Prize candidate, **R** denotes Rankin Prize candidates, * denotes presenter)

8:00 Brief Presidential Remarks, Scott Warren, NEERS President

8:10 (**K**) Carabetta*, M. and, R.S.Warren
HYDROPERIOD, SALINITY, AND SOIL DRAINAGE INFLUENCES ON *PHRAGMITES* EXPANSION IN TWO UNRESTRICTED TIDAL MARSHES

8:30 (**R**) Greenbaum*, A.H. and A.E. Giblin.
DIFFERENCES IN PROPERTIES OF SALT MARSH SEDIMENT BETWEEN HAYED AND REFERENCE SITES

8:50 (**R**) Horowitz*,J.D., L.Deegan, R. Garritt.
STABLE ISOTOPIC ANALYSIS OF FOOD WEBS IN HAYED AND REFERENCE SALT MARSHES

9:10 (**R**) Jamie R. Haines*, Matthew Cieri and Linda Deegan
FOOD CHOICE CONVERGENCE OF BENTHIC AND PELAGIC FISHES ALONG AN ESTUARINE GEOMORPHOLOGICAL GRADIENT

9:30 (**K**) Holt, E.R
THE IMPORTANCE OF MARSH SIZE IN THE DISTRIBUTION OF SALTMARSH SHARP-TAILED SPARROWS — IMPLICATIONS FOR SALT MARSH MITIGATION

9:50 BREAK – Foyer Spring House Hotel, informal poster viewing

10:10 (**K**) Taylor, D.L.
EFFECTS OF INCREASED WATER TEMPERATURE ON SAND SHRIMP PREDATION ON YOUNG-OF-THE-YEAR WINTER FLOUNDER PREY: A PROPOSAL

10:30 (**K**) Kelly*, R.P. and Moran, S.B.
SEASONAL VARIATION IN GROUNDWATER FLUX AND DISPERSION IN A TEMPERATE ESTUARY USING RADIUM ISOTOPES AS TRACERS

10:50 (**K**) Pospelova*, Vera, Gail L. Chmura, and James S. Latimer
DINOFLAGELLATE CYST RECORDS AND HUMAN DISTURBANCE IN NEW BEDFORD HARBOR AND APPONAGANSETT BAY ESTUARIES, MASSACHUSETTS (USA)

11:10 (**K**) Spasojevic*, Zorana, Gail L. Chmura, James S. Latimer, Warren S. Boothman
THE BIOGENIC SILICA SEDIMENT RECORD IN NEW BEDFORD HARBOR, MASSACHUSETTS.

11:30 (**K**) Ford*, K.H., J.W. King, J.G. Quinn
BASELINE DISTRIBUTION OF CONTAMINANTS AND EVIDENCE OF STORM IMPACT IN QUONOCHONTAUG POND, RHODE ISLAND

11:50 (**K**) Beskenis, J. L.
DOES THE BIOFILM ON THE BROWN ALGA *FUCUS VESICULOSUS* BIND COPPER OR ZINC AND REDUCE THE METAL LOAD OF THE HOST PLANT?

12:10-1:30 LUNCH – Dining Room, Spring House Hotel (must either be staying there or have pre-registered)
Accompanied by kite flying on the Spring House Hill by NEERS Past President Fred Short and a soccer demonstration by NEERS president elect Linda Deegan & ERF Executive Director Joy Bartholomew on the Spring House Volley Ball Court.

SHALLOW WATER SPECIAL SESSION

Session Chair = Veronica Berounsky, University of Rhode Island

1:30 (K) Vaudrey*, J.M.P. and J.N. Kremer
ECOSYSTEM METABOLISM IN THREE SHALLOW SUB-ESTUARIES IN RELATION TO NUTRIENT LOADING

1:50 (K) Biddle*, A.B. and J.N. Kremer.
THE RELATIVE IMPORTANCE OF CHLOROPHYLL AND COLORED DISSOLVED ORGANIC MATTER (CDOM) IN THE ATTENUATION OF LIGHT IN SHALLOW COASTAL WATERS

2:10 (R) Hinckley*, E.S., and C. Neill
THE PATH OF TOTAL DISSOLVED NITROGEN IN AN INTACT COASTAL FOREST, EDGARTOWN, MASSACHUSETTS

2:30 Hughes*, J. E., L. A. Deegan, and J. E. Costa.
THE RELATIONSHIP OF WATER QUALITY TO FISH COMMUNITY STRUCTURE IN SOUTHEASTERN NEW ENGLAND ESTUARIES

2:50-3:50 BREAK TO LOOK AT POSTERS – Sunroom Wing, (D) indicates Dean Award Candidate

(D) Adamowicz*, S.C., C.T. Roman.
NEW ENGLAND SALT MARSH POOLS: A SURVEY OF CURRENT CONDITIONS AND AN INITIAL EVALUATION OF RESTORATION EFFORTS IN SOUTHERN MAINE

(D) Beecher*, C. Beth and Gail L. Churma
CALIBRATION OF POLLEN ASSEMBLAGES FOR VEGETATION RECONSTRUCTION IN BAY OF FUNDY SALT MARSHES

Benoit, L.K
A THREAT TO THE CONNECTICUT RIVER ESTUARY: THE AQUATIC INVASIVE PLANT WATER CHESTNUT IS REMOVED FROM A TIDAL COVE AND A TRIBUTARY

(D) Ruth H. Carmichael* and Erica T. Weiss
THE EFFECT OF TERRIGENOUS NITROGEN LOADING ON GROWTH RATES OF QUAHOGS (*MERCENARIA MERCENARIA*) AND SOFTSHELL CLAMS (*MYA ARENARIA*) THROUGH CHANGES IN WATER COLUMN AND HABITAT CHARACTERISTICS.

Casanova, T.
THE ECOLOGY OF THE JAPANESE SHORE CRAB (*HEMIGRAPSUS SANGUINEUS* DE HAAN) AND ITS NICHE RELATIONSHIP TO THE GREEN CRAB (*CARCINUS MAENAS*) ALONG THE COAST OF CONNECTICUT, U.S.A.

Concascia*, R., D. Scott and J. Swenarton.
LONG TERM MONITORING COMBINED WITH ENVIRONMENTAL EDUCATION

Currie*, W. J. S. and J. N. Kremer
MODEL SEEKS DATA FOR MUTUAL GRATIFICATION

(D) Goldstein*, J.H., and J.H. McKenna
TIDAL PULSING, ENVIRONMENTAL VARIABILITY, AND PHYTOPLANKTON DYNAMICS IN THE MYSTIC RIVER ESTUARY, CT

Hale*, S.S., and H.W. Buffum.
MANAGING TROUBLED DATA: GETTING COASTAL MONITORING DATA SYSTEMS TALKING TOGETHER

Hampson, G.R
DESTRUCTION AND RECOVERY OF THE WINSOR COVE, CATAUMET SALT MARSH FROM A #2 FUEL OIL SPILL: A 25 YEAR HISTORY.

(D) Ignudo*, S.E., and R.N. Zajac
SPATIAL RELATIONSHIPS AMONG NATURAL PROCESSES, HUMAN IMPACTS, AND BENTHIC COMMUNITY STRUCTURE IN NEW HAVEN HARBOR, CONNECTICUT

(D) Kroeger*, K. D., M.L. Cole, J. W. Brawley, and I. Valiela,
THE INFLUENCE OF WATERSHED LAND USE AND VADOSE ZONE THICKNESS ON THE QUANTITY AND LABILITY OF ORGANIC NITROGEN TRANSPORTED BY GROUNDWATER TO COASTAL WATERS

Laliberte*, E.M., J.W. King
HISTORIC AND RECENT SEASONAL CHANGES IN ANTHROPOGENIC TRACE METAL CONTAMINANTS IN NARRAGANSETT BAY, RHODE ISLAND SEDIMENTS

(D) Lewis*, J.L., S. Pianka, D.T. Osgood, R.M Chambers, and D.J. Yozzo
DOES *PHRAGMITES* EXPANSION INFLUENCE NEKTON HABITAT UTILIZATION?

Peck*, Myron A., Timothy R. Gleason, and David A. Bengtson
PROJECTED POPULATION-LEVEL EFFECTS OF PENTACHLOROPHENOL EXPOSURE ON THE INLAND SILVERSIDE, *MENIDIA BERYLLINA*.

Pregnall*, A. M. and M. M. Pregnall
LONG-TERM RECOVERY AND FLUCTUATION IN AN EELGRASS (*ZOSTERA MARINA*) POPULATION IMPACTED BY COMMERCIAL OYSTER CULTURE

(D) Refai*, F.R. and R.N. Zajac.
RESPONSES OF FIDDLER CRABS (*UCA* SPP.) TO PATCH STRUCTURE IN DISTURBED AND UNDISTURBED SALT MARSHES

Ryan*, William B. F., Robin Bell, Suzanne Carbotte , Cecilia McHugh , Roger Flood, Henry Bokuniewicz, Vicki Lynn Ferrini
EXPLOITING A NEW GIS DATABASE OF THE HUDSON RIVER TO UNDERSTAND ESTUARY PROCESSES

Robert Shields* and David Klarer
OLD WOMAN CREEK ESTUARY: THE HEALTHY ALTERNATIVE (WE ARE LOW SALT)

Taplin*, B.K., and R.J Pruell
STABLE ISOTOPE RATIOS IN ARCHIVED STRIPED BASS SCALES

(D) Thimmayya, A.C
ABOVEGROUND BIOMASS RESPONSES TO NITROGEN AND PHOSPHORUS ADDITIONS ALONG A TIDAL GRADIENT IN A TIDAL, FRESHWATER MARSH

Exhibit 1: ERF 2001, AN ESTUARINE ODYSSEY, Joy Bartholomew, ERF Executive Director.

Exhibit 2: YSI EQUIPMENT DEMONSTRATIONS. Kevin McClurg, General Manager and Northeast Regional Sales Manager, YSI Massachusetts

3:50 PM Special session talks resume, Victoria's Parlor

3:50 Gaines, A.G.
TROPHIC "INWELLING" IN A SHALLOW ESTUARY: SENGEKONTACKET POND, MARTHA'S VINEYARD.

4:10 Brawley*, J.W. and J.N. Kremer
MODELING ECOSYSTEM RESPONSES TO NUTRIENT INPUTS TO THE WAQUOIT BAY ESTUARINE SYSTEM

4:30 Crawford, R.
MONITORING IN AN ESTUARY: MATCHING SCALE OF OBSERVATIONS TO DYNAMIC STABILITY IN ESTUARINE CIRCULATION

4:50 Cicchetti*, Giancarlo, James Latimer, Edward Dettmann, Richard McKinney, Steven Rego, Darryl Keith, Russell Ahlgren, and Robert Diaz
EUTROPHICATION OF COASTAL WATER BODIES: RELATIONSHIPS BETWEEN NUTRIENT LOADING AND ECOLOGICAL RESPONSE.

5:10 Wrap Up: What have we learned about nutrient enrichment in shallow water systems?

5:15 BUSINESS MEETING, INCLUDING NEERS ELECTIONS (any NEERS member leaving the room may be nominated!)

6:00 POSTER RECEPTION AND SHALLOW WATER SOCIAL, Sunroom Wing and Foyer
(Note: Posters need to be taken down later tonight.)

7:00 Arrival of more NEERSians on the ferry that departed Pt. Judith at 6 PM

7:30 Awards Banquet, Dining Room, Spring House Hotel
(must either be staying at the Spring House Hotel Friday night or have pre-registered for banquet)
Presentation of Student Prizes: Ketchum, Rankin, and Dean; other fun & games & music

Saturday, 4 November 2000

MORNING CONTRIBUTED PAPERS SESSION

Session Chair = Charles Roman, USGS

8:10 Osgood*, D., D. Yozzo, D. Jacobson, T. Hoffman, and J. Wnek
SPATIAL PATTERNS OF NEKTON USE WITHIN *PHRAGMITES* AND *SPARTINA* HABITAT ON THE HOUSATONIC RIVER, CT.

