

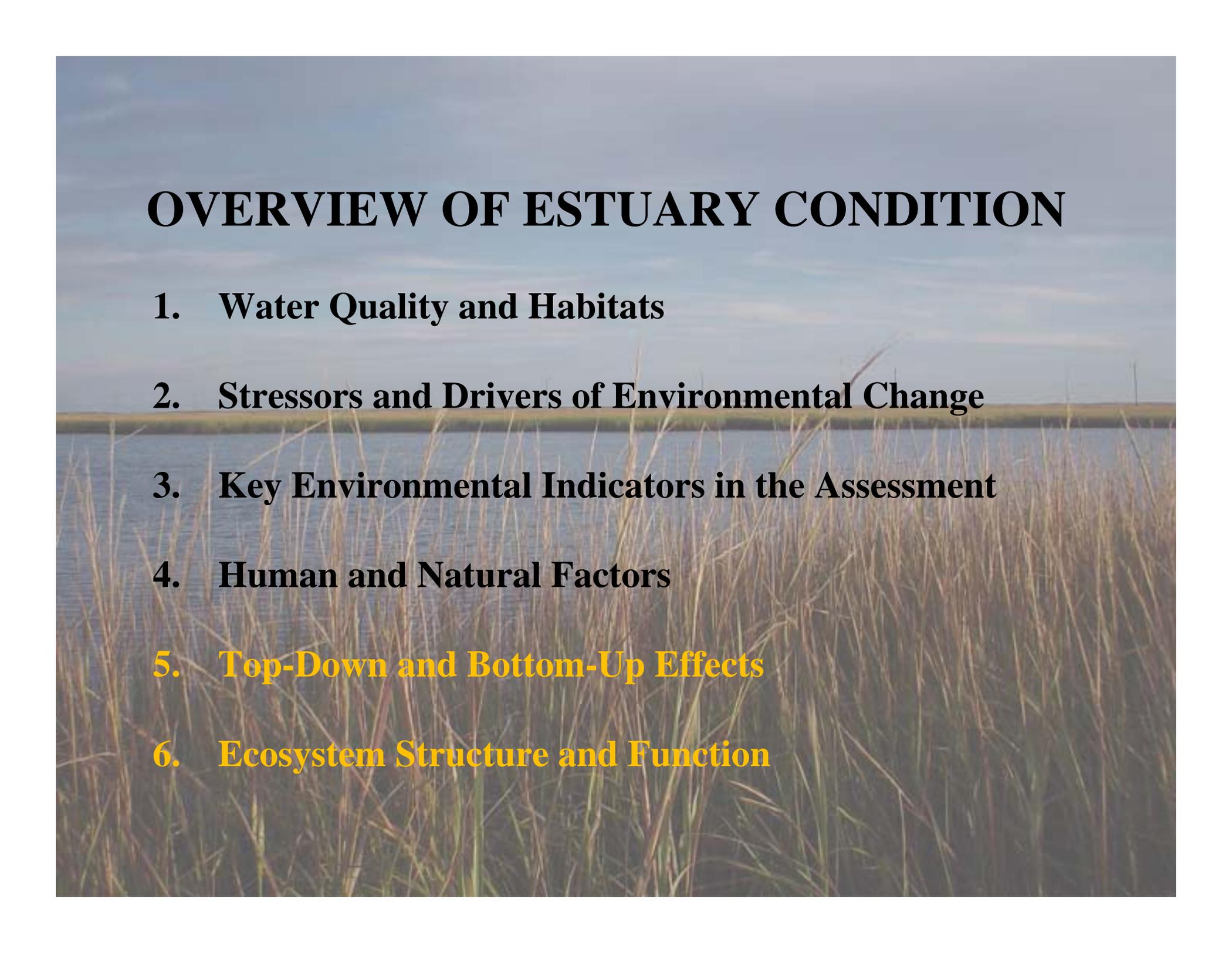
Barnegat Bay-Little Egg Harbor: Eutrophication Update

