Environmental and Ecological Research in Barnegat Bay (2011 -2014)

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New Jersey Department of Environmental Protection
Office of Science

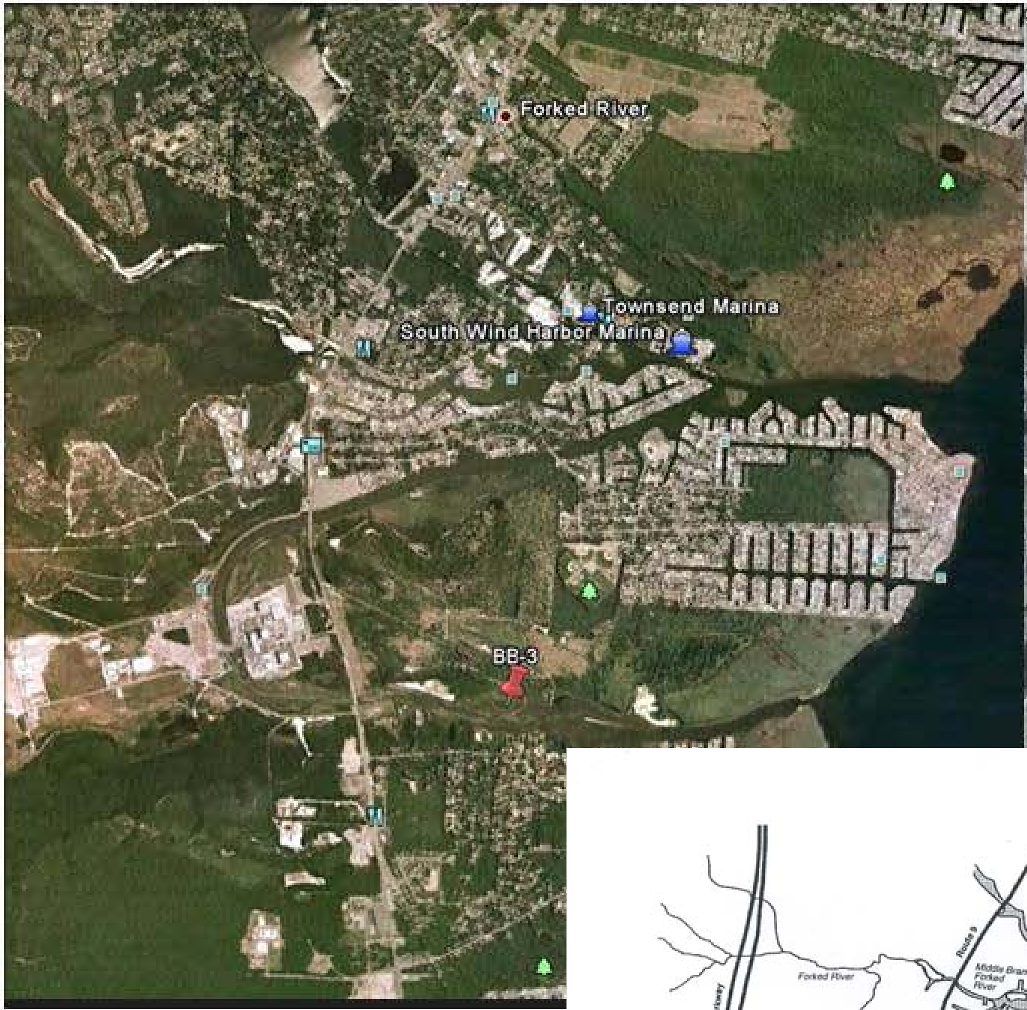
Delaware Estuary Science and Environmental Summit
Conference Cape May, New Jersey
January 27 – 30, 2013

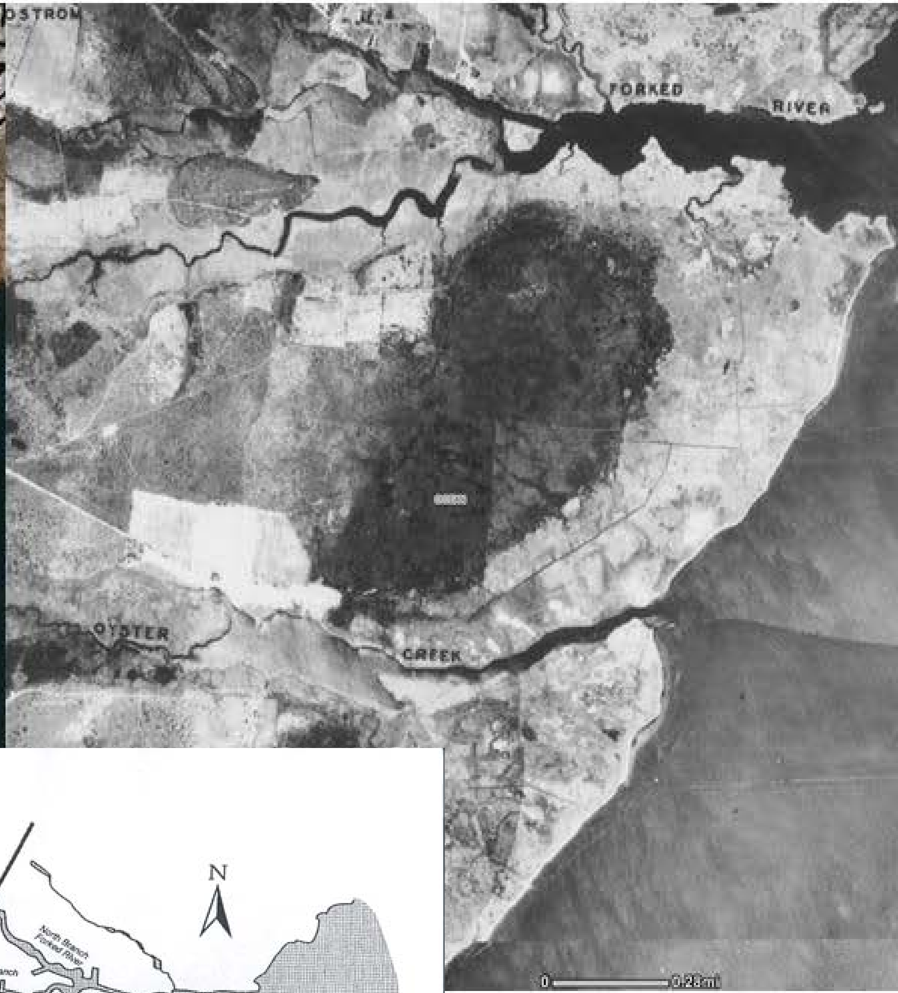
Barnegat Bay

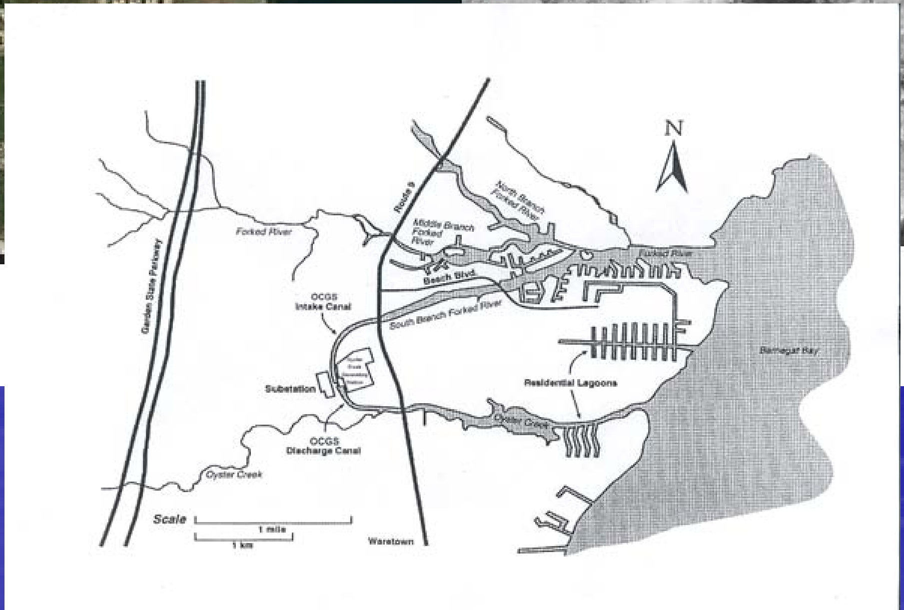
Human Impacts on Estuary

- 1. Eutrophication (Cascading Ecosystem Decline)
- 2. Power Plant Operation Impingement, Entrainment, Thermal Discharges
- 3. Habitat Loss and Alteration (Estuary and Watershed)
- 4. Stormwater/Pathogens
- 5. Hardened Shorelines/Reduced Biodiversity
- 6. Reduced Freshwater Input/Altered Salinity/Susceptibility
- 7. Invasive Species (Sea Nettles, Chinese Mitten Crabs)
  8. Dredging/Boating/Jet Skis
- 9. Marina Operations
- 10. Climate Change/Sea-Level Rise
- 11. Chemical Contaminants
- 12.Trash/Floatables