8:30 Vasilakos*L., R. Orson, D. Osgood and R. Zajac
BASELINE SAMPLING AND HABITAT ASSESSMENT OF SYBIL CREEK MARSH, BRANFORD, CT. PRIOR TO RESTORATION

8:50 Wigand*, C., R. McKinney and M. Charpentier
TOWARDS DEVELOPING INDICATORS OF SALT MARSH CONDITION

9:10 James-Pirri*, M.J., K. Tuxbury and S. Koch
SPAWNING DENSITIES AND POPULATION DEMOGRAPHICS OF HORSESHOE CRABS FROM PLEASANT BAY, CAPE COD BAY, AND MONOMOY NWR, MASSACHUSETTS.

9:30 Bell*, R.E , R. Flood, S. Carbotte, W.B.F. Ryan, C. McHugh, V. Ferini, H. Bokuniewicz, J. Thissen, J.W. Ladd , W.C. Nieder , and E.A. Blair
SEDIMENT TRANSPORT AND BENTHIC HABITATS IN THE HUDSON RIVER

9:50 Hinga, K.R.
IMPROVED PREDICTIONS OF BIODEGRADATION RATES OF LOW MOLECULAR WEIGHT AROMATIC HYDROCARBONS IN COASTAL SEDIMENTS

10:10 BREAK

10:30 Walker*, H.A., B. Yarnel, V.M.Berounsky, E.H. Dettmann, J.S. Latimer, and N. Jaworski
CLIMATE VARIABILITY, ANTHROPOGENIC CHANGE AND CONSEQUENCES IN THE MID-ATLANTIC.

10:50 Berounsky*, V.M., H. A. Walker, and N. Jaworski
THE ROLE OF ANTHROPOGENIC WATERSHED LOADING AND CLIMATE VARIABLITY ON NITROGEN FLUXES TO THE POTOMAC RIVER ESTUARY

11:10 Dettmann*, E.H. and H.A. Walker
EFFECTS OF NITROGEN LOADING, FRESHWATER RESIDENCE TIME, AND INTERNAL LOSSES ON NITROGEN CONCENTRATIONS IN ESTUARIES

11:30 Brush*, M. J., S. L. Granger, and S. W. Nixon
OFFSHORE NUTRIENT INPUTS AND THE PRODUCTIVITY OF NARRAGANSETT BAY.

11:50 Bintz*, Joanne C., Scott W. Nixon, Betty Buckley, Stephen Granger, and Susan Sherwood
RESPONSE OF COASTAL LAGOON PHYTOPLANKTON, MACROALGAE AND SEAGRASS TO MANIPULATIONS OF TEMPERATURE AND NUTRIENT LOADING

12: 10 Final Presidential Remarks, Linda Deegan, new NEERS President
(Al Gore and G. W. Bush too busy to join us)

12:15 Adjourn, box lunches available to those who ordered them

1:30 Field Trip of Block Island natural sites led by Scott Commings of The Nature Conservancy, or Ferry Trip to Pt. Judith.

5:00 Last Ferry of the day to Point Judith, Return to "real" life.

Estuaries: How Smoothly Will They Flow into the 21st Century?

SYMPOSIUM SPEAKER BIOGRAPHIES:

(in order of presentation)

Michael S. Connor

Mike Connor is Vice President of Programs and Exhibits at the New England Aquarium. Before joining the Aquarium, he was Director of Environmental Quality at the Massachusetts Water Resources Authority (MWRA). In the mid-1980's, Mike worked on the start-up of the National Estuary Program in New England. Mike completed his undergraduate degree at Stanford University, his doctorate at the Woods Hole Oceanographic Institution/Massachusetts Institute of Technology Joint Program in Biological Oceanography, and his post-doctoral work at the Harvard School of Public Health's Interdisciplinary Programs in Health.

Anne E. Giblin

Anne Giblin received her B.S. from Renssealear Polytechnic Institute in Biology in 1975 and Ph.D. from the Boston University Marine Program in 1982. After being a Post-Doctoral investigator at the Woods Hole Oceanographic Institution, Anne joined the Ecosystems Center at the Marine Biological Laboratory in 1983 where she is currently an Associate Scientist. Her major research focus has been on the cycling of elements in the environment, especially the biogeochemistry of iron, sulfur, nitrogen, and phosphorus. Much of her work has been focused in soils and sediments where she has examined element cycling under different conditions of oxidation and reduction.

Anne is also a past President of the New England Research Society (NEERS) and the current president of the Estuarine Research Federation (ERF).

Jan Reitsma

Jan Reitsma was appointed Director of the Rhode Island Department of Environmental Management in March of 1999. Previously he had served as undersecretary for policy and programs in the Massachusetts Executive Office of Environmental Affairs, and before that he served as Assistant Secretary for Environmental Impact Review. He holds a Juris Doctorate from Northeastern University School of Law and a Bachelor of Arts in Environmental Studies from Brown University.

Scott W. Nixon

Scott Nixon joined the faculty of the Graduate School of Oceanography at the University of Rhode Island in 1970, and has remained there ever since. He received his B.A. in biology from the University of Delaware and his Ph.D. in botany (ecology) from the University of North Carolina at Chapel Hill under the direction of H. T. Odum. He served as director of the R. I. Sea Grant College Program from 1984-2000. He serves as co-editor-in-chief of Estuaries, the journal of the Estuarine Research Federation, as a member of the National Research Council (NRC) Ocean Studies Board, as Vice-Chair of the NRC Committee on the Restoration of the Great Everglades Ecosystem, as a member of the editorial boards of the journals, Estuarine, Coastal and Shelf Science and Sea Research, and as a member of the International Ecology Institute.

Peter B. Lord

Peter B. Lord has been a reporter at the Providence Journal newspaper for more than 20 years and during most of that period he has focused on environmental issues. He has covered two major oil spills as well as hundreds of other stories about water pollution, suburban sprawl, hazardous wastes, and land conservation. Three years ago he was appointed Journalism Director of the Metcalf Institute for Marine and Environmental Reporting, a program for working journalists based at U.R.I.'s Graduate School of Oceanography. Two years ago he took a leave of absence from the Journal and spent an academic year at U.R.I.'s main campus teaching environmental journalism.

Estuaries: How Smoothly Will They Flow into the 21st Century?

SYMPOSIUM SPEAKER ABSTRACTS

(in order of presentation)

Connor , M.S., New England Aquarium, Boston, MA 02210, mconnor@neaq.org

WHAT WILL THE PUBLIC WANT FROM COASTAL RESEARCH IN THE NEXT CENTURY?

A generation ago, estuarine laboratories were small facilities in backwater settings where habitats were mostly studied without concern for anthropogenic influences. Today, with human influences dominating most major element cycles and with the rapid rate of habitat modification, it is hard to imagine the study of any coastal process without considering people. But people make it harder to study the process. Standard experimental treatments can be hard to develop, and the problems are so multi-dimensional that individual scientists often become a cog in a multi-disciplinary engineering study.

For New England estuaries, the primary social trend that concerns environmentalists and managers is suburban sprawl. In Massachusetts we are losing 44 acres each day to development. These developments are transforming coastal habitats and introducing large-scale, diffuse pollution loads. More and more, we are seeing interference with the water cycle. Through interception of ground water and cross-watershed transfer of surface waters, the amount and timing of fresh water inflows to estuaries is changing.

Another major social trend affecting us is globalization. The major impact of globalization on New England is through the introduction of biological immigrants which can present both ecological and public health threats. Managers are totally unprepared to assess the size of these threats or prevent and mitigate them.

In addition, the local manufacturing process is changing from petroleum-based to increased use of genetic engineering. There is little consensus on the ecological significance of this trend. However, aquaculture releases of genetically-modified salmon stock are commonplace already.

Finally, our estuarine science community is part of the national trend of increasing speed of communication and networking. These advances in communication present great opportunities for scientists to collect data from remote field locations without leaving their office. However, these advances also create a public demand for more instantaneous responses from the scientific community to address all these problems, as well as their own access to the information.

There is an increasing social backlash to the growing pace of energy and consumer consumption. By either economic or environmental necessity, the Northeast will reverse these trends at some point in the future. Scientists will be asked to provide the vision for what changes are necessary for that sustainable future to develop.

Giblin, A.E. The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA, 02543

ESTUARINE SCIENCE AND MANAGEMENT IN THE 21ST CENTURY – WILL WE EVER GET OUR MINDS OUT OF THE SEWER?

Studies on nutrients from people, animals and agriculture have occupied a significant percentage of the efforts of estuarine scientists and managers in the 20th century. In spite of this, many experts would say the problems are getting worse. Will anything change in the 21st century? My prediction is probably not soon, although nutrients from aquaculture will probably become a growing issue. Is the problem insufficient scientific understanding, lack of appropriate technologies, ineffective management strategies, or public perception? Using examples from Boston Harbor and the Town of Falmouth, I'll try to identify barriers to solving the nutrient problem. What may save us from nutrients? Water – if it becomes scarce enough. Where may the new serious challenges to estuaries come from – water. Do we know enough about how estuaries may respond to changes in fresh and salt water inputs? Using an example from Plum Island I'll point out how changes in water can effect estuaries in unexpected ways.

Reitsma, Jan , R.I. Department of Environmental Management, Providence, RI, 02908
KEY ESTUARINE ISSUES IN NARRAGANSETT BAY: A RESOURCE MANAGER'S PERSPECTIVE
This presentation discusses the major issues facing Narragansett Bay and its watershed from the perspective of the director of the state environmental management agency. Issues covered in the presentation include land and coastal development, fisheries health and management, habitat restoration, dredging and contaminated sediments, invasive species, sea level rise, rise in estuarine/ocean water temperatures, and, in relation to all of the above issues, ecosystem monitoring and indicators. Identified are key estuarine research areas including risk assessment of invasive species, effects of water temperature rise, understanding ecosystem and species shifts, effects of air deposition of nitrogen to New England estuaries, the need for more accurate environmental indicators, the need for research related to fisheries management, and impacts of contaminated sediment resuspension in estuary dredging projects.
Also included will be a brief discussion of the major unanswered questions regarding natural systems and human impacts as well as a perspective on how all interests involved in estuaries might be able to more effectively inform and engage the public. A final section will discuss how the State of Rhode Island has been taking steps to address some of the key estuarine issues and how the creation of the Coastal Institute at the University of Rhode Island may provide a good model for bringing together the research community with coastal managers and the public to address these issues in a collaborative manner.

Nixon, S. W., Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882.
NEW ENGLAND ESTUARIES — A FUTURE REMEMBERED?
The efforts of regulatory agencies, environmental advocacy organizations, and educators have achieved remarkable reductions in point source pollution inputs of many kinds to the urban estuaries of New England. The fluxes of pathogens, organic matter, most metals, and numerous toxic organic compounds are now lower than they have been for many decades. It appears very likely that EPA will soon begin to require large reductions in point source nutrient discharges. Atmospheric nitrogen deposition is likely to diminish with more stringent NO_y emission regulations for fixed and mobile sources. Agriculture and associated fertilizer use is not a major nutrient source in this region and we are generally blessed by an absence of concentrated animal feedlots and attendant manure generation. One hopes that the crisis in the New England fisheries will have taught the states how to manage their inshore fisheries better. Coastal zone management programs are focusing on wetland and submerged grass bed protection and restoration. As a result of all of this, we may be entering a period of general recovery during which our estuaries may begin to resemble more closely the ecosystems they once were. But warming is a wild card. An interesting experiment is underway.