Michael J. Kennish
Institute of Marine and Coastal Sciences
Rutgers University

**Presented at: NJ Water Monitoring
Council Meeting**

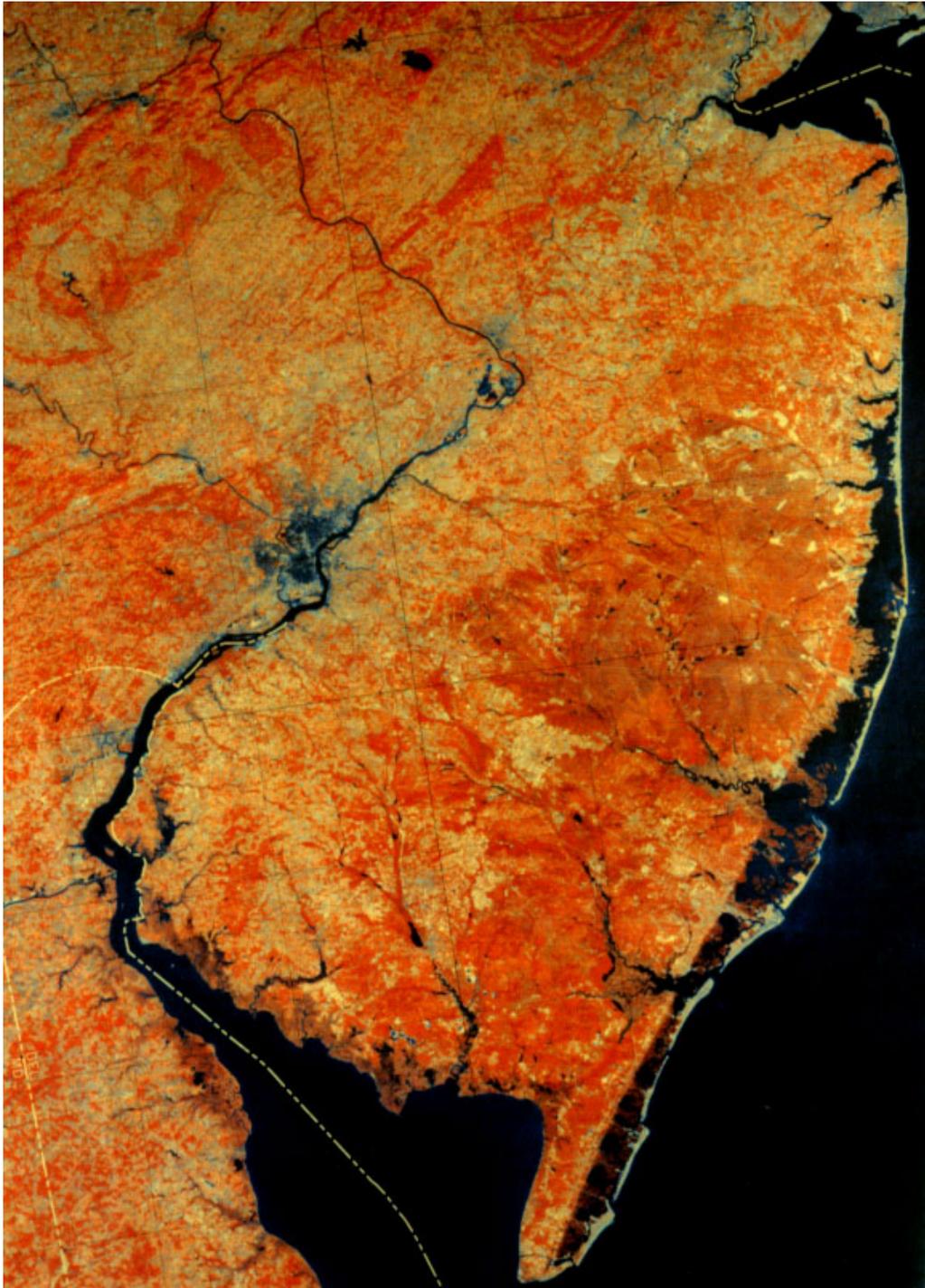
September 22, 2010





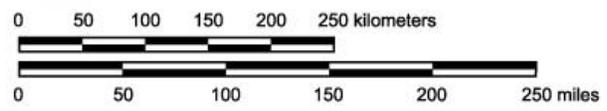