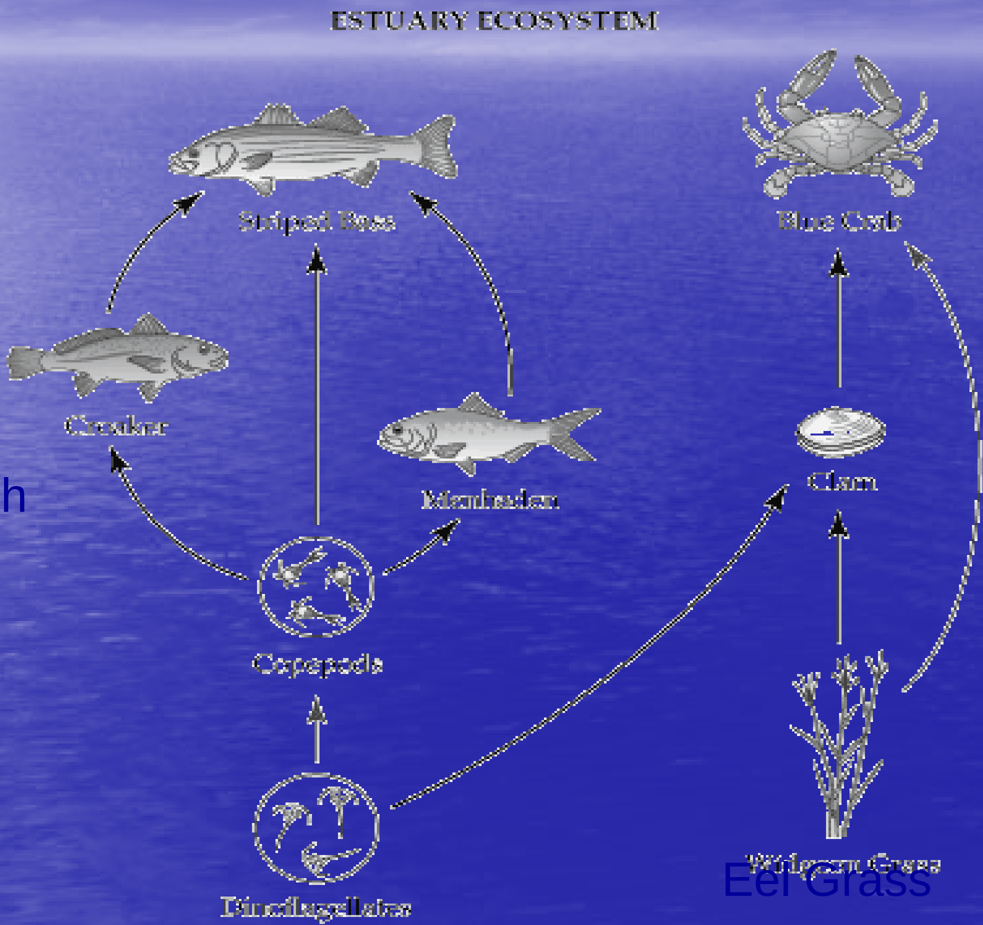
Change in Barnegat Bay Land Use at Forked River and Oyster Creek (1931 and 2011)







Generic Estuarine Ecosystem



Jellyfish

Eel Grass

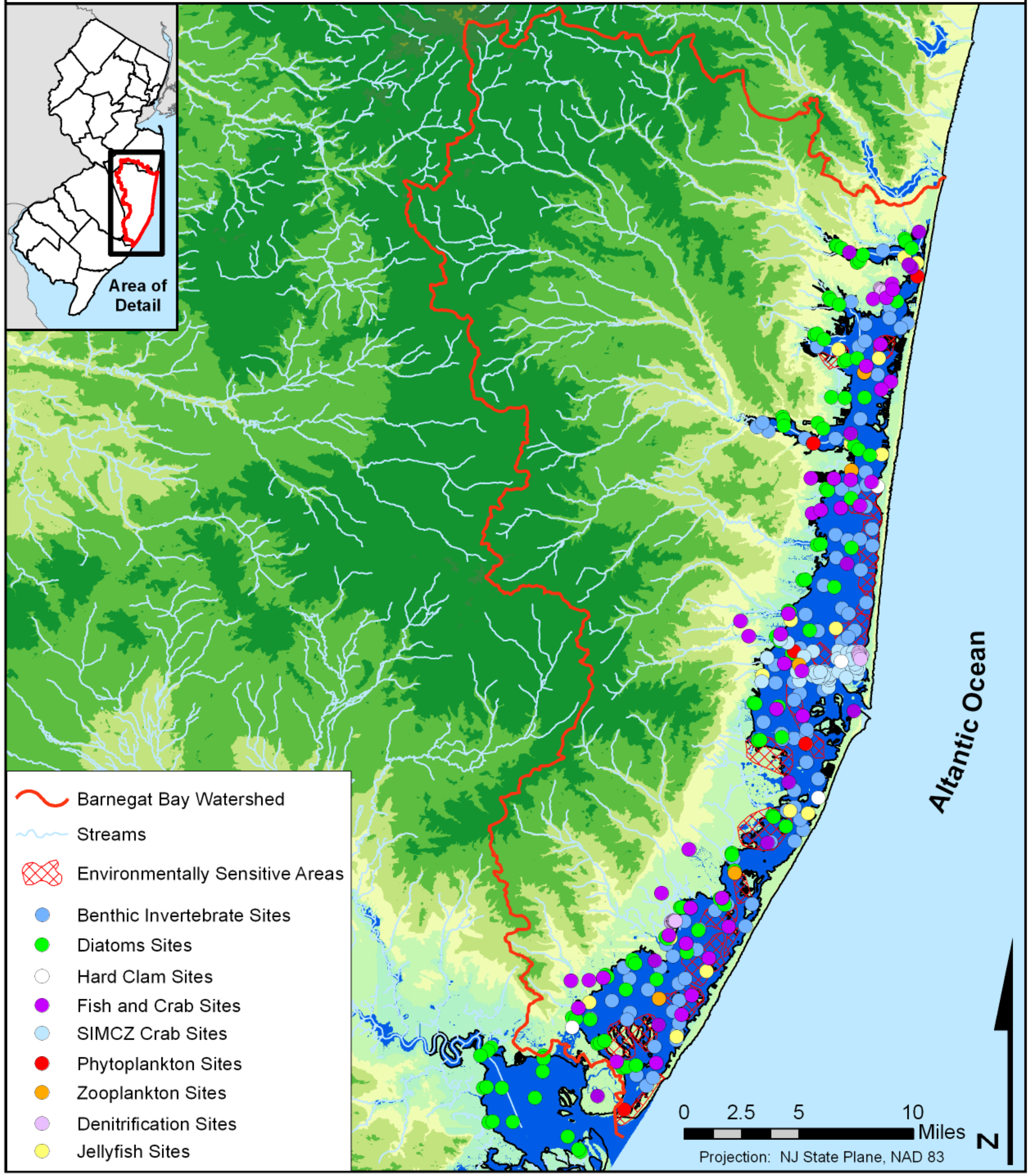
Benthic Invertebrates

BARNEGAT BAY COMPREHENSIVE RESEARCH - OBJECTIVES

	Research Project (in order of priority)	Nutrient Bio-Criteria	TMDL	Power Plant	Tourism & Recreation	Food Safety	Comprehensive/ Baseline/Data Gaps
1	Benthic Invertebrate Community Monitoring and Indicator Development for Barnegat Bay.	X	X	X			X
2	Nutrient and Ecological Histories of Barnegat Bay	X	X				X
3	Assessment of Hard Clam Populations in Barnegat Bay			X	X		X
4	Assessment of Fishes and Crabs Responses to Human Alteration of Barnegat Bay.			X	X		X
5	Assessment of the Distribution and Abundance of Stinging Sea Nettles (Jellyfishes) in Barnegat Bay			X	X		X
6	Baseline Characterization of Phytoplankton Communities and Harmful Algal Blooms (HABs)	X	X		X	X	X
7	Baseline Characterization of Zooplankton Communities	X	X	X			X
8	Multi-Trophic Level Modeling of Barnegat Bay			X	X		X
9	Tidal Freshwater and Salt Marsh Wetland Studies of Changing Ecological Function and Adaptation Strategies				X		X
10	Ecological Evaluation of Sedge Island Marine Conservation Area in Barnegat Bay				X		X

Action Item # 9 Monitoring Sites

Barnegat Bay Region, NJ



New Jersey DEP - Office of Science
428 E. State. St.
Trenton, NJ 08625

Barnegat Bay Researchers Workshop
Oct. 30, 2012

Drawn By: NAP, Oct 25, 2012

1. Baseline Characterization of Phytoplankton and Harmful Algal Blooms

Dr. Ling Ren, Academy of Natural Sciences of Drexel University

Objectives

- Describe temporal and spatial distribution of phytoplankton
- Identify species composition and succession, and investigate the effects of environmental change on phytoplankton community
- Compare with previous studies to assess long-term change of phytoplankton community
- Provide baseline information on the diversity and distribution of phytoplankton for water-quality assessment, management and restoration efforts

Harmful Algal Blooms

Brown tides: *Aureococcus anophageffens*

Polyclonal antibody method

An immunofluorescence procedure; using antibodies to label the cells; examine and enumerate under fluorescence microscope with blue excitation (450-490nm).

Samples→Normal Goat Serum→primary and secondary anti-serum

Comparison with AA culture (Cells ml^{-1})

Direct count: 2.7×10^6 (n=3)
Antibody method: 2.9×10^6 (n=3)

Preliminary Phytoplankton Results

- Phytoplankton community showed large difference in species composition between Northern, Center and Southern sites

- Northern sites are more characterized with *Nannochloris atomus*, small phytoflagellates.

- Center area is abundant with a mixture of small centric diatoms (<10 μm) and small flagellates.

- Southern sites are more dominated by undetermined pico-size coccoids and chain- forming diatoms.

- Sometimes, phytoplankton in neighboring sites was very different (BB09 and BB10).