Lord, Peter B., Providence Journal and Metcalf Institute of Marine and Environmental Reporting, 75 Fountain St., Providence, R.I. 029 02
THE AHUPUA`A CONCEPT OF WATERSHED MANAGEMENT IN HAWAII
Faced with some of the country's worst environmental problems – including loss of species, invasions of exotics, water pollution and land erosion – Hawaii is turning to a concept of watershed management called Ahupua`a that is based on a holistic approach to managing a watershed from the headwaters to the mouth. Key parts of this program included balanced use of resources, recovery periods for resources, recycling, population control and conservation.

CONTRIBUTED PRESENTATIONS

(in alphabetical order)

Adamowicz*, S.C., C.T. Roman. Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 02882;, USGS Patuxent Wildlife Research Center, University of Rhode Island, Narragansett, RI 02882

NEW ENGLAND SALT MARSH POOLS: A SURVEY OF CURRENT CONDITIONS AND AN INITIAL EVALUATION OF RESTORATION EFFORTS IN SOUTHERN MAINE

Salt marsh pools, broadly defined, are depressions within salt marshes that hold water throughout a tidal cycle. Preliminary results of the first quantitative pool survey of 11 New England salt marshes indicate that pools range in size from 0.6 m to over 890 m^2 have steep sides as was described in several qualitative reports and range in depth from a few centimeters to over 70 cm, while median pool depth is only 24 cm. Pool density and other characteristics vary markedly between ditched and unditched marshes. Recent restoration work at the Rachel Carson National Wildlife Refuge in southern Maine, USA employed ditch-plugging as a means of restoring pool habitat. Effects of ditch plugging on pool geography (size, density, nearest pool distance, distance to tidal flow), groundwater levels, surface vegetation, and nekton use were determined by using a modified BACI (Before, After, Control, Impact) design. Despite significant differences in a number of these variables, a complete evaluation of the systems' response to ditch plugging can only be made if monitoring is continued at least intermittently over the next several years.

Beecher*, C. Beth, Gail L. Chmura, Department of Geography (and Centre for Global Climate Change Research); McGill University; 805 Sherbrooke St. W.; Montreal, QC H3A 2K6 Canada

CALIBRATION OF POLLEN ASSEMBLAGES FOR VEGETATION RECONSTRUCTION IN BAY OF FUNDY SALT MARSHES

Our study focuses on three salt marshes on Point Lepreau, located on the New Brunswick coast of the outer Bay of Fundy. Plant cover was determined and corresponding surface soil samples were collected from a series of plant associations spanning low marsh to the forest edge. We compare pollen in each sample to vegetation on two scales. Our large scale corresponds to obvious marsh zonation that usually varies with elevation. Our smaller scale reflects the variability in species cover within a single zone and corresponds to the species cover over the soil sample. The marsh forbs, Spergularia, Potentilla, Lingusticum, Plantago, Triglochin, Limmonium, Glaux, as well as the submergent Ruppia, which are fairly abundant in Fundy marshes, are represented by distinct pollen types. Grasses, sedges or members of the Chenopodiaceae (e.g., Salicornia, Suaeda, and Atriplex) families cannot easily be distinguished below that level. Each plant taxon and its corresponding pollen type are compared using regression analysis which allows us to determine which pollen types are over-represented or under-represented in a pollen assemblage. Plant communities are compared to pollen assemblages using multivariate "distance" measures. Results indicate that paleo-marsh assemblages (in buried soils) reflect the broad marsh zone, and will not be sensitive to highly localized changes.

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SEDIMENT TRANSPORT AND BENTHIC HABITATS IN THE HUDSON RIVER

For the past 2 years the New York State Department of Environmental Conservation and the Hudson River Estuary Program has supported a team of scientists to conduct a high resolution geophysical study of 35 miles of the Hudson River in order to better understand the processes of sediment transport and distribution of benthic habitats. The program has used a broad suite of modern geophysical tools including dual frequency side scan sonar, multi-beam bathymetry with backscatter measurements and CHIRP subbottom profiling complemented by grabs and cores. Sediment deposition in the northern portion of the river is limited to the marginal flats while the coarse fraction is transported in large sediment waves in the channel axis. Sediment waves from 5 centimeters to 3 meters high appear to migrate both upriver and downriver. We estimate the rate of sand wave migration to be on the order of 2 m/year. Most tributaries have distinctive generally elongate coarse-grained deposits at their mouths which can extend over five kilometers along the river margin. In the estuarine portion of the study area recent deposition is restricted to

locations where dredging has occurred within the past century. The data set enabled us to identify some major benthic habitats including broad bands of oyster reefs presently being both buried and eroded. Although some live oysters have been identified the majority of the oysters dated in this region are between 1500 and 6200 years old. In the freshwater portion of the river, zebra mussels are found in many of the sediment samples in the Kingston-Saugerties and Stockport Flats regions. The live zebra mussels were concentrated at the mouths of tributaries and close to bedrock outcrops and were not found in the axial sediment waves.

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A THREAT TO THE CONNECTICUT RIVER ESTUARY: THE AQUATIC INVASIVE PLANT WATER CHESTNUT IS REMOVED FROM A TIDAL COVE AND A TRIBUTARY.

The Connecticut Department of Environmental Protection (DEP) and numerous project partners worked together to restore aquatic habitat in the Hockanum River and Keeney Cove (tidal Connecticut River) through the removal of two recently discovered populations of a non-native invasive plant, water chestnut (*Trapa natans*). During the summer of 1999, less than one acre of water chestnut was found in Keeney Cove, a tidal freshwater embayment along the Connecticut River in Glastonbury. A second and much larger population, estimated at seven acres, was subsequently discovered in the non-tidal section of the Hockanum River, a tributary to the Connecticut River. These plant populations pose a serious threat to the downstream fresh and oligohaline areas of the tidal Connecticut River, which has been designated a "Wetland of International Importance" and an American Natural Heritage River. A particular threat to fisheries resources is the replacement of native submerged aquatic vegetation beds (SAV) by water chestnut in the numerous coves that occur in this river segment. DEP staff hand-pulled the small population in Keeney Cove in 1999, but the larger population in the Hockanum River was discovered in late summer, after the plants had already dropped their seeds. A contractor was hired to harvest the water chestnut plants during summer 2000 at the Hockanum River using an aquatic weed harvester, and staff and volunteers hand-pulled plants in shallow waters at both sites. The Keeney Cove population showed a noticeable decrease in the number of plants after one year of removal efforts. It will likely take five to ten years to eliminate the larger population in the Hockanum River.

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THE ROLE OF ANTHROPOGENIC WATERSHED LOADING AND CLIMATE VARIABLITY ON NITROGEN FLUXES TO THE POTOMAC RIVER ESTUARY

To better anticipate responses of estuaries and coastal ecosystems to human activity and climate variation, it is useful to examine the historical record of nitrogen fluxes from watersheds to receiving waters and the factors affecting them. This study undertook a statistical examination of long-term data sets (approximately 90 years) of monthly nutrient concentrations and stream flow values for the Potomac River Estuary in relation to climate (air temperature, precipitation, and Palmer drought severity index), and nutrient inputs from atmospheric emissions, fertilizer use, and wastewater sources to the watershed. There is a general increasing trend in the yearly nitrate flux over this period. Since the 1920's to the mid-1990's, there has been a three-fold increase in the slope of the nitrate flux vs. river flow relationship, although some years in the 1960's were anomalously low, and some years in the 1980's were much higher. Increased anthropogenic loading increases the nitrogen flux per unit flow. Climate also plays a role in that wet years generally have a higher nitrogen flux per unit flow than do dry years, such as the severe drought of the 1960's. This reduction of nitrogen loading from the watershed during dry years maybe due to storage in groundwater, soils, or plant matter, or it may be lost as a result of denitrification. When comparing droughts of the 1930's with the 1960's, it appears that increased anthropogenic loading amplifies storage or loss.

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DOES THE BIOFILM ON THE BROWN ALGA-*FUCUS VESICULOSUS* BIND COPPER OR ZINC AND REDUCE THE METAL LOAD OF THE HOST PLANT?

A biofilm composed of bacteria, algal cells and molds is commonly found on surfaces in the marine environment including that of the brown alga: *Fucus vesiculosus*. Many of the bacteria in the biofilm produce a capsule or slime layer composed of polysaccharides which are known to "capture" metal ions. Polysaccharides are also produced by algal cells and these also contribute to this biofilm layer. I wanted to learn if the biofilm may be acting as an "exclusion mechanism" and reducing the uptake of copper and zinc by the host plant. To examine this possibility, attached fronds of *Fucus vesiculosus* were gathered at Seapoint Beach, Kittery Point, ME and brought to the Jackson Estuarine Lab in Durham Point, NH. They were added to tanks of unfiltered seawater with added zinc or copper for a period of two weeks. Following this, the surface of a subsample was cleaned with a toothbrush and the material collected for analysis. Thin sections of the tissue were also prepared which were examined using Electron Diffusion System (EDS) and Scanning Electron Microscopy (SEM). Samples of the tissue, matrix material and surface material were also gathered for chemical evaluation. Both methods showed that the biofilm bound up and concentrated the metals and probably reduced the metal load to the host seaweed, although metals were also found in the surface layers of cells of the *Fucus* as well as in the interstitial material. The binding capacity of the biofilm was overwhelmed at the elevated metals concentrations used (20 mg/l either copper or zinc). The *Fucus* plants that were exposed to copper were badly broken down by the time the experiment ended, while the controls and plants with zinc exposure were in better condition.

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THE RELATIVE IMPORTANCE OF CHLOROPHYLL AND COLORED DISSOLVED ORGANIC MATTER (CDOM) IN THE ATTENUATION OF LIGHT IN SHALLOW COASTAL WATERS

Light attenuation in natural waters is caused by absorption by dissolved and particulate materials, as well as particulate scattering. In open-ocean systems, the diffuse attenuation coefficient (c) of the water can typically be predicted from its chlorophyll concentration alone. Our field sampling shows, however, that in shallow coastal systems, the relationship between chlorophyll and light extinction is weak at best. In these environments, colored dissolved organic matter (CDOM) may play a more important role in light attenuation. Using field data from five shallow coastal ponds and estuaries, some patterns emerge that suggest that factors other than chlorophyll are influencing light attenuation. In some cases, an inverse relationship between salinity and attenuation coefficient implicates CDOM, since its primary sources are freshwater run-off and groundwater seepage. This work suggests that prediction of underwater light availability requires routine measurements of CDOM as well as photosynthetic pigments in shallow coastal waters.

Bintz*, Joanne C., Scott W. Nixon, Betty Buckley, Stephen Granger, Susan Sherwood University of Rhode Island, Graduate School of Oceanography

RESPONSE OF COASTAL LAGOON PHYTOPLANKTON, MACROALGAE AND SEAGRASS TO MANIPULATIONS OF TEMPERATURE AND NUTRIENT LOADING

In Rhode Island, USA, coastal lagoons are being subjected to increasing inputs of inorganic nutrients from intensive development. Shallow lagoons are also subject to large inter-annual changes in water temperatures due to climatic variability. Understanding and predicting the ecological consequences of nutrient enrichment in combination with temperature changes in coastal lagoons is complicated by the diversity of plant life found there, including phytoplankton, macroalgae, and the seagrass, *Zostera marina*. An experiment was conducted at a lagoon mesocosm facility to determine if water temperature could be a factor in the eutrophication response of shallow marine systems. Replicate mesocosm tanks were maintained at 4° C above, 4° C below or at the 10-year mean temperature of RI coastal lagoons with or without the addition of 6 mmolN/m^2/d from May to August 1999. Phytoplankton production had a pronounced response to nutrient loading in the early summer. Macroalgal production was stimulated with nutrient loading in both cold and warm water systems in late summer. *Zostera marina* exhibited significant declines in canopy height and survivorship in systems with combined warmer water & nutrient enrichment.

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MODELING ECOSYSTEM RESPONSES TO NUTRIENT INPUTS TO THE WAQUOIT BAY ESTUARINE SYSTEM

A spatially explicit model has been developed to simulate phytoplankton and macroalgae production, nutrient concentrations, benthic recycling processes, and total system metabolism in shallow estuarine/lagoon systems. Through its development, we have explored two distinct methods of modeling phytoplankton growth, a novel macroalgae production formulation, and have incorporated hypsography into water column processes. The model has provided insight to ecosystem responses with regard to inputs of nitrogen from watersheds and direct atmospheric deposition, the potential role of dissolved organic nitrogen inputs, water residence times, and hypsography to three subestuaries of Waquoit Bay, Massachusetts. The modeling process has also allowed us to identify important aspects that require additional research and consideration.

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OFFSHORE NUTRIENT INPUTS AND THE PRODUCTIVITY OF NARRAGANSETT BAY.

The annual cycle of phytoplankton in Narragansett Bay is typically characterized by a marked winter-spring bloom. However, numerous short-term blooms (5-15 mg Chl m-3) occur on the order of days to weeks throughout the summer and account for an estimated 40% of the productivity observed in the bay. These sporadic blooms occur despite low nitrogen concentrations and an insufficient supply of nitrogen from the watershed and pelagic recycling. Recent field surveys have documented an offshore source of nitrogen in Rhode Island Sound bottom water, which is transported into Narragansett Bay through estuarine circulation. Monitoring probes located in the bay indicate that the water column alternates between thermal stratification and mixing on the order of several days. Under stratified conditions, bottom water nutrient concentrations in the lower bay are high, reflecting intrusions of deep RI Sound water. When tidal and wind energy are sufficient to mix the water column these nutrients are made available to the plankton, which may support the frequent blooms and high productivity observed in the bay during summer.

Carabetta*, M. and R.S.Warren, Department of Botany, Connecticut College, New London, CT 06320
HYDROPERIOD, SALINITY, AND SOIL DRAINAGE INFLUENCES ON PHRAGMITES EXPANSION IN TWO UNRESTRICTED TIDAL MARSHES

Historic changes in the distribution of the invasive reed *Phragmites australis* were examined in two unrestricted mesohaline tidal marshes using aerial photographs. The photographs show that the initially rapid expansion of *Phragmites* observed from the mid-1960's through the mid-1980's has slowed, possibly indicating that it has filled the available suitable habitat at these marshes. In order to investigate the factors influencing *Phragmites* expansion, we measured hydroperiod, salinity, REDOX potential, and depth to groundwater at slack low tide in areas dominated by *Phragmites* and in contiguous areas of high marsh dominated by *Spartina patens*. Salinity did not differ between areas dominated by *Phragmites* and areas of uninvaded high marsh at either study site. At the more frequently flooded of the two marshes, areas of uninvaded marsh were submerged by the tides significantly more frequently than areas dominated by *Phragmites*. At the drier site tidal flooding frequency did not differ, but depth to groundwater was significantly deeper and REDOX potential was significantly higher in areas dominated by *Phragmites*. The same trends were observed at the wetter site, however, these differences were not statistically significant. Results suggest that soil aeration, as influenced by flooding frequency and/or soil drainage characteristics, may influence *Phragmites* distribution and expansion patterns at these sites.

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THE EFFECT OF TERRIGENOUS NITROGEN LOADING ON GROWTH RATES OF QUAHOGS (*MERCENARIA MERCENARIA*) AND SOFTSHELL CLAMS (*MYA ARENARIA*) THROUGH CHANGES IN WATER COLUMN AND HABITAT CHARACTERISTICS

Increased nitrogen loading from land-derived sources and resulting eutrophication has been the primary agent of anthropogenic change in coastal waters. These changes may affect shellfish by directly altering

food supply and indirectly altering sediment composition. Increased N loads affect food supply for quahogs and softshell clams because N is the major limiting nutrient for primary production in coastal waters. As a result, increased terrigenous N loading to estuaries increases macroalgal growth and phytoplankton concentrations. Because phytoplankton is a major food source of quahogs and softshell clams, increased phytoplankton chlorophyll concentrations are expected to enhance growth rates of quahogs and softshell clams. Increased N load may also change the sediments in which quahogs and softshell clams live by increasing organic matter from detritus of phytoplankton and macroalgae. N enrichment may result in finer grained, organic rich bottoms which are less preferred for quahogs and softshell clams. Past research has suggested that flow mediated food supply is the primary factor affecting shellfish growth. However, N enrichment may create an environment in which food supply and sediment types may change, affecting growth rates without changes in flow regime. To establish the net result of these contrary effects, we identify and quantify the effects of land-derived N loads on the water column and habitat characteristics of hatchery reared quahogs and softshell clams transplanted into estuaries that differ in N loads due to different types of development within their watersheds. Although water temperature, salinity, depth and water residence times were comparable among study sites, growth rates of quahogs and softshell clams increased as N load increased across estuaries. Correlations between N loading, sediment and water column characteristics and growth rates were explored.

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THE ECOLOGY OF THE JAPANESE SHORE CRAB (*HEMIGRAPSUS SANGUINEUS* DE HAAN) AND IT'S NICHE RELATIONSHIP TO THE GREEN CRAB (*CARCINUS MAENAS*) ALONG THE COAST OF CONNECTICUT, U.S.A.
Since the introduction of the Japanese Shore Crab (*Hemigrapsus sanguineus* de Haan) to the Connecticut coastline *Hemigrapsus sanguineus* has spread at an alarming rate and has become well established on the Connecticut rocky inter-tidal coastline. Its effect on the native crab species is unknown. The purpose of this study still in progress is to obtain baseline data on the relative abundance and distribution of *Hemigrapsus sanguineus* at two sites on the Connecticut Shoreline. Samples of crabs were taken from 5 of 10 one meter square quadrants sampled randomly at each transect line set at low, mid and high tide for a total of 15 samples for each sample period. The placement of quadrants along each 60m transect were chosen based on the substrate uniformity along each transect. Crabs were identified, measured (maximum carapace width [CW]) to the nearest 0.1 mm with hand Vernier calipers, sexed and in female crabs examined for eggs. Crabs were then placed in relative size categories. The abundance, population density and size class distribution for each species recovered from each quadrant was determined. Although no definite conclusion can be drawn at this time, this data provides strong baseline work for future sampling for this study.

Cicchetti*[1], Giancarlo, James Latimer[1], Edward Dettmann[1], Richard McKinney[1], Steven Rego[1], Darryl Keith[1], Russell Ahlgren[1], and Robert Diaz[2] [1]US Environmental Protection Agency, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett RI 02882, [2]Virginia Institute of Marine Science P.O. Box 1346 Gloucester Point, Virginia 23062-1346
EUTROPHICATION OF COASTAL WATER BODIES: RELATIONSHIPS BETWEEN NUTRIENT LOADING AND ECOLOGICAL RESPONSE.
This newly initiated research is intended to provide environmental managers with an empirical method to develop regional nutrient input limits for East Coast estuaries and other coastal water bodies. Our goal is to create an improved model of nutrient load-response relationships. We will estimate nutrient loading with land use/GIS models, adjusted to estuarine flushing times. A combination of four indicators (chlorophyll-a, SAV coverage, sediment profile imagery, and epibenthic macrofauna), taken either individually or as a multidimensional index, will be used to assess system response to nutrient overenrichment and allow comparisons among systems. Specifically, time-averaged remotely sensed chlorophyll-a data will assess the water column biomass response. Seagrass coverage will examine the shallow-water benthic response. Sediment profile camera images will assess benthic condition in deeper water. Benthic surface video imagery will provide an assessment of epibenthic macrofaunal community structure. Within an estuarine system, the combination of all four variables is designed to provide good spatial coverage. We will initially minimize latitudinal variation in this model by examining estuaries, sub-estuaries, and other embayments in southern New England. Once nutrient load-response relationships are successfully formulated for this

region, we will expand this approach to other areas of the East Coast. The expected research results will be delivered in stages, with each successive stage refining the scientific basis for management decisions. The first stage will be development of a method to determine if a system has a eutrophication problem. In this talk, we will present a preliminary model that includes three of the four response variables for nine systems in Narragansett Bay, & discuss the applicability of our approach to future efforts in Southern New England

Concascia, Robert, David Scott, and John Swenarton. Clark Lane Middle School & NU Environmental Lab
LONG TERM MONITORING COMBINED WITH ENVIRONMENTAL EDUCATION
Clark Lane Middle School has sustained an active interest in coastal marine issues throughout the last twenty-nine years. Much of that time work has been carried out on the Niantic River and other Waterford sites. Students have monitored a variety of chemical, physical and biological parameters during many of those years. Active student interest and participation along with an appreciation of the coastal environment have been the major goals. We have accumulated a body of data stretching for over twenty years. This year a collaboration between Clark Lane and the Millstone Power Station has pulled together much of this data. A general presentation of our initial findings and presentation of the data for use by others is planned.

Crawford, R. Woods Hole Oceanographic Institution, Woods Hole, MA
MONITORING IN AN ESTUARY: MATCHING SCALE OF OBSERVATIONS TO DYNAMIC STABILITY IN ESTUARINE CIRCULATION
The realization that estuaries are exceedingly affected by human activity has spawned a new generation of monitoring devices that record repeated measurements of water conditions. The amount of data being gathered continues to expand. Unfortunately, the process of examining why and how monitoring should be undertaken tends to be neglected. Designs ought to include considerations of temporal and spatial variability and appropriately matching sampling effort to their scale. Unfortunately, information about this variability is rarely available. This talk examines by way of example the issue of whether an initial evaluation of this variability is justified. While I was conducting a project that required monitoring environmental conditions in a eutrophic estuary (Waquoit Bay, Cape Cod), I examined patterns of hydrologic structure. Relating field measurements to a 2-dimensional hydrodynamic model revealed details about a complex yet persistent pattern of gyres that are driven by wind and tidal forces. Knowledge of these gyres is essential to the success of a monitoring program as well as to the broad area of estuarine research in general. It is argued that this type of preliminary assessment ought to be broadly incorporated into the practice of estuarine research, monitoring or otherwise.

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MODEL SEEKS DATA FOR MUTUAL GRATIFICATION
We are investigating the role of watershed development in the eutrophication of shallow coastal lagoons using an ecological simulation model. Our focus is shallow systems a few meters in depth, which are usually highly productive. They generally exchange ocean water via constricted inlets and are often severely stressed by anthropogenic development and activies. Our model tries to predict the relative contribution of seagrasses, macroalgae, and phytoplankton as producers, growth of macroalgae, and the frequency of anoxic events as a function of nutrient loading.
Data from Waquoit Bay have been used to parameterize the model. We currently have data for 9 additional sites to evaluate the model's generality. In MA: Inner Apponagansett Bay, Sippican Harbor, Red Brook Harbor, Buttermilk Bay; in RI: Ninnigret Pond, Quonochontaug pond, Pawcatuck River; in CT: Mumford Cove, and Niantic River. Data for these sites include watershed area and land use, bay size, flushing rate, depth and hypsography, meteorological data, plus summer estuarine surveys of DIN, PO4, Chl-a, macroalgae and macrophyte densities, sediment organics, profiles of salinitiy, temperature, light, oxygen. We would welcome any additional data from these or any other coastal lagoon sites that may help us determine loading responses for these highly variable environments.