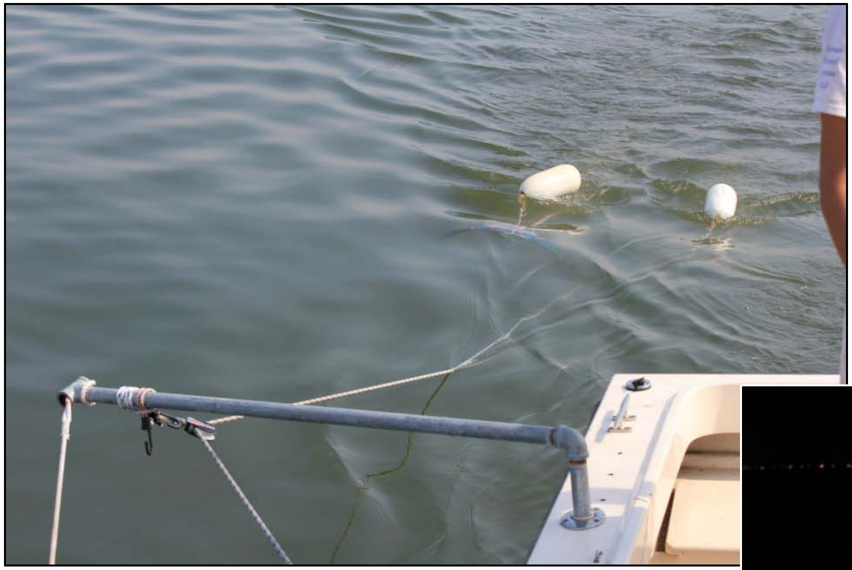
- Dominant species from the same site changed with seasons. Sept-Oct-Jan-Mar

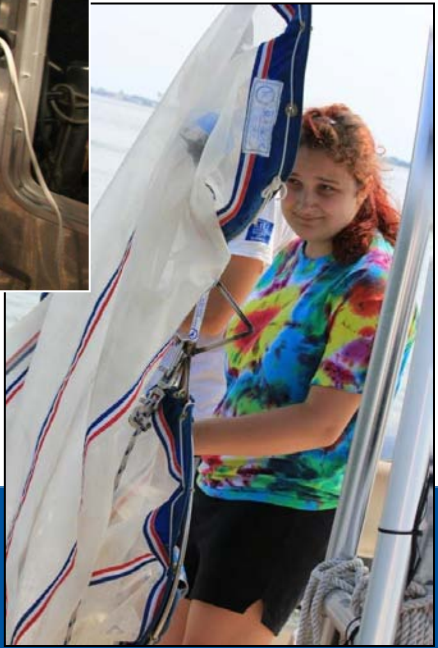
2. BASELINE CHARACTERIZATION OF ZOOPLANKTON IN BARNEGAT BAY

Jim Nickels[1] Ursula Howson[2] Tom Noji[3] Jennifer Samson[3]
[1]Urban Coast Institute, Monmouth University, [2]Department of Biology, Monmouth University, [3]Sandy Hook Lab, NOAA

- Characterize zooplankton distribution and abundance
  - Spatially and temporally
- Correlate with abiotics
- Quantify gelatinous macrozooplankton

Plankton sampling





3. Assessment of the Distribution and Abundance of Sea Nettles and Gelatinous Zooplankton in Barnegat Bay

Paul Bologna & Jack Gaynor, Department of Biology and Molecular Biology, Montclair University

2012 Research Objectives:

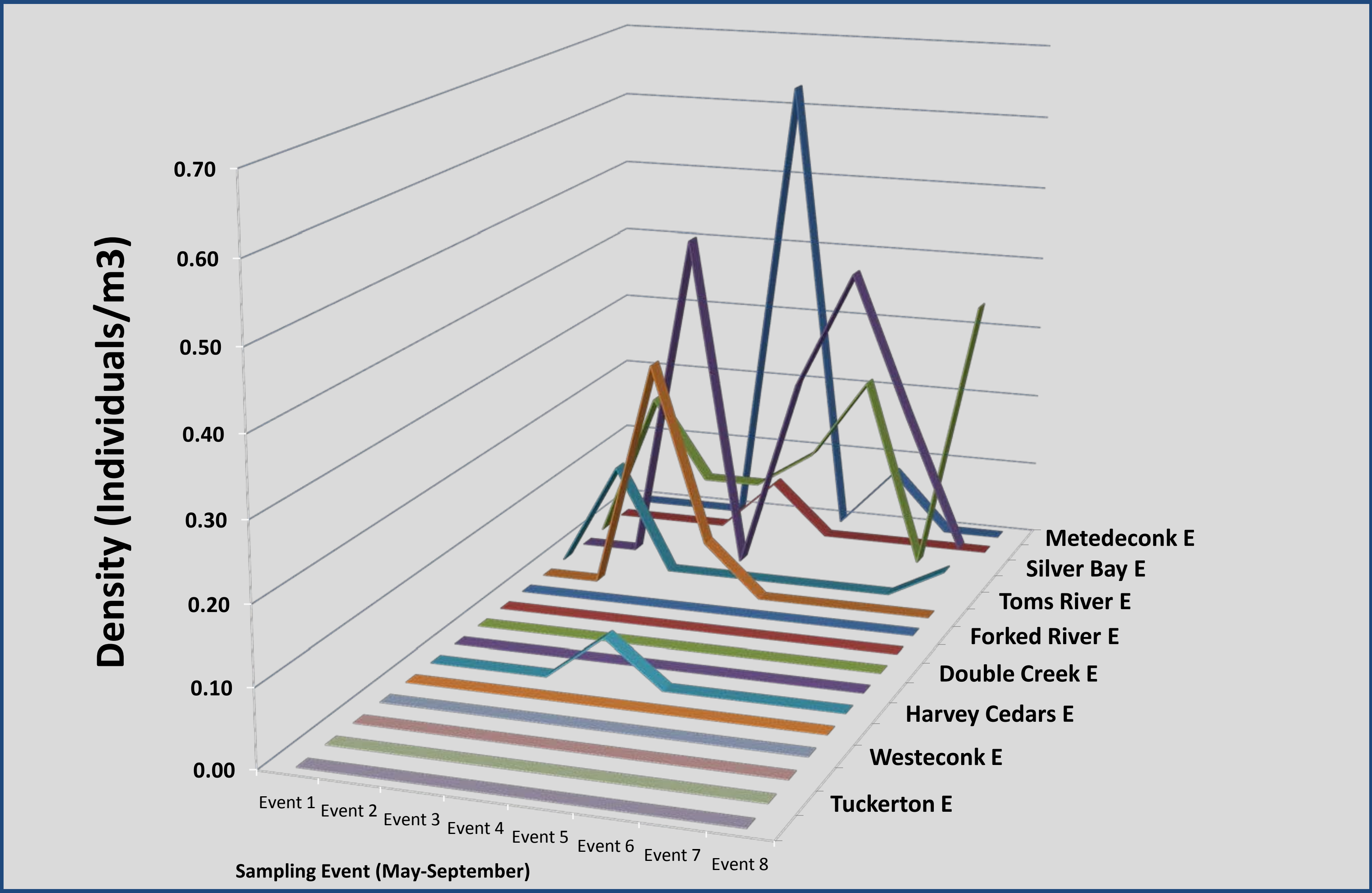
1. **Assess the distribution and Abundance of Gelatinous Zooplankton**

1. **Assess the distribution of settling larval Sea Nettles (i.e., Polyps)**

2. **Assess the of larvae and early pelagic stages using DNA analysis**

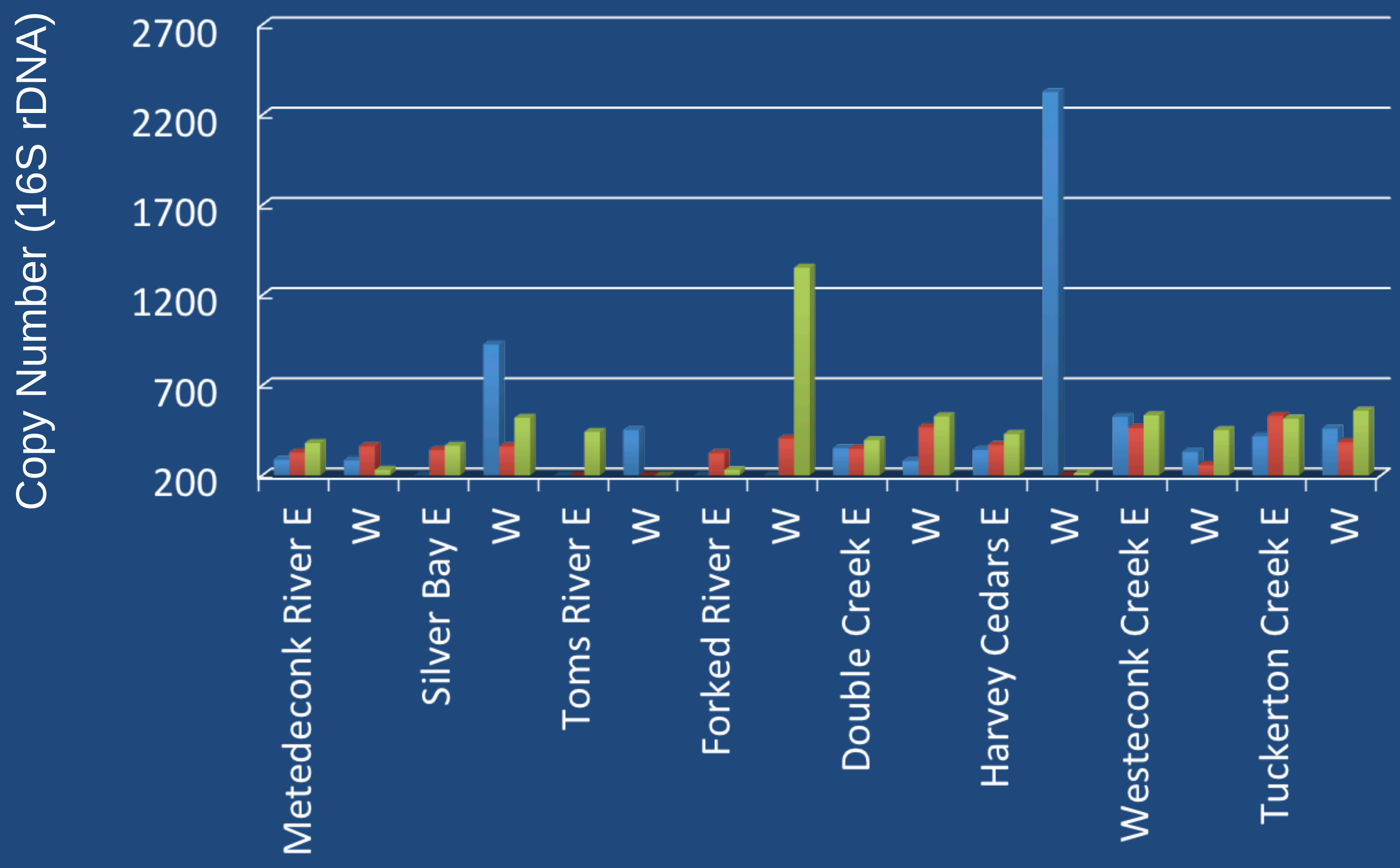
3. **Develop a time-step predictive model between early pelagic stages and juveniles and adults**