Dettmann*, E.H. and H.A. Walker. U.S. Environmental Protection Agency, National Health and Environmental Effects Laboratory, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett, RI 02882.
EFFECTS OF NITROGEN LOADING, FRESHWATER RESIDENCE TIME, AND INTERNAL LOSSES ON NITROGEN CONCENTRATIONS IN ESTUARIES

A simple model is presented that uses the annual loading rate of total nitrogen (TN) and the water residence time to calculate: 1) average annual TN concentration and internal loss rates (e.g. denitrification and incorporation in sediments) in an estuary, and 2) the rate of nitrogen export across the seaward boundary. Similar to Vollenweider's calculations for phosphorus concentrations in lakes, the model calculates the annual mass balances of TN in estuaries, and has been applied and calibrated by using field data for 11 North American and European estuaries having a broad range of characteristics. It has also been used to calculate TN concentrations in 18 small side-embayments of Buzzards Bay, Massachusetts. Results show strong relationships between freshwater residence time and the fractions of nitrogen that are exported, denitrified, and permanently incorporated into sediments. The relatively small data requirements of the model may suit it particularly to management applications in small estuaries. Some applications include: model-calculated TNv concentrations as predictors of other indicators of trophic state, such as peak chlorophyll *a* concentration and peak macroalgal abundance; and a preliminary analysis of interannual variations in TN concentration and net export of TN in response to changes in nutrient loading and freshwater residence time in the Potomac estuary.

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BASELINE DISTRIBUTION OF CONTAMINANTS AND EVIDENCE OF STORM IMPACT IN QUONOCHONTAUG POND, RHODE ISLAND

An understanding of baseline conditions is critical in order to gauge the relative impact on a system of both gradual changes incurred through time and more episodic and catastrophic changes such as storms or oil spills. In the summer of 1999, inorganic and organic contaminants were examined in 17 surface sediment samples and one piston core from Quonochontaug Pond, Charlestown and Westerly, Rhode Island, a micro-tidal coastal lagoon. The surface sediments were analyzed for grain size, organic carbon content, organic contaminants including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides (such as DDT), and total petroleum hydrocarbons (TPHs), and metal contaminants Al, As, Cd, Cr, Cu, Hg, Fe Mn, Ni, Pb, Ag, and Zn. Surface contaminant distribution is being correlated with proximity to streams and the circulation within the pond. The contaminants are higher in the eastern and western ends of the pond. Since a man-made tidal channel (a breachway) enters the pond near the center, the contaminant data supports the suggestion that the central area is better flushed than the eastern or western ends. Also, streams enter the pond at the eastern and western ends, and may influence the contaminant distribution. The piston core was measured for the same parameters as the surface samples, as well as magnetic susceptibility. The susceptibility and organic carbon data correlate closely, with decreases in organic content reflected in increases in susceptibility. These layers also correspond with changes in the lithofacies and the concentration of various organic and inorganic contaminants. It is possible that these intervals represent storm events, and that the effect of the storms is recorded in the sediments. We plan to undertake multidisciplinary studies of sediment cores (dating, geochemistry, and fossils) to interpret the effects of major storms on coastal pond habitats.

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TROPHIC "INWELLING" IN A SHALLOW ESTUARY: SENGEKONTACKET POND, MARTHA'S VINEYARD.

Mass balances of dissolved and particulate nutrient materials were prepared for Sengekontacket Pond, an estuary off Nantucket Sound on Martha's Vineyard, during the summer of 1994. Water samples for analysis were collected over six days time at 2-hour intervals and tidal fluxes were determined using electronic instrumentation, sampling water surface elevation and salinity at 6- to 15-minute intervals. Not surprisingly, balances indicated a net export of freshwater and of dissolved silica. However, they also indicated a net tidal export of dissolved phosphorus and dissolved nitrogen species. Both particulate carbon and particulate nitrogen were also exported in net flux but chlorophyll a was imported into the estuary from Nantucket Sound. Diurnal oxygen curves and L-D bottle experiments suggest net primary productivity within the estuary was negative. Thus it appears not all estuaries are net sources of primary

productivity relative to the adjacent sea. Nevertheless, this estuarine system sustains an active shellfishery and no doubt serves as a significant nursery and habitat for fishes and invertebrates.

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TIDAL PULSING, ENVIRONMENTAL VARIABILITY, AND PHYTOPLANKTON DYNAMICS IN THE MYSTIC RIVER ESTUARY, CT
An ecosystems-level study of the Mystic River estuary, CT, USA was performed during the summer of 1999 to examine how short-term environmental variability, induced by pulses such as tidal cycles and storm events, influenced short-term variability in phytoplankton dynamics. Fluorescence measurements used to monitor phytoplankton biomass throughout the estuary exhibited a pulsing pattern over an approximately two-week cycle, with peak magnitudes increasing as the summer progressed. The timing of this pulsing suggested a coupling between variations in tidal energy subsidy over the neap-spring tidal cycle and phytoplankton growth patterns. Regression analysis showed a second-order fit between tides and fluorescence with phytoplankton biomass being maximized at intermediate levels of tidal energy. Resuspension of benthic nutrients by tidal mixing appeared to be one major effect of tides in driving variability in phytoplankton biomass. In mid-August, the synchronization of a storm pulse and the tidal cycle pulsing coincided with a period of high levels of phytoplankton biomass. Throughout the summer, the strength of environmental pulses dampened going down the estuarine gradient, and the highest phytoplankton biomass was found in the upper part of the river where environmental variability was greatest. Tidal fluctuations induce periodic short-term variability in physical and chemical conditions, and tidal pulsing appears to be an important, regular, external pulse driving short-term variability in phytoplankton dynamics in the Mystic River estuary.

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DIFFERENCES IN PROPERTIES OF SALT MARSH SEDIMENT BETWEEN HAYED AND REFERENCE SITES
The practice of haying salt marsh grasses began in colonial times and continues today in some areas. Current haying removes more than 90% of aboveground plant biomass and could have a number of effects on processes within the marsh. This study examines the effect of detritus removal on several sediment properties to assess the long-term effects of haying. Sediment cores were taken from Plum Island Sound inter-tidal marsh, a long term ecological research site located in northeastern Massachusetts. We measured the bulk density, percent organic matter, total sulfur, sedimentation rates, and total phosphorus of sediment in areas where the grass is hayed by commercial farmers. We compared these results to those of reference areas, which are not hayed. Current haying practices did not significantly alter most of the properties we measured. There was no significant difference in bulk density between the surface sediments of the hayed and reference sites. Similarly, there was no significant difference in percent organic matter, total sulfur, and sedimentation rates between the hayed and reference sites. There was a significant difference between total phosphorus measured in hayed and reference sites. The difference in phosphorus between hayed and reference areas could be due to the low input of phosphorus to the marsh. We will next measure nitrogen in the sediment of hayed and reference sites to examine the effects of haying on another essential nutrient in the system.

Haines*, Jamie R., Center for Conservation Biology and Enviornmental Studies, Connecticut College, New London, CT 06320, Matthew Cieri and Linda Deegan, The Ecosystem Center, Marine Biological Laboratory, Woods Hole, MA 02543
FOOD CHOICE CONVERGENCE OF BENTHIC AND PELAGIC FISHES ALONG AN ESTUARINE GEOMORPHOLOGICAL GRADIENT
The mummichog, *Fundulus heteroclitus*, and the Atlantic silverside, *Menidia menidia*, are two of the most abundant fish species in New England estuaries. Mummichogs are found in association with the benthos and are considered part of the benthic food web, while silversides tend to live higher in the water column and are considered part of the pelagic food web. It is suggested that these fish feed solely within their respective habitats. Consistent with this model, stable C and N isotope analysis in the Rowley River differ between the two species captured in deeper downstream areas. In shallow upstream sites, however, C and N

ratios converge. This study tests the hypothesis that the stable isotope convergence reflects a convergence of food choice along the geomorphological gradient. Mummichogs and silversides were collected at 1-kilometer increments, from the mouth at 8K to 14K, along the Rowley River, Plum Island Sound, Massachusetts. All fish were counted and a sub-sample was taken for size distribution and gut content analysis. Contents were identified to the lowest possible taxon; gut composition and fullness were assessed quantitatively. Mummichogs consumed primarily benthic food items throughout the gradient, including detritus, amphipods and isopods. Silversides consumed a larger proportion of benthic foods when captured in shallower, up-river waters. The abundance of shrimp and harpacticoid copepods in the stomach contents of silversides moving up river suggests that this species is not an obligate pelagic feeder, but a versatile, opportunistic predator, able to take advantage of other available food sources. Mummichogs are primarily benthic feeders, with few occurrences of pelagic prey. These changes in food choice by silversides suggest an increase in the importance of benthic food resources in shallow upstream areas of the estuary for this species.

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MANAGING TROUBLED DATA: GETTING COASTAL MONITORING DATA SYSTEMS TALKING TOGETHER
Making assertions about the condition of New England estuaries requires the use of many different data sets, collected by different groups for various purposes, and managed in numerous ways. One way to achieve data comparability is for data collectors to agree to a common data collection protocol. The Coastal 2000 program uses such a protocol for water column measurements, sediment chemistry, and fish and invertebrate communities from eight northeastern coastal states. Data are managed by use of existing or enhanced systems and are brought together into a consistent database for region-wide analyses. The database, with querying and mapping tools, will be put on the Web for use by all.

Hampson, G.R., Department of Biology, Woods Hole Oceanographic Institution, Woods Hole MA. 02543.
DESTRUCTION AND RECOVERY OF THE WINSOR COVE, CATAUMET SALT MARSH FROM A #2 FUEL OIL SPILL: A 25 YEAR HISTORY.
The goal of this study, initiated in 1974, was to document the mortality of a salt marsh community and invertebrates, and to follow the recovery of an oil impacted salt marsh. Winsor Cove salt marsh is located within the estuary of Buzzards Bay in Bourne, Massachusetts. This accident was the result of a # 2 fuel oil spill which occurred on October 9, 1974. The study site was initially monitored for 3 years and the findings were published in the Fisheries research Board of Canada (Hampson,Moul 1978). It was noted at that time that the marsh was undergoing additional changes extending well beyond the initial findings. These changes occurred both in marsh species composition and erosion caused by the mortality of holdfasts (roots) plus tidal exchange and storm action. Additional field studies were carried out over the years 1990,1992, 1994, and 1999 to document ongoing changes to the marsh. To help finance this research, support was obtained from the Woods Hole Oceanographic Institution innovative high school science program, which made this long term study possible.

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THE PATH OF TOTAL DISSOLVED NITROGEN IN AN INTACT COASTAL FOREST, EDGARTOWN, MASSACHUSETTS
Land use changes can influence the amount and forms of nitrogen (N) that flows in groundwater from coastal forests to estuaries. It is important to study N concentrations in the groundwater of intact, undeveloped forests as a baseline against which concentrations in more developed coastal areas can be compared. In an undisturbed 150-acre forest located on Job's Neck peninsula in Edgartown, Massachusetts, we examined: (1) How do the forms and concentrations of dissolved N change in water that flows from the forest to the estuary? and (2) How do spatial differences in vegetation and topography affect the forms and concentrations of N along this same flowpath? During June, July, and August 2000, we measured ammonium (NH4 nitrate (NO3 and total dissolved N concentrations in precipitation, throughfall, groundwater under the forest, and seepage face water along the edge of the estuary. We also characterized the vegetation at the seepage face. We found that total dissolved N concentrations were 63.59 uM in

groundwater under the forest and 93.57 uM in seepage face water. DON was approximately 80% of the total dissolved N. N concentrations were nearly identical in seepage face water sampled in the groundwater flowpath up- and down-gradient of three coastal marshes, indicating that shoreline vegetation type may have little influence on the N concentrations of water reaching the estuary from the forest. These data can serve as a comparison for areas of the Cape and Islands altered by residential development. They will also form a baseline to document changes that take place when part of this forest is cut and burned in a habitat restoration project by The Nature Conservancy and The Marine Biological Laboratory.