Distribution of Sea Nettles



qPCR of Ephyra

Collection I (May 31, 2012)

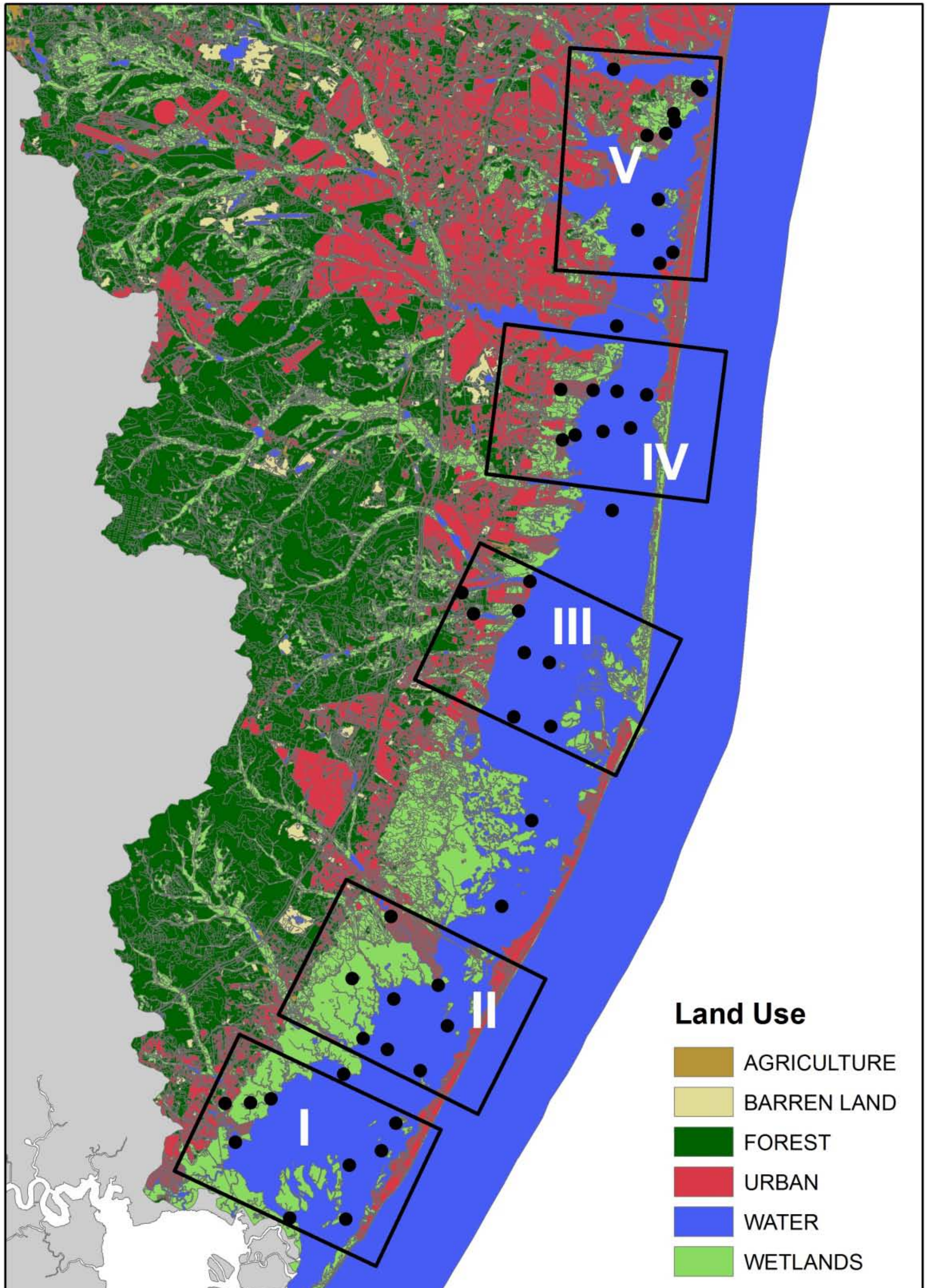


4. Assessment of Fish and Crab Response to Human Alteration in Barnegat Bay

Kenneth W. Able, Thomas M. Grothues, Rutgers University Marine Field Station and Paul Jivoff, Rider University

Long Term Goal:
Determine how fish and crabs respond to human alterations in Barnegat Bay

YEAR ONE
Compare the temporal (annual, seasonal) and spatial variation along the gradient of human alterations
Determine seasonal variation in species composition and abundance for larval fishes
Determine juvenile and adult fish and crab distribution and abundance across habitats (SAV, non-SAV and in sub-estuary/tidal creek tributary, open bay)


V
IV
III
II
I
Land Use
AGRICULTURE
BARREN LAND
FOREST
URBAN
WATER
WETLANDS

Preliminary Results

- Fishes and crabs well represented across multiple habitats with otter trawls
- Pronounced seasonal variation in abundance
- Extensive sampling along gradient of human developement indicates reduced fish abundance in upper bay during June
- Larval fish supply at multiple inlets (Little Egg Inlet, Barnegat Inlet, Pt. Pleasant Canal) and OCNGS still being evaluated
- Adult fish distribution still in process

5. Benthic Invertebrate Community Monitoring and Indicator Development

Gary Taghon, Judith Grassle, Charlotte Fuller, Rosemarie Petrecca

Institute of Marine and Coastal Sciences

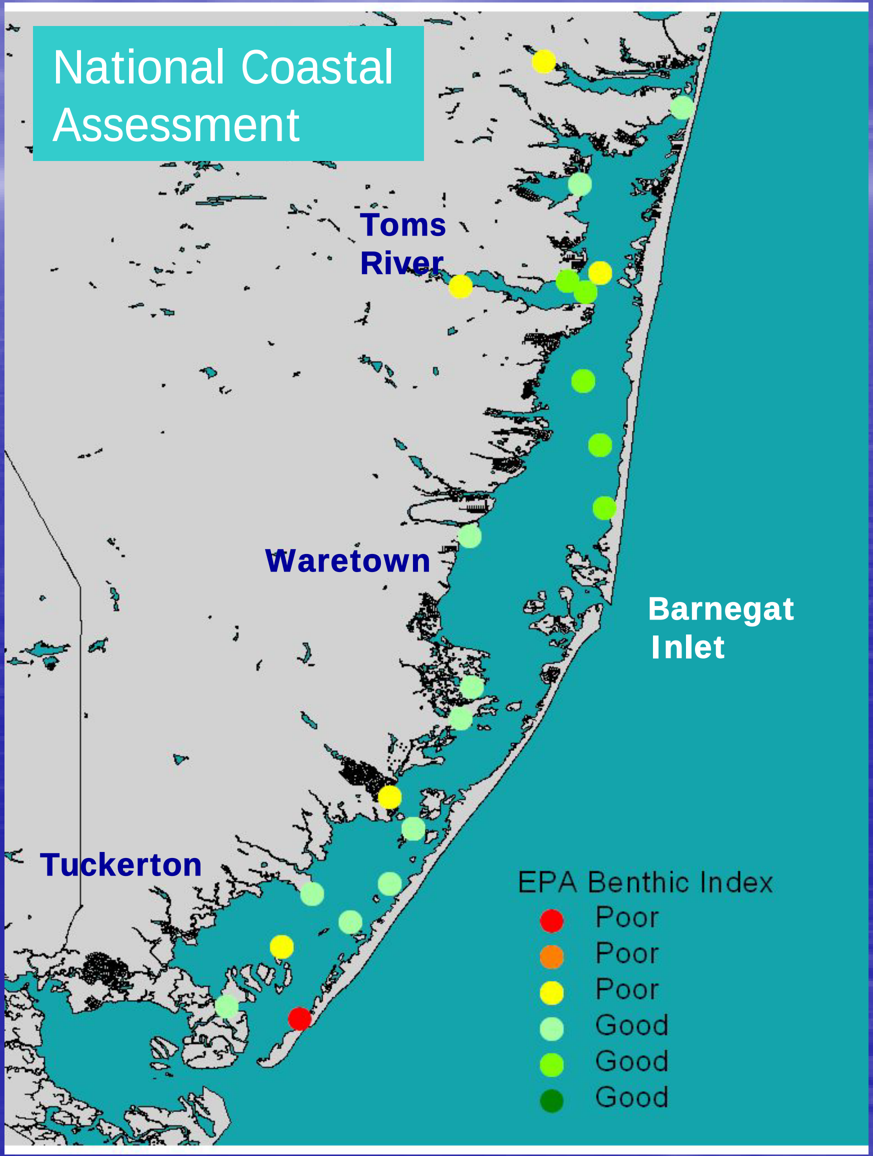
Ecosystem Health Research – Benthic Index

Regional Environmental Monitoring and Assessment Program (REMAP)

- **A benthic index looks at the diversity of organisms in the bottom of the bay. High diversity = good conditions; Low diversity = poor conditions.**

- **Benthic Index* shown to the right was developed for broad application nationally, but needs refinement before applying to management decisions locally.**

- **This USEPA funded research is a collaboration between USEPA ORD, USEPA Region 2, NJDEP Water Monitoring & Standards and Rutgers University.**



NJDEP, Water Monitoring & Standards

* Based on Paul, J. et al., 2001.