Hinga, K.R. Graduate School of Oceanography, Univ. of R.I., Narragansett, RI 02882.
IMPROVED PREDICTIONS OF BIODEGRADATION RATES OF LOW MOLECULAR WEIGHT AROMATIC HYDROCARBONS IN COASTAL SEDIMENTS.
Observations from the *North Cape* oil spill indicate that the degradation rates of low molecular weight polycyclic aromatic hydrocarbons (LMW PAH) in subtidal coastal sediments correlate with sediment total organic carbon (TOC). Degradation rates were slower with higher TOC. Using that concept, a model was developed to predict the concentrations of LMW PAH over time. The model also uses a time-varying degradation rate to account for seasonal changes in temperature and for a short-term response to hydrocarbon introductions. The shape of the time-variable degradation rate, and a base degradation rate were derived from MERL marine enclosure experiments with fuel oil. The quantative predictions of the model are completely independent from the *North Cape* data and may be applied to other coastal areas. The model was tested against field data from the *North Cape* spill and was found to greatly improve accuracy of predictions over other models.

Holt, E.R. Dept. of Biology, University of Massachusetts, Boston. Boston, MA 02125
THE IMPORTANCE OF MARSH SIZE IN THE DISTRIBUTION OF SALTMARSH SHARP-TAILED SPARROWS - IMPLICATIONS FOR SALT MARSH MITIGATION.
Saltmarsh Sharp-tailed Sparrows (*Ammodramus caudacutus*) are salt marsh obligates whose distributions may be influenced by marsh size. In New England, flooding of the marsh surface occurs at least once a month, and is the major cause of nestling mortality. The frequency of that flooding is dependent on microtopography, and is broadly indicated by changes in dominance between *Spartina alterniflora* and *S. patens*. These salt marsh graminoids can thus be expected to be a major predictor of Sharp-tailed sparrow density. Fifteen transects of various lengths were located on 10 marshes on Cape Cod and subdivided into a total of 118, 50x100m sections. These were surveyed first for *A. caudacutus* and subsequently for plant composition and structure, distance to upland and lineal meters of water bodies. *A. caudacutus* distributions were highly clumped in space. Predictive analytical techniques were largely confined to Spearman's Rank Correlation Coefficients. As expected a positive correlation was found between *A. caudacutus* and either *S. patens* alone, or all high marsh graminoids together. Surprisingly a positive correlation was also found with the distance of the section surveyed to upland vegetation. This has important implications for salt marsh conservation and mitigation. COLLABORATORS ARE SOUGHT to help test these findings using nonparametric techniques (perhaps using Negative Binomial or other Poisson distributions), and to add data that may be available in GIS format.

Horowitz*, J.D., L.Deegan, R. Garritt. School of Natural Science, Hampshire College, Amherst, MA 01002; and Ecosystems Center, MBL, Woods Hole, MA 02543.
STABLE ISOTOPIC ANALYSIS OF FOOD WEBS IN HAYED AND REFERENCE SALT MARSHES
Hay has been harvested from New England salt marshes (*Spartina patens*) since colonial times. *Spartina* detritus is an important basis of the salt marsh food web and its removal by haying may affect marsh food webs. As a result of haying, 80-90% of the above-ground grass biomass is removed, and more light reaches the marsh surface thus potentially increasing the importance of algae in the food web. To test this idea, we measured the changes in plant standing stock and food webs in six reference and three hayed saltmarsh areas in Plum Islands Estuary, MA. Marsh surface chlorophyll a was higher in the hayed areas in May compared to the reference areas indicating higher benthic algal biomass. We used carbon and nitrogen stable isotopes to examine the effects of haying on food webs. Delta 13C was lower in *Melampus bidentatus* (by -2.8 00/0), *Orchestia grillus* (by -1.2 00/0), and *Ilyanassa obsoletus* (by -1.1 00/0) in hayed compared to reference sites. This shift in delta 13C isotopic content may indicate more algae in the diets of these organisms in the hayed areas. Several other animals, *Fundulus heteroclitus, Menidia menidia,*

Palaemonetes sp., Nereis virens, Littorina sp., and Philoscia sp., did not show a negative isotopic shift. This difference between species may be due to varying trophic position, habitat in the marsh system, and feeding ecology.

Hughes*, J. E., L. A. Deegan, J. E. Costa. Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA 02543; and Buzzards Bay Project, Massachusetts Coastal Zone Management, Wareham, MA
THE RELATIONSHIP OF WATER QUALITY TO FISH COMMUNITY STRUCTURE IN SOUTHEASTERN NEW ENGLAND ESTUARIES
We applied the Estuarine Biotic Integrity Index (EBI) to 36 sites in 16 estuaries on Cape Cod and in Buzzards Bay, Massachusetts USA. Two estuaries were sampled in 6 years, from 1988-1999 (Waquoit and Buttermilk Bays), and a total of 14 others in Buzzards Bay were sampled in 1993, 1996 and 1998. Habitats at each site were classified as either low- or medium-quality by density and biomass of submerged rooted vegetation (eelgrass) and the relative biomass of macroalgae to eelgrass. The EBI and its metrics (fish abundance, biomass, total species, species dominance, life-history, and proportion of the EBI and its metrics in classifying habitat quality occurred when eelgrass habitats were least degraded. Progressive loss of eelgrass was associated with declining values of the EBI in medium-quality habitats. The relationship of the EBI to an independent measure of water quality - the Eutrophication Index - demonstrated inherent time lags between the degradation and improvement of water quality and response of the fish community.

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SPATIAL RELATIONSHIPS AMONG NATURAL PROCESSES, HUMAN IMPACTS, AND BENTHIC COMMUNITY STRUCTURE IN NEW HAVEN HARBOR, CONNECTICUT
New Haven Harbor is an essential element of Connecticut's coastal landscape. However, the harbor and its surroundings reflect centuries of development, which has resulted in a diverse mix of habitats which vary greatly in their disturbance history. Few researchers have studied the benthic biology of New Haven Harbor. Therefore, we are examining the patterns of benthic community structure in New Haven Harbor, and exploring relationships between the spatial distribution of benthic communities, shoreline landuses, and benthic habitat characteristics. Because the harbor is influenced by tides, freshwater inputs, and various coastal processes, the challenge is to determine the relative importance of natural processes and habitat characteristics versus human activities and habitat modifications in shaping benthic communities. Therefore, several areas within the harbor, including subtidal and intertidal habitats, are being sampled, and analyzed in a variety of ways. It is hoped that this study will provide an up-to-date baseline for future studies of benthic communities in New Haven Harbor. In addition, a GIS database is being developed, which incorporates research from past studies, and from this work.

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SPAWNING DENSITIES AND POPULATION DEMOGRAPHICS OF HORSESHOE CRABS FROM PLEASANT BAY, CAPE COD BAY, AND MONOMOY NWR, MASSACHUSETTS.
In the summer of 2000, surveys of spawning horseshoe crabs (*Limulus polyphemus*) were conducted on Cape Cod, MA. Sites were located within Pleasant Bay (PB), Cape Cod Bay (CCB), and Monomoy National Wildlife Refuge (MNWR). Average spawning density was higher in PB (1.04 crabs/25 m2 and MNWR (0.92) than in CCB (0.27). Spawning index was also higher in PB (0.33 female crabs/25 m2 than in CCB (0.07). Female to male sex ratio was higher in PB (1:4.5) than in CCB (1:3.1). Additionally, 2000 crabs (1000 each in CCB and PB) were tagged with double-T-Bar anchor tags and prosomal width, sex and age were recorded. Mean prosomal width of young female crabs, and young and middle aged male crabs were significantly larger in PB than those found in CCB. To date 110 tags have been reported, primarily from the general public and Associates of Cape Cod, a biomedical facility. The return rate for crabs tagged in CCB was higher (7.8%) than in PB (3.3%) presumably due to the greater recreational use of beaches at the CCB study area.

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SEASONAL VARIATION IN GROUNDWATER FLUX AND DISPERSION IN A TEMPERATE ESTUARY USING RADIUM ISOTOPES AS TRACERS

Quantifying seasonal variations in groundwater input and mixing is important for evaluating hydrological balances and the input of dissolved chemicals to the coastal zone. Radium isotopes are useful tracers in this regard as they provide an integrated measure of the large-scale input of submarine groundwater and its dispersion into the coastal ocean. In this study 226Ra (half-life 1600 y, 228Ra (half-life 5.75 y), and 224Ra (half-life 3.6 d) have been used to evaluate groundwater input and horizontal mixing over an annual cycle in the Pettaquamscutt River Estuary, RI. Large-volume samples were collected along the salinity gradient at five locations at approximately monthly intervals from June 1999 - June 2000. Radium isotopes were extracted from solution using MnO2 impregnated cartridges and quantified by gamma non-conservative distributions, with elevated activities observed at brackish salinities. Excess radium is attributed to advection of Ra-enriched pore waters from sediment and adjacent salt marsh aquifers. Using a simple box model and 226Ra and 228Ra activities, groundwater fluxes were determined to be highest during summer 1999 (8-34 L m2/d (upper- lower estuary, 3 month average), decreasing through the fall (7-15 L m2/d) and reaching a minimum during the winter (5-6 L m2/ d). Values increased through spring 2000, approaching levels observed the previous summer (1-10 L m2). The implication is that input of groundwater and associated chemicals (e.g., nutrients, trace metals, DOC) may vary significantly on a seasonal basis, possibly as a function of rainfall. Horizontal eddy diffusion coefficients calculated from 224Ra distributions ranged from 3400 m2/ s in the summer of 1999 to 10 m2/s in the winter. Taken together, these results indicate a marked seasonality in the input of groundwater and its dispersion from the estuarine regime to the coastal ocean.

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THE INFLUENCE OF WATERSHED LAND USE AND VADOSE ZONE THICKNESS ON THE QUANTITY AND LABILITY OF ORGANIC NITROGEN TRANSPORTED BY GROUNDWATER TO COASTAL WATERS

Dissolved organic nitrogen (DON) frequently comprises the major portion of nitrogen loads to estuaries. However, controls on the quantity of DON loaded are not known, and it is not known how much of this DON is biologically available (labile). Protocols for modeling nitrogen loads either do not include DON (and therefore to the extent that DON is labile they underestimate N loads) or they include all of the DON (and therefore overestimate biologically available N loads).

The objective of this work is to define how the quantity and lability (based on bacterial batch incubations) of terrigenous DON, transported to estuaries by groundwater flow, are influenced by watershed land use mosaics and geological characteristics. We are using variations in land use and vadose zone thickness within the watersheds of several estuaries on Cape Cod, Massachusetts as a regional-scale experiment in terrigenous N loading. Preliminary results suggest that 1) increasing urbanization decreases the quantity of DON exported from watersheds while increasing the percentage that is labile, and 2) increasing vadose zone thickness decreases both the quantity and lability of exported DON.

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HISTORIC AND RECENT SEASONAL CHANGES IN ANTHROPOGENIC TRACE METAL CONTAMINANTS IN NARRAGANSETT BAY, RHODE ISLAND SEDIMENTS

Extensive surveys of the contaminants in the sediments of Narragansett Bay were performed between 1988-1989 and 1997-1998. A comparison of the two data sets indicated that there was a general trend of decreased trace metal (cadmium, copper, lead, nickel and zinc) concentration in the northern portion of the Bay (Providence River) and increased trace metal concentration in the upper-middle portion of the Bay. An on-going study is currently being performed to assess the impact of seasonal and episodic (storms, ship activities) events on the resuspension and remobilization of contaminants in the Bay. Surface sediments were collected and sediment traps were deployed in the late fall of 1999, winter of 2000, and spring of 2000. Based on sediment trap studies, the accumulation rate between the winter and the spring collections was much higher than the accumulation rate between the late fall and winter. Surface sediments and sediment trap material were analyzed for trace metal concentrations and grain size. In general, there were

higher trace metal concentrations in the Providence River and lower trace metal concentrations down the Bay. Trace metal concentrations were normalized by grain size to determine trends independent of lithology. Normalized sediment trap sediments had higher trace metal concentrations than the normalized surface sediment concentrations from the upper-mid Bay stations indicating that more highly contaminated sediment is being transported into that region. Surface sediments were also analyzed for acid volatile sulfide (AVS) and concentrations (which vary seasonally) to SEM concentrations can give an indication of the potential bioavailability of the trace metals. The SEM-AVS data shows some seasonality to the trace metal bioavailability. The only positive SEM-AVS values (indicating potential bioavailability) were from the sediment from four stations during the spring collection.