Interim Results and Conclusions

Previously dominant amphipod (*Ampelisca*) now rare

Long-term trend or year-to-year variability?

Polychaete worms now numerical dominants

Species diversity may be greater than 11 years ago

Sediment organic carbon concentration remains low, with some exceptional hot spots

Sediment nitrogen concentration less than expected (using Redfield ratio yardstick)

Sediment phosphorus concentration greater than expected

6. Barnegat Bay Diatom Water Quality Calibration

Marina Potapova, Jerry Mead, Roger Thomas, David Velinsky
Academy of Natural Sciences of Drexel University

Mihaela Enache, Thomas Belton
New Jersey Department of Environmental Protection

Study design

- Select sampling sites along gradients of land use and habitat types (GIS)
- Collect surface sediment and water chemistry samples
- Investigate taxonomy of diatom species
- Develop a regional calibration set to relate nutrient levels and other human impacts to diatom communities

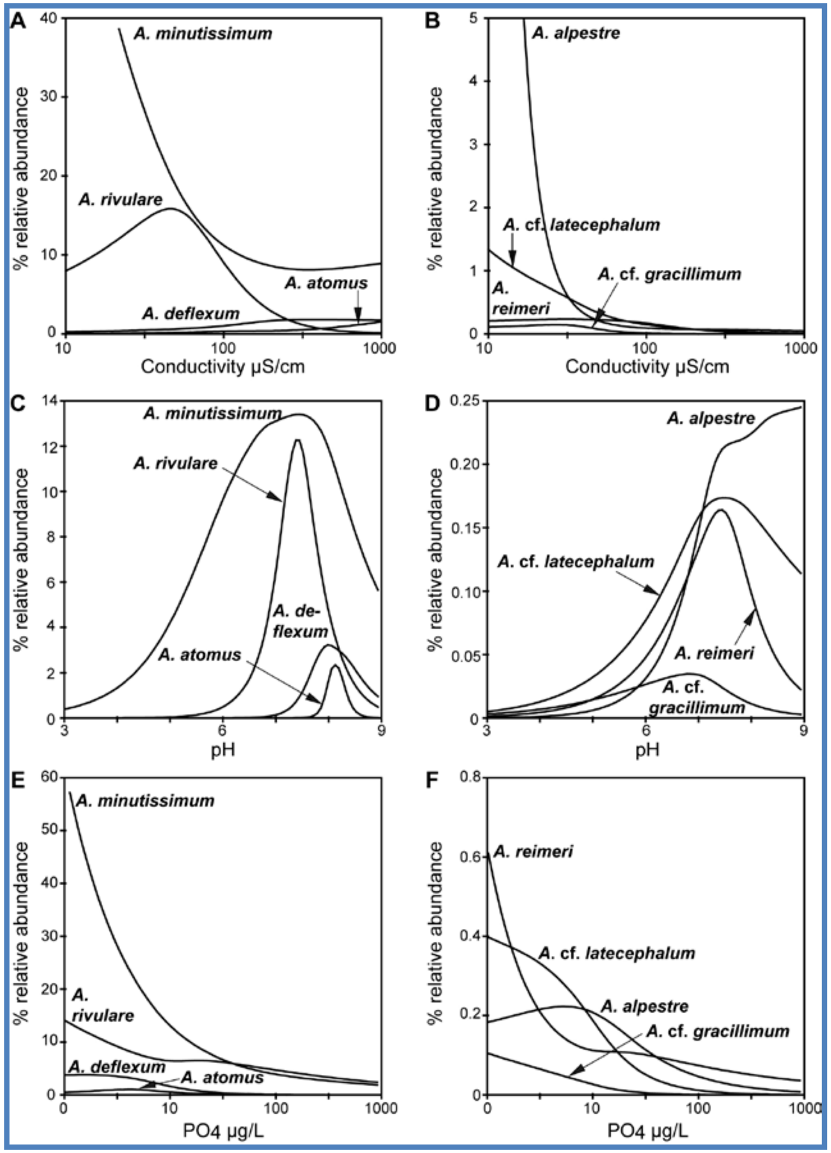
Diatoms as environmental indicators

1. "Calibration" = Determine what presence/ abundance of various diatom species tells us about environment?

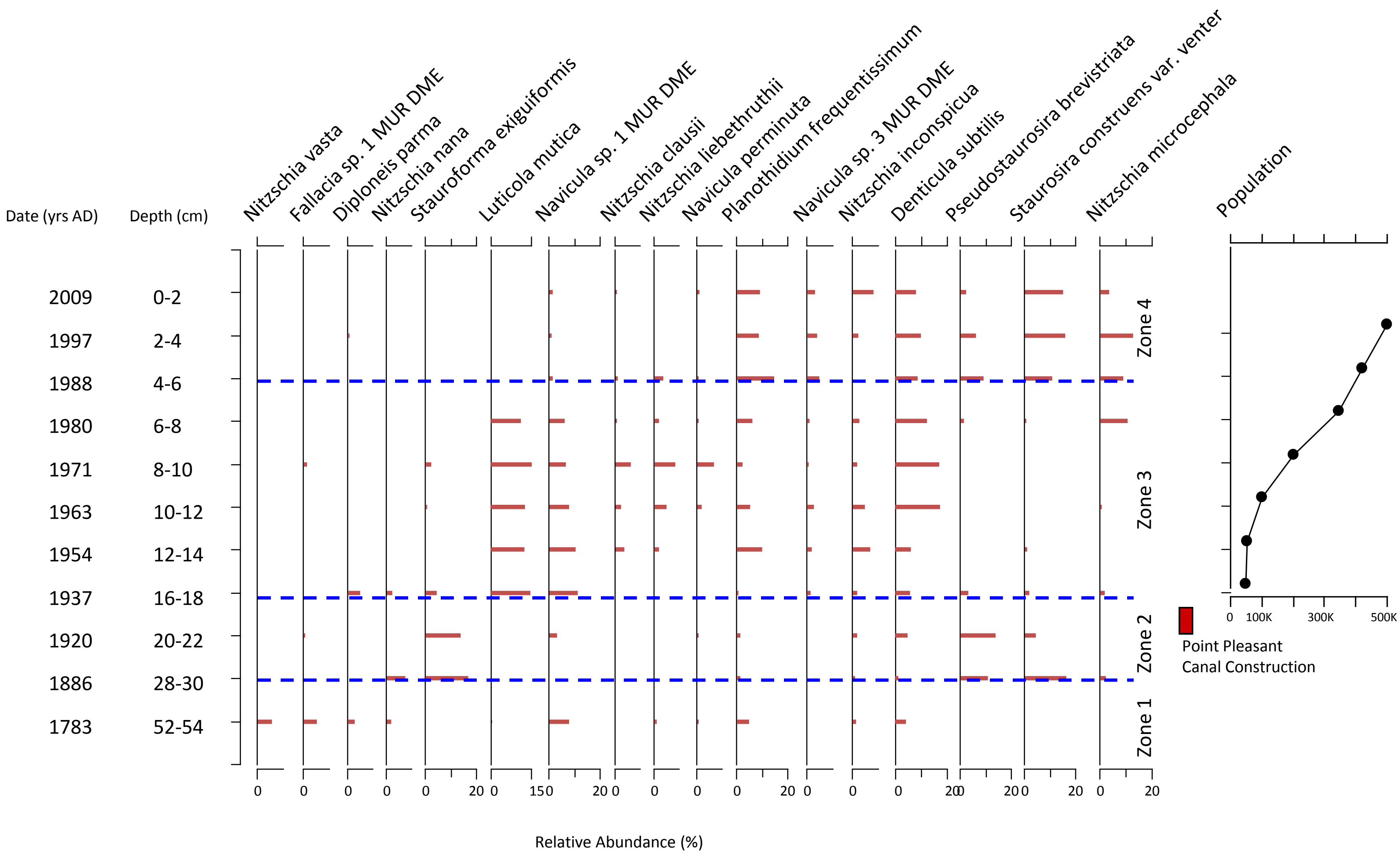
   From subjective opinions to carefully quantified species responses to environmental characteristics

2. "Inference" = Use the information on species ecology to infer environmental conditions from the composition of diatom assemblages

   From simple indices of the 1900-1960s to sophisticated modern modeling techniques



Northern Barnegat Bay Diatom stratigraphy



7. Benthic-Pelagic Coupling: Hard Clams as Indicators of Suspended Particulates in Barnegat Bay – Little Egg Harbor

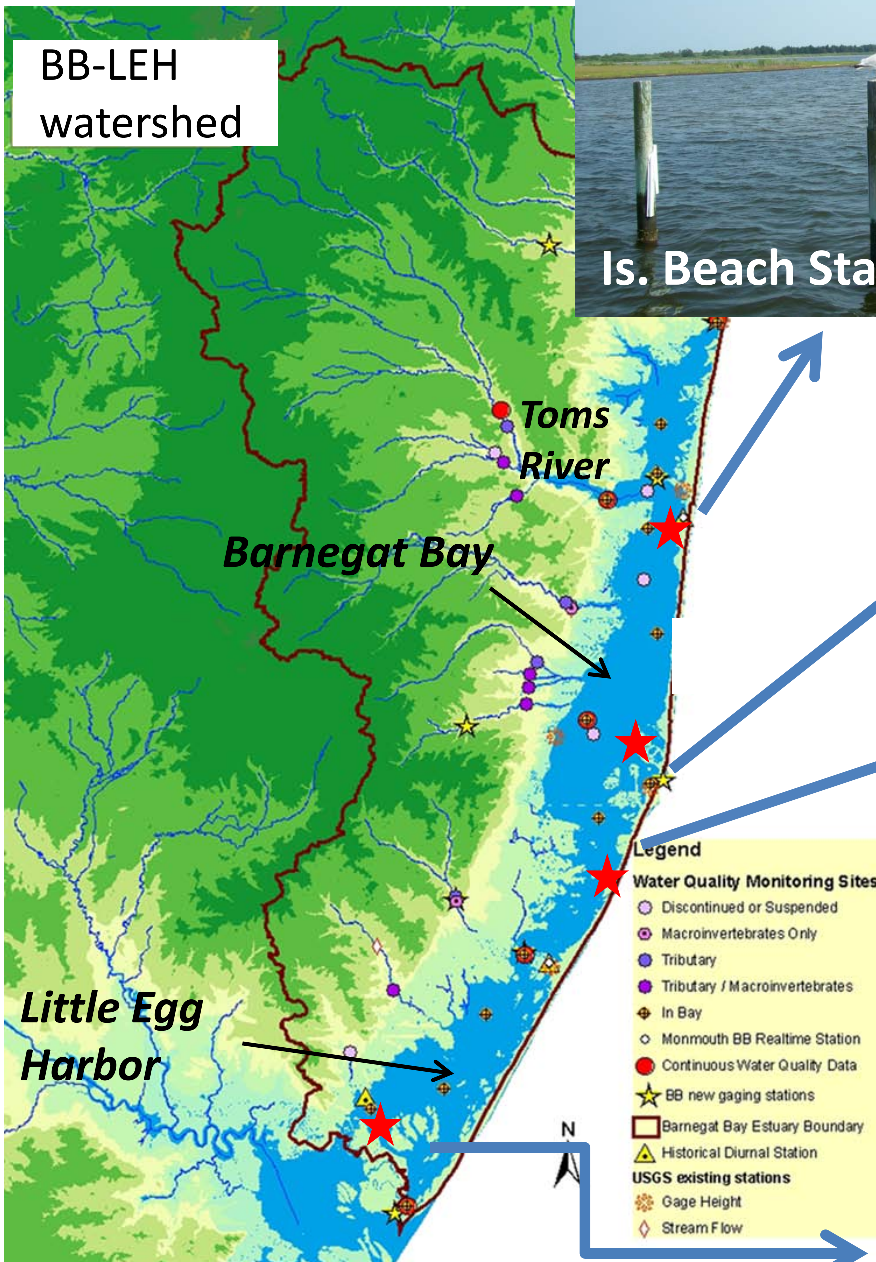
Monica Bricelj[1], John Kraeuter,[2] Gef Flimlin[3]

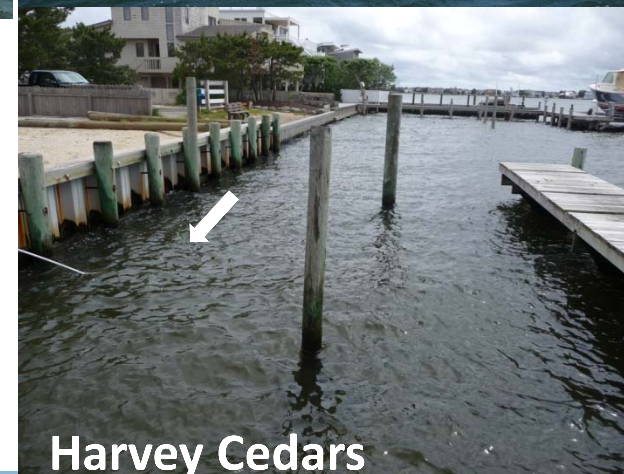
[1]Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ
[2]Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ
[3]Cooperative Extension of Ocean County, Toms River, NJ

GOALS

- Determine the seasonal and spatial variation in seston quality/quantity in BB-LEH using suspension-feeding juvenile hard clams, Mercenaria mercenaria, as a biosensor
- Determine the relationship between clam growth, temperature, salinity & seston characteristics at 4 sites

FIELD STUDY SITES





Mesh bag containing juvenile clams 23 cm (9") off-bottom

Survival, growth in SL & soft tissue DW, & condition (DW/SL^3):

3 to 4 cages per site

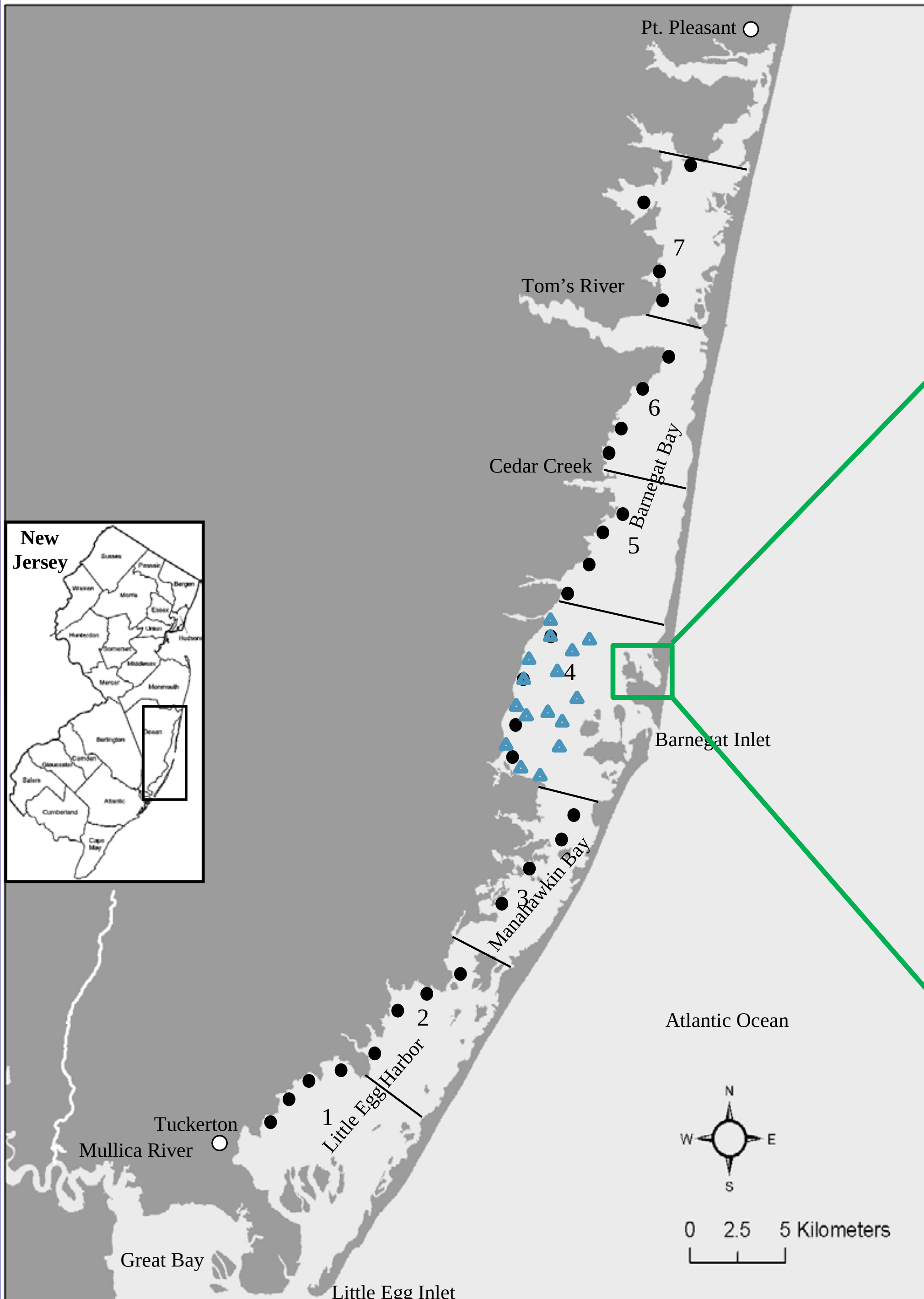
30 to 50 clams/cage/sampling date

Initial size of juvenile clams = 9 to 13 mm shell length, SL

8. Ecological Evaluation of Sedge Island Marine Conservation Area in Barnegat Bay

Paul Jivoff
Department of Biology

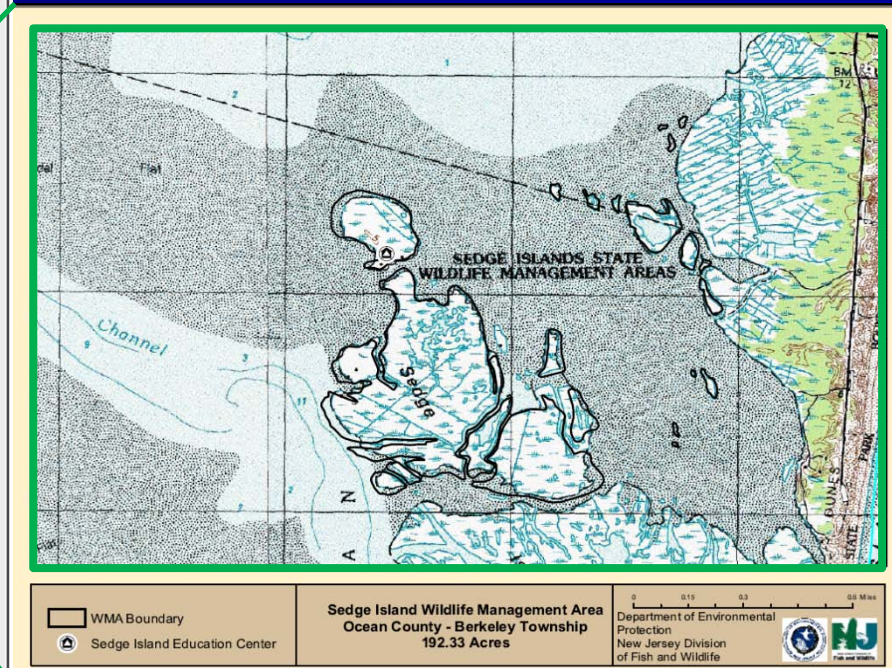
RIDER UNIVERSITY
1865



Rationale

-NJ's First Marine Conservation Zone….
for preserving diversity of essential habitats