Lewis*, J.L., S. Pianka, D.T. Osgood, Dept of Biology and Environmental Science, University of New Haven, West Haven, CT 06437; Chambers, R.M. Dept. of Biology, Fairfield University, Fairfield, CT 06430; and Yozzo, D.J. Barry A. Vittor and Associates, Kingston, NY 12401,
DOES PHRAGMITES EXPANSION INFLUENCE NEKTON HABITAT UTILIZATION?
Phragmites australis (common reed) invasion into tidal wetlands could influence wetland function. We quantified the impact of *P. australis* on spatial and temporal distribution of nekton along the tidal creek/marsh surface gradient at Iona Island, Hudson River, NY. We specifically measured the effect of tidal creek characteristics (submerged structure, light intensity, dissolved oxygen, temperature) and marsh surface tidal stage (ebb, flood, slack high) on species diversity and size class distribution of nekton within *P. australis* and *Typha angustifolia* (cattail). Measurements were made along three transects in each vegetation type with stations at the tidal creek, the low marsh and the high marsh. Preliminary results have shown that marsh surface nekton (virtually all *Fundulus heteroclitus*) are more abundant in *T. angustifolia* (182 individuals) compared to *P. australis* (42 individuals). Differences in abundance are not reflected in lift net densities of nekton caught at the same site. This implies that nekton are not evenly distributed on the marsh surface. Out of the total 1323 nekton caught in the tidal creek there was a trend of more *F. heteroclitus* caught adjacent to *T. angustifolia* (641 individuals) compared to *P. australis* (455 individuals). Species diversity was higher within the tidal creek adjacent to *P. australis* stands (12 species) relative to the tidal creek surrounded by *T. angustifolia* (5 species). To date the tidal creek characteristics have shown no consistent trends between vegetation. *T. angustifolia* appear to support a higher abundance of *F. heteroclitus* in both tidal creeks and on the marsh surface. In contrast *P. australis* may support a more diverse tidal creek nekton community.

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SPATIAL PATTERNS OF NEKTON USE WITHIN PHRAGMITES AND SPARTINA HABITAT ON THE HOUSATONIC RIVER, CT.
Phragmites australis invasion into tidal marshes could influence wetland function, including use of the marsh surface by fish and invertebrate species. Nekton density and tidal flooding were measured at varying distances (5-13 m) from tidal creeks in adjacent *Phragmites* and *Spartina* habitat. Bottomless lift net collections conducted monthly from April - August showed lower nekton density in *Phragmites* (1.2 m2) relative to *Spartina* (2.9 m2) stands. Within *Phragmites* stands, nekton density did not vary significantly with distance from the creek edge. Longer average flooding duration within and between vegetation stands (3.7 - 5.6 h tidal cycle/ m for *Spartina*, 1.0 - 2.6 h tidal cycle/ m for *Phragmites*) corresponded with higher nekton distribution. In contrast, flooding depth was lower in areas with higher nekton density. Specific attributes of tidal flooding may therefore be important in predicting spatial patterns of nekton utilization on the marsh surface. Previous research has shown that nekton utilization in Phragmites and non-Phragmites habitat is comparable adjacent to tidal creeks. Hydrogeomorphic characteristics (increased elevation, reduced flooding duration) may result in reduced nekton access to interior Phragmites habitat.

Peck[1], Myron A., Timothy R. Gleason[2], and David A. Bengtson[3]. [1]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 02882; [2] US EPA, Atlantic Ecology Division, Narragansett, RI; [3] Department of Fisheries and Animal Veterinary Science, URI, Kingston, RI.
PROJECTED POPULATION-LEVEL EFFECTS OF PENTACHLOROPHENOL EXPOSURE ON THE INLAND SILVERSIDE, MENIDIA BERYLLINA,
The population-level response of inland silversides, *Menidia beryllina* (Cope), to pentachlorophenol (PCP) exposure was projected using a stage-classified matrix model and laboratory bioassay results. Acute PCP effects on survival and fecundity were used to directly model acute PCP effects. Somatic growth rate reductions were used to model chronic PCP effects, through modification of field estimates of length specific overwinter survival and fecundity for this species in the Pettaquamscutt River Estuary in southern RI. The dose-specific effect of PCP was determined by projecting inland silverside population growth rate at five concentrations of PCP. In both cases, projected population growth rate was inversely related to PCP concentration. When including only acute PCP effects in the model, a classic sigmoidal dose-response relation was evident, whereas a linear dose-response relation was observed when chronic effects were added to the model. Reduced individual fish growth associated with exposure to PCP markedly reduced the predicted overwinter survival and reproductive potential of a population of this estuarine fish in southern RI, USA. Results of this study, assessing the population-level effects of PCP on inland silversides, emphasize the importance of incorporating aspects of the ecology and life history of an organism within single-species toxicological population modeling.

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DINOFLAGELLATE CYST RECORDS AND HUMAN DISTURBANCE IN NEW BEDFORD HARBOR AND APPONAGANSETT BAY ESTUARIES, MASSACHUSETTS (USA)
We studied the dinoflagellate cyst records in sediments from New Bedford Harbor and Apponagansett Bay over the last 350 yr to determine if cysts are sensitive to environmental change caused by human activity in the watershed. Changes in the total number, and absolute and relative abundance of dinoflagellate cyst taxa reflect main periods of historical development in estuaries. The most dramatic change in the dinoflagellate cyst record in New Bedford Harbor occured within the past 40 years. In the late 1960s, the total cyst abundance in the harbor reached its maximum, while the total number of cyst taxa decreases from 25 to 16. We hypothesize, that these changes are related to human activity in the harbor and in the watershed, and represent a "pollution" signal. We suggest that construction of the hurricane barrier across the harbor in the 1960s induced major changes in dinoflagellate population recorded in the cyst assemblages. Quantitative and qualitative analyses of dinoflagellate cysts indicate that they can be used as biological indicators of environmental conditions in estuarine systems.

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LONG-TERM RECOVERY AND FLUCTUATION IN AN EELGRASS (*ZOSTERA MARINA*) POPULATION IMPACTED BY COMMERCIAL OYSTER CULTURE
Low-intertidal eelgrass populations were decimated by commercial oyster culture in four experimental plots in the South Slough NERR in the Coos Bay, Oregon estuary. Following oyster harvest in 1992, eelgrass abundance and biomass increased rapidly over the next year, and were enhanced by transplantation of eelgrass shoots into oyster-harvest plots, until abundance and biomass nearly converged with adjacent control plots. In the seven years since that convergence, eelgrass abundance, biomass, and biomass per shoot have shown some between-year fluctuation, but have generally continued to increase, while macroalgal biomass has generally decreased. Interestingly, adjacent control plots of eelgrass have also fluctuated but generally shown increases in biomass and biomass per shoot, as well as decreases in macroalgal biomass and in eelgrass shoot abundance. Longer-term decreases in macroalgal biomass after oyster harvest may be a consequence of loss or burial of shells and other hard-substratum attachment surfaces, while increases in shoot abundance, biomass, and biomass per shoot may reflect a progressive, multi-year return to mature eelgrass population structure in former oyster-culture areas. The longer-term changes in the adjacent control plots suggest either that oyster culture impacts even the nearby eelgrass community in negative ways or that regional, multi-year fluctuations in the population structure occur on a significant scale.

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RESPONSES OF FIDDLER CRABS (*UCA SPP.*) TO PATCH STRUCTURE IN DISTURBED AND UNDISTURBED SALT MARSHES

Fiddler crabs are fairly ubiquitous in northeastern salt marshes, and can play critical functional roles in trophic and biogeochemical marsh dynamics. They primarily occupy creek banks, mosquito ditches and can be found in pannes in upper marsh areas. Many salt marshes along the Connecticut coast have been disturbed (e.g. tide gates) creating more complex patch structures, with typical marsh zonation becoming less evident. The altered structure of the salt marsh landscape may change the behavioral and physiological responses of certain organisms, and in turn their population distributions and abundances. We are conducting a study of fiddler crabs (*Uca spp.*) in Sybil Creek, a tidally altered salt marsh in Branford, CT, to explore their distribution and abundance relative to patch structure. We are also analyzing our data in order to determine if there are ontogenetic differences in patch use, and how the patches are utilized relative to their size, form, and location on the marsh. Our initial analyses suggest that most individuals are found along creek banks. However, significant numbers of crabs appear to occupy upper marsh areas perhaps due to the presence of an extensive mosaic of open patches. Our data suggests that on the upper marsh, crabs create burrows along the edges of these patches utilizing a cover of *S. patens*, whereas in patches closer to creek banks, burrows are found dispersed throughout the habitat. Crab populations are also being sampled on less disturbed salt marshes for comparison.

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EXPLOITING A NEW GIS DATABASE OF THE HUDSON RIVER TO UNDERSTAND ESTUARY PROCESSES

The Benthic Mapping Project of the Hudson River Estuary Program (funded by the New York State Department of Environmental Conservation) has surveyed 35 miles of the estuary floor with acoustic remote sensing measurements of bathymetry, backscatter and sub-bottom structure. Ground truth exists with grab samples, coring and bottom photography. The data from the estuary and its margins have all been assembled into a Graphical Information System that can be explored on one's desktop computer with ArcView tools or can be manipulated interactively over the WEB from an internet browser by means of a server side ArcIMS. The GIS lets us look back though the estuary's history and examine its evolution as it passed from a ice-carved fjord to become a lake, then a fluvial system and then an estuary. The steps are paced by ice sheet retreat, sea level rise, crustal rebound and sediment supply to fill the changing accommodation space. In some sections of the estuary, the bottom has reached a stasis in which sediment accumulation is only occurring where human activity or storms make new space through the removal of material. In other stretches one can see sediment actively travelling through the system in migrating bedforms. The remote sensing permits the bottom to be classified into different substrate types. These signify different physical and biological processes at work ranging from the building of oyster reefs, the colonization of invasive species such as zebra mussels, and the construction of ribbons downstream in the leeward side of bridge abutments. We find an excellent correlation between the changes through time seen in the sediment layering of a core and the layering seen in the acoustic profiles. This poster will present the seabed maps and imagery of the project as charts and will provided a few laptop computers to allow the visitor to roam through the GIS database.

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OLD WOMAN CREEK ESTUARY: THE HEALTHY ALTERNATIVE (WE ARE LOW SALT)

The concept of a freshwater estuary has long been ignored by the effete eastern coastal elite of estuarine scientists. The estuarine colleagues from the western frontier of NEERS believe that the time has come to renew the discussion of this concept. The best known definitions of estuaries are those of Pritchard and Fairbridge in which three characteristics are identified to define estuaries: estuaries are coastal features with some constriction at the opening to the sea; they have a free connection to the sea which allows a continuous exchange of water between the estuary and sea; and the sea and river water mix in an estuary. We will show that those three concepts can be applied along Lake Erie and specifically at Old Woman

Creek which lies along the south shore of Lake Erie's central basin. Discussions of coastal estuaries also often refer to the influence of glaciers on their physical development, the influence of tides, circulation patterns and productivity. Such concepts, including that of lunar tides, can also be discussed in the context of Old Woman Creek. Our purpose is not so much to convince our salty brethren as to encourage consideration of this concept which dates back nearly 30 years.

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THE BIOGENIC SILICA SEDIMENT RECORD IN NEW BEDFORD HARBOR, MASSACHUSETTS.
Biogenic silica (BSi) in sediments has been recognized as a proxy of diatom production. Its use in estuaries has been limited, but increased levels of BSi have been associated with nutrient over-enrichment in coastal waters in the Chesapeake Bay and the Gulf of Mexico. In the last few centuries, New Bedford Harbour, Massachusetts has received high nutrient loads, as well as exceptionally high inputs of heavy metals, PAHs, PCBs and other chemicals that possible impacted the aquatic flora. Will periods of high nutrient loading be reflected as increased BSi concentrations in the presence of industrial pollutants, or do these toxins counteract the productivity that would have been stimulated by nutrient enrichment? We are attempting to answer this question through study of sediments cored from New Bedford Harbor. In this presentation we show preliminary data on BSi concentrations in sediments from four cores. Our samples cover the time span from the present until before human settlement. We have performed extensive analyses of the sediment chemistry with depth and are using these data as indicators of the Harbor's pollution history. We will compare their patterns to that of BSi concentrations with depth.

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STABLE ISOTOPE RATIOS IN ARCHIVED STRIPED BASS SCALES
In recent years fishermen and scientists have noted that striped bass caught along the East Coast of the United States have reduced weight to length ratios with many of the fish caught in Chesapeake Bay exhibiting skin lesions. Several theories have been suggested to explain these occurrences including bacterial disease, habitat changes due to anthropogenic impacts or dietary shift as a result of reduced prey abundance for the striped bass. Measurements of stable isotopes of nitrogen (15N/14N) and carbon (13C/12C) in striped bass scales and muscle tissue were used to determine trophic structure and changes in diet of striped bass over the past two decades. Archived striped bass scales and muscle tissue from Rhode Island and Chesapeake Bay were prepared and analyzed for stable isotopes of carbon and nitrogen using Isotope Ratio Mass Spectrometry (IRMS). Consistent relationships were observed between isotope ratios in striped bass scales and muscle tissue for Rhode Island fish. Nitrogen isotope ratios were enriched by about 2‰ in scales compared to muscle, and carbon isotope ratios were depleted in scales by about 3‰ compared to muscle tissue. In Rhode Island striped bass scales, carbon isotope ratios increased from 1989 to 1996; carbon isotope ratios in Chesapeake Bay striped bass scales increased from 1982 to 1997. Isotopic analysis of potential striped bass prey items from Rhode Island and Chesapeake Bay showed that benthic/invertebrate species were isotopically enriched in delta 13C relative to pelagic/fish species. Changes in delta 13C in scales were consistent with a shift in the feeding patterns of striped bass from a diet of fish (menhaden, anchovy, and herring) to a diet higher in benthic/invertebrate species (crabs and shrimp). Preliminary results from this study support the idea that over the past 20 years there has been a detectable shift in feeding patterns of striped bass.

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EFFECTS OF INCREASED WATER TEMPERATURE ON SAND SHRIMP PREDATION ON YOUNG-OF-THE-YEARWINTER FLOUNDER PREY: A PROPOSAL
Winter flounder have traditionally supported a valuable fishery in Narragansett Bay, Rhode Island. As result of heavy exploitation in the recent past, however, abundances have decreased to record low levels. Under the Sustainable Fisheries Act (1996), management plans were initiated to reduce further stock losses due to fishing mortality. The rebuilding process has been successful for the majority of the New

England/mid-Atlantic stock complex. The sub-population attributed to Narragansett Bay, however, is not following this regional trend, and attempts to revitalize this depleted winter flounder stock have been unsuccessful. Documented climatic changes over the last 40 years, perpetuating increases in water temperature during winter and early spring in Narragansett Bay, is hypothesized to be a critical factor determining young-of-the-year (YOY) winter flounder survival - imposed not directly as a physiological mortality factor, but rather by altering predation pressure. The following proposed research attempts to examine the effects of water temperature on juvenile and larval winter flounder population dynamics in relation to its predator-prey relationship with the predatory sand shrimp *Crangon septemspinosa*. It is speculated that increases in Narragansett Bay water temperature during winter and spring has a two-fold negative effect on YOY winter flounder survival. First, elevated winter water temperature, above Crangon's lower tolerance limit, increases over-winter survivorship of the sand shrimp, thus, increasing their overall abundance during the spring - coinciding with the following YOY flounder prey generation. Second, elevated water temperature in early spring initiates a premature seasonal return migration of Crangon from deep to shallow estuarine water (areas used by developing flounder) and also enhances sand shrimp metabolic activity. This creates a spatial and temporal overlap between predator and prey, thus, potentially increasing predator-induced mortality of newly settled flounder.

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ABOVEGROUND BIOMASS RESPONSES TO NITROGEN AND PHOSPHORUS ADDITIONS ALONG A TIDAL GRADIENT IN A TIDAL, FRESHWATER MARSH

I measured the influence of nitrogen and phosphorus additions, alone and in combination, on the aboveground biomass in the tidal, freshwater marshes of South Tivoli Bay (Hudson River, NY) at three different sites along the tidal gradient. Nutrients were added to the sediment in early June, 1999 and aboveground biomass was harvested in late July and mid-September, 1999. The dominant vegetation was spatterdock (*Nuphar advena*) and pickerelweed (*Pontederia cordata*) with mean biomasses in control plots of 289 g m^{-2} and 457.6 g m^{-2} respectively. Phosphorus additions did not cause any significant change in biomass. Nitrogen additions, however, resulted in a 70% increase in biomass at the middle tidal elevation in July. In contrast, in September, additions resulted in a 63% decrease in biomass at the lower tidal elevation. The increase of aboveground biomass in July may reflect a nitrogen limitation in some areas of the marsh. I hypothesize that the decrease of biomass associated with the additions of nitrogen during September in the lower tidal elevation could either be a result of accelerated decomposition of nitrogen-rich plants or nitrogen loss from potential plant uptake through enhanced denitrification.

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BASELINE SAMPLING AND HABITAT ASSESSMENT OF SYBIL CREEK MARSH, BRANFORD, CT. PRIOR TO RESTORATION

Tidal restriction (e.g. tide gates) has greatly impacted the structure and function of salt baseline sampling at Sybil Creek Marsh, Branford, CT. to determine the ecosystem-level effects of tidal restriction, and guide restoration efforts. We measured plant biomass, tidal flooding, nekton use, and nutrients in the unrestricted and restricted marsh. Vegetation cover consists primarily of *Phragmites australis* in the tidally-restricted area and *Spartina alterniflora* and *Spartina patens* in the tidally-unrestricted area. Total aboveground biomass in the restricted marsh (5004 g m^{-2} was significantly greater than in the unrestricted marsh (1594 g m^{-2}During July, flooding duration was greater in the unrestricted versus the restricted marsh. Despite significant differences in flooding duration across the marsh, nekton density was not significantly different among sampling areas on the unrestricted marsh surface. Nekton density was considerably higher in the restricted creek (53.8 m^{-2}) than in the unrestricted creek (27.5 m^{-2}). In contrast, percent abundance of *Fundulus heteroclitus* and *Palaemonetes pugio* were similar between the restricted versus the unrestricted marshes in June (9% vs. 10%; 89% vs. 90%) and in August (9% vs. 7%; 89% vs. 91%). Nutrient concentrations were significantly higher in the restricted creek than in the unrestricted creek. Sediment ammonium concentrations were significantly higher in the unrestricted (0.22 mm cc^{-1}) relative to the restricted marsh (0.49 mm cc^{-1}) $p<0.003$). Reintroduction of tidal flow to the restricted marsh should cause a decline in *P. australis*, decrease in aboveground biomass and an increase in water levels. We also expect nekton utilizing the restricted creek to move onto the marsh surface during flooding.

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ECOSYSTEM METABOLISM IN THREE SHALLOW SUB-ESTUARIES IN RELATION TO NUTRIENT LOADING

Ecosystem production and respiration were calculated from diel changes in dissolved oxygen in three shallow sub-estuaries of Waquoit Bay, on Cape Cod, MA. Ecosystem production and respiration were calculated from hourly averages of the oxygen rate of change, integrated over the depth (to yield g m^{-2} day^{-1}), and corrected for atmospheric exchange based on local wind data and site-specific transfer coefficients. Our goal was to document interannual variability of summer metabolism and relate these rates to potential contributing factors, i.e. nutrient loading, meteorological conditions and dominant vegetation. Summer rates of daytime ecosystem production and nighttime ecosystem respiration were compared to estimates of nitrogen loading rates for the three sites. While annual average net ecosystem production increases with increasing nitrogen loading, monthly averages for the summer months do not follow the same trend.

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CLIMATE VARIABILITY, ANTHROPOGENIC CHANGE AND CONSEQUENCES IN THE MID-ATLANTIC.

Relative to the preceding millennium, the rate of change of temperature in the Northern Hemisphere over the past century strongly suggests that we are in a period of rapid global climate change. Globally, continued anthropogenic increases in concentrations of atmospheric greenhouse gases will probably result in increased surface temperatures, an accelerated hydrological cycle, changed patterns of climate variation, and altered frequencies and intensities of climate extremes. Regionally, human population trends and modification of watersheds in the Mid-Atlantic Region have amplified some risks associated with climate extremes: increasing demands for water increase the impacts of drought; increased nutrient loading to watersheds means that nitrogen flux per unit flow has increased substantially over the past century; and wet years in recent decades have different consequences in coastal receiving waters than equivalent wet years earlier in the 20th century. From an analysis of historical and long-term proxy records of indices of climate variability, soil moisture, streamflow, and water quality variations, and from a consideration of the anthropogenic causes of change, we conclude that risks in the Mid-Atlantic Region associated with both dry and wet extremes of regional climate are increasing.

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TOWARDS DEVELOPING INDICATORS OF SALT MARSH CONDITION

Five ecosystem services: water quality maintenance, erosion and flood control, recreation and cultural use, wildlife habitat, and food production were identified from the literature as key ones to characterize salt marshes of high integrity. We describe a systems approach to link metrics of structure and function with indicators of these services. For example, plant zonation is linked to erosion control and wildlife habitat. Ten salt marshes in Narragansett Bay, RI, with similar geological bedrock and sea exchange, were identified to examine plant zonation. Sub-watersheds adjacent to the salt marshes were characterized by land use practices and stream nutrient concentrations. We use a space-for-time approach: gradients of low to high % residential land use and low to high nitrate concentrations in the headwater streams were measured for the salt marshes. In the Fall, there was a significant correlation ($p < 0.05$; $r = +0.84$) between total dissolved nitrogen and % residential land use among the ten sites. Ribbed mussel (*Geukensia demissa*) and smooth cordgrass (*Spartina alterniflora*) stable nitrogen isotopic signatures reflected the nitrogen sources from the adjacent watersheds and were significantly correlated with % residential. Because human wastewater is known to enrich stable nitrogen isotope ratios in organisms, our results suggest that with increasing residential development, the salt marshes are receiving increasing nitrogen loads associated with human activities. Results from plant zonation transects in the salt marshes showed a significant correlation between the extent of saltmeadow hay (*Spartina patens*) and the total number of plant zones ($p < 0.05$; $r = +0.69$). Furthermore, the transects revealed an inverse relationship between the extent of *S. patens* and % residential ($p < 0.05$; $r = -0.66$). Since the root structure of *S. patens* is known to promote peat accumulation, we propose that salt marshes are more susceptible to erosional processes when

enriched with nitrogen. Finally, we describe how the number of plant zones and areal extent of *S. patens* may be good indicators of some salt marsh services. However, additional metrics of structure and function are needed to make a strong link with salt marsh condition.