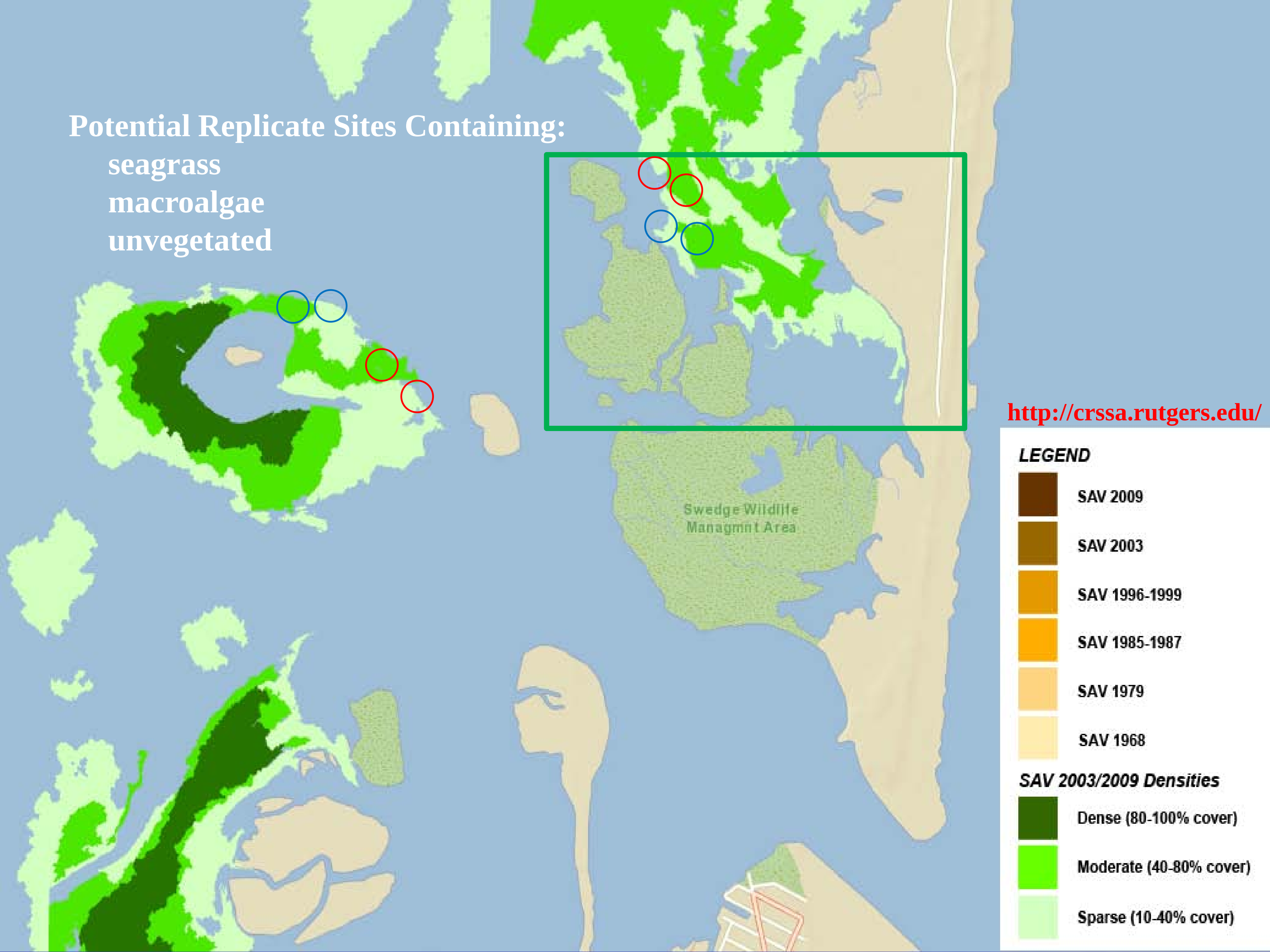
-Little work to assess habitats present or evaluate effectiveness for organisms



Objectives

-Use blue crab as a model organism for evaluating relative effectiveness of SIMCZ

-Increase understanding of factors influencing blue crab fecundity



Potential Replicate Sites Containing:
seagrass
macroalgae
unvegetated
Swedge Wildlife Managmnt Area
http://crssa.rutgers.edu/
LEGEND
SAV 2009
SAV 2003
SAV 1996-1999
SAV 1985-1987
SAV 1979
SAV 1968
SAV 2003/2009 Densities
Dense (80-100% cover)
Moderate (40-80% cover)
Sparse (10-40% cover)

9. Wetland Studies of Ecological Function and Adaptation: Denitrification Year 1

T. Quirk and D.J. Velinsky; Academy of Natural Sciences of Drexel University and A. Smyth and M. Piehler, University of North Carolina

OBJECTIVES

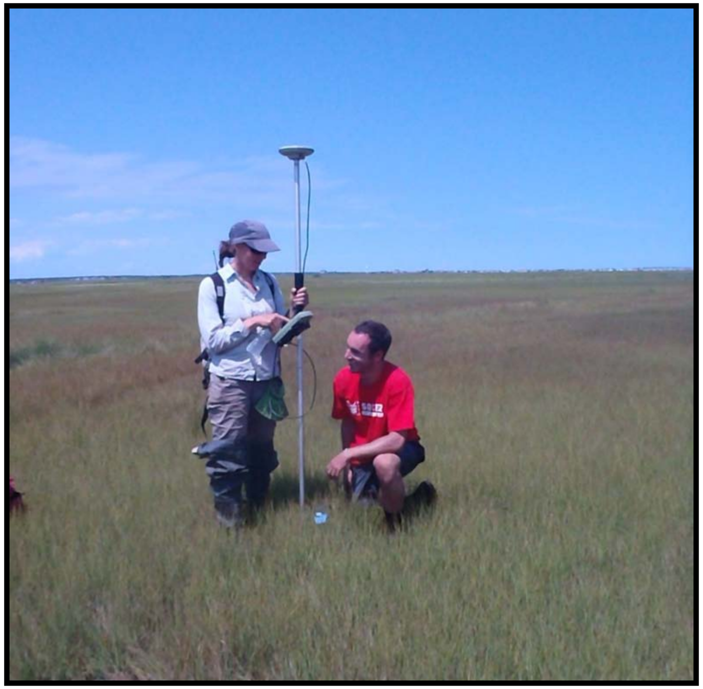
- Evaluate permanent nitrogen (N) removal services provided by Barnegat Bay coastal wetlands
- Bay-wide seasonal denitrification rates in salt marshes
- Mosquito control pond effect on denitrification
- Combine data with existing N burial rates (Velinsky et al. 2010) to begin to obtain an overall estimate of N removal services provided by Barnegat Bay wetlands

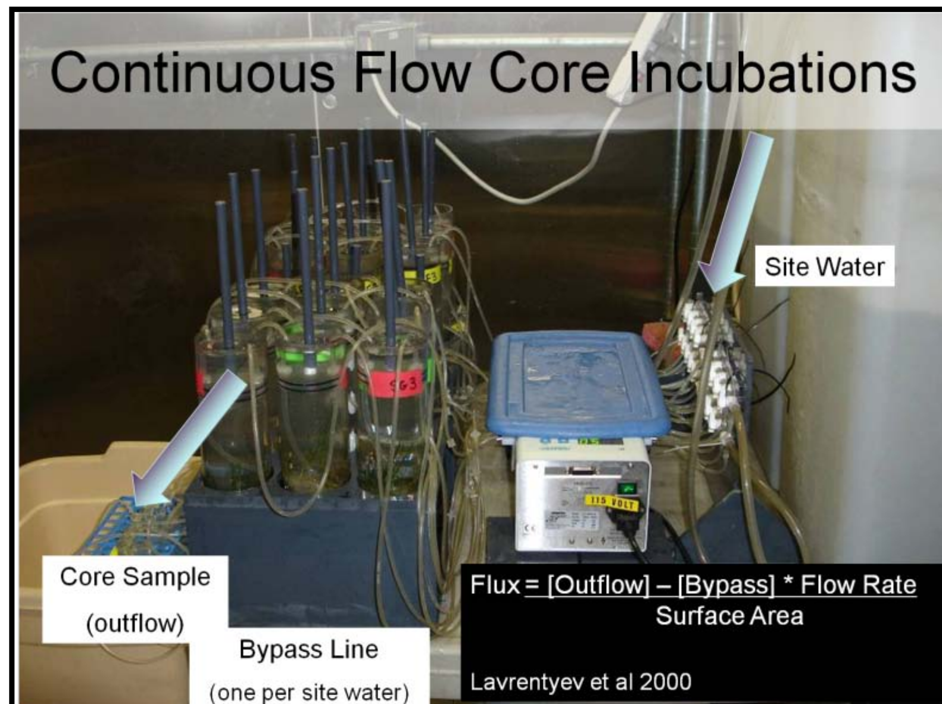
Methods

Seasonal denitrification rates

- 3 salt marshes in north, mid-, and south bay
- 6 cores per marsh
- 3 times per year (May, July, October)
- Analyze cores for N- fluxes, oxygen demand, sediment carbon and nitrogen
- Determine average bay-wide flux rates (g N m^{-2} d^{-1})

Field and lab





10. Conceptual social-ecological models and traditional ecosystem models in ecosystem based management

Olaf Jensen and Heidi Fuchs, Institute of Marine and Coastal Sciences, Rutgers University

Jim Vasslides, Barnegat Bay Partnership, Department of Ecology and Evolution, Rutgers University

A. Fuzzy Cognitive Maps

Help us understand the relationships between organisms and their biotic and abiotic environment

This includes humans (and their abstract concepts), making these social-ecological system models

B. EcoPath - NPZ Models

Mass balance models based on the flow of energy among different species/taxa (production – consumption).

A snapshot of the ecosystem state, interactions, and exploitation

Creating the Barnegat Bay FCM

Stakeholder group	Maps (N)	Occupation/organization/social group
Scientists	19	Academic scientists, federal and state agency research scientists
Managers	11	Federal, state, county, and local resource managers
Environmental NGOs	6	Regional, statewide, and local environmental non-profits
Local people	6	Baymen, commercial fisherman, local fisherman, longtime residents

"What do you think are the major components and relationships that are important to understanding how the Barnegat Bay ecosystem works?"

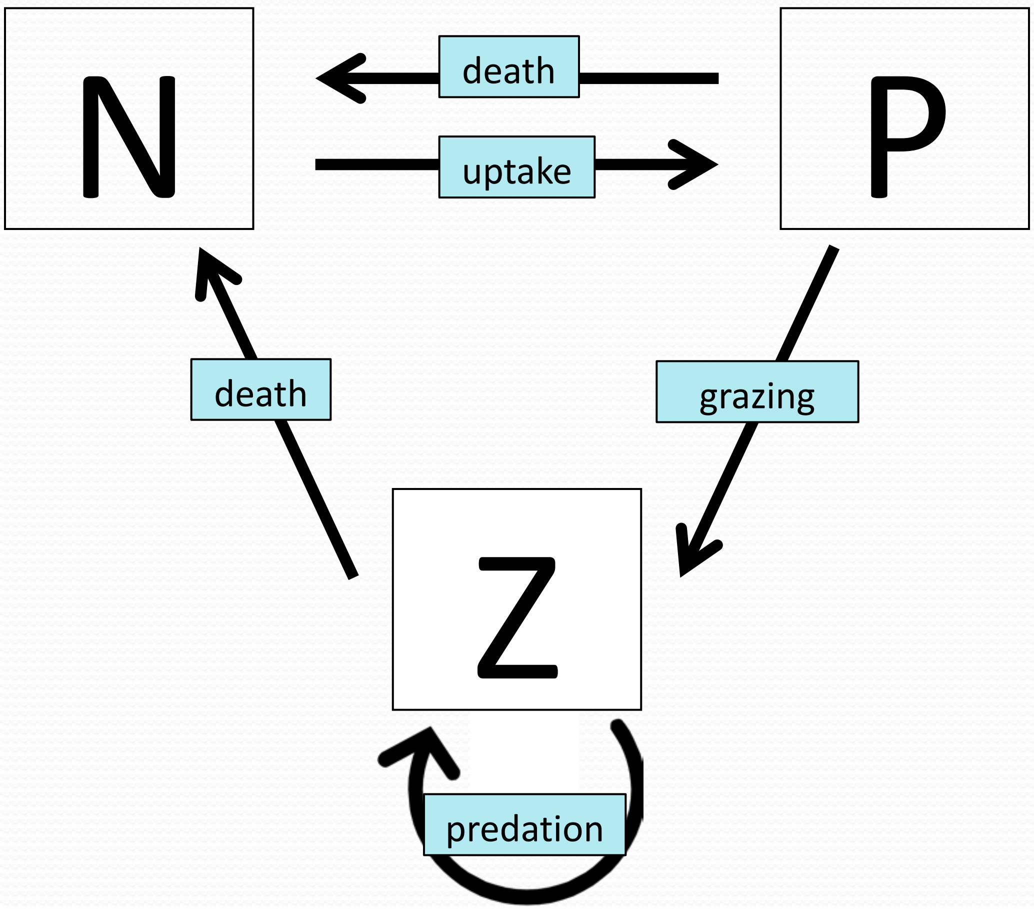
EcoPath Model Inputs

For each species/taxa stanza we need:

Biomass	t/km^2
Production/Biomass (PB)	yr^{-1}
Consumption / Biomass (Q/B)	yr^{-1}
Other mortality (EE)	proportion
Diet information	proportions
Catches	$t/km^2/yr$

*EcoPath can estimate one parameter given the rest

The NPZ Model



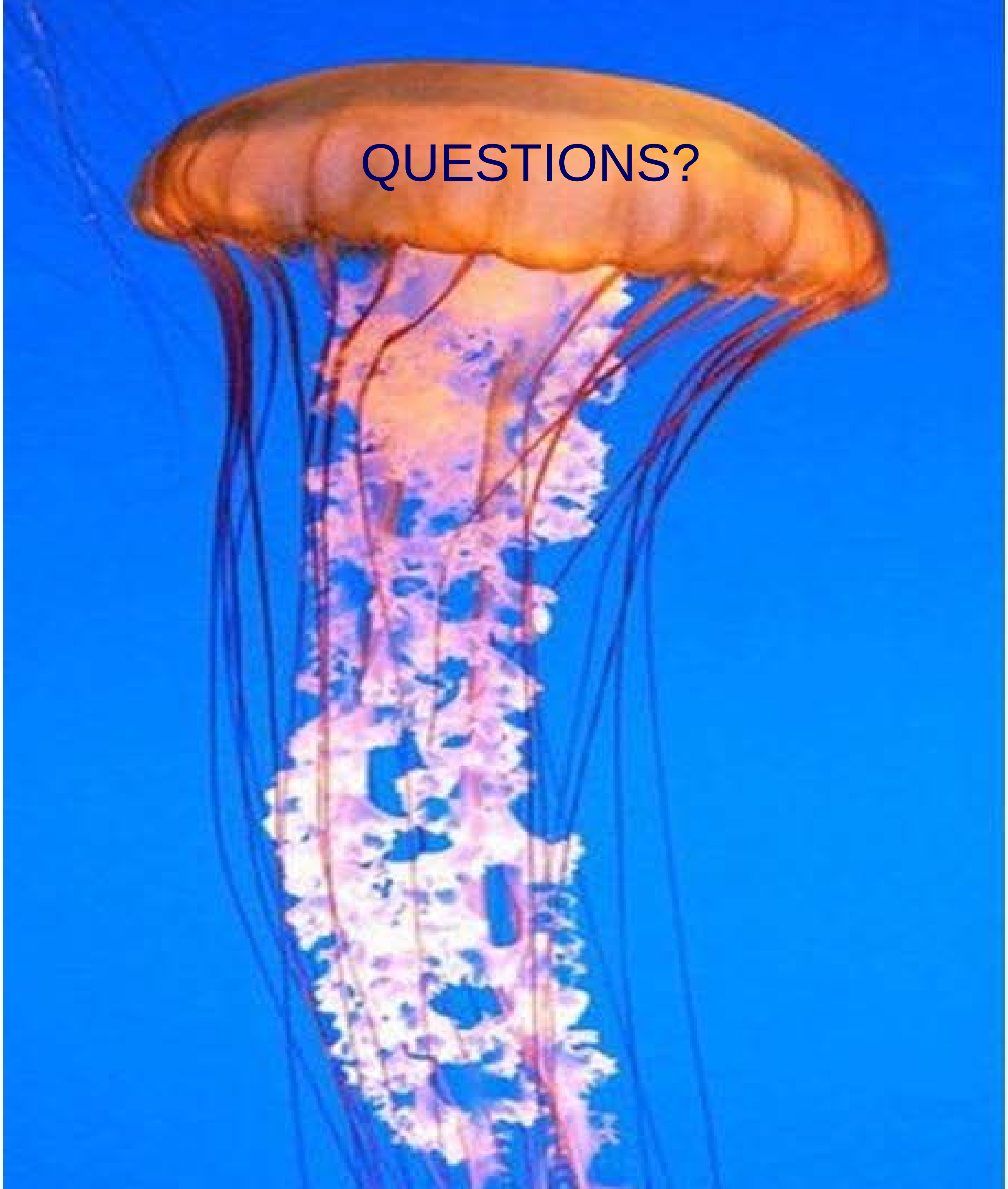
Steps for Developing Estuarine Nutrient Bio-Criteria

Research: Develop a scientifically defensible nutrient stressor-response model and/or reference condition for comparisons.

Standards: Select criteria supported by defensible science to protect designated uses (aquatic life, recreation, aesthetics)

Monitoring: Must be cost-effective and implementable field lab protocols for routine monitoring in support of short term water quality goals (Bi-annual 305b/303d) and long term restoration goals (TMDLs)

Assessment: Statistical protocols to assess monitoring data for meeting standards recognizing the relationships between water chemistry criteria and biocriteria (TN Vs Chl A and/or biodiversity)


QUESTIONS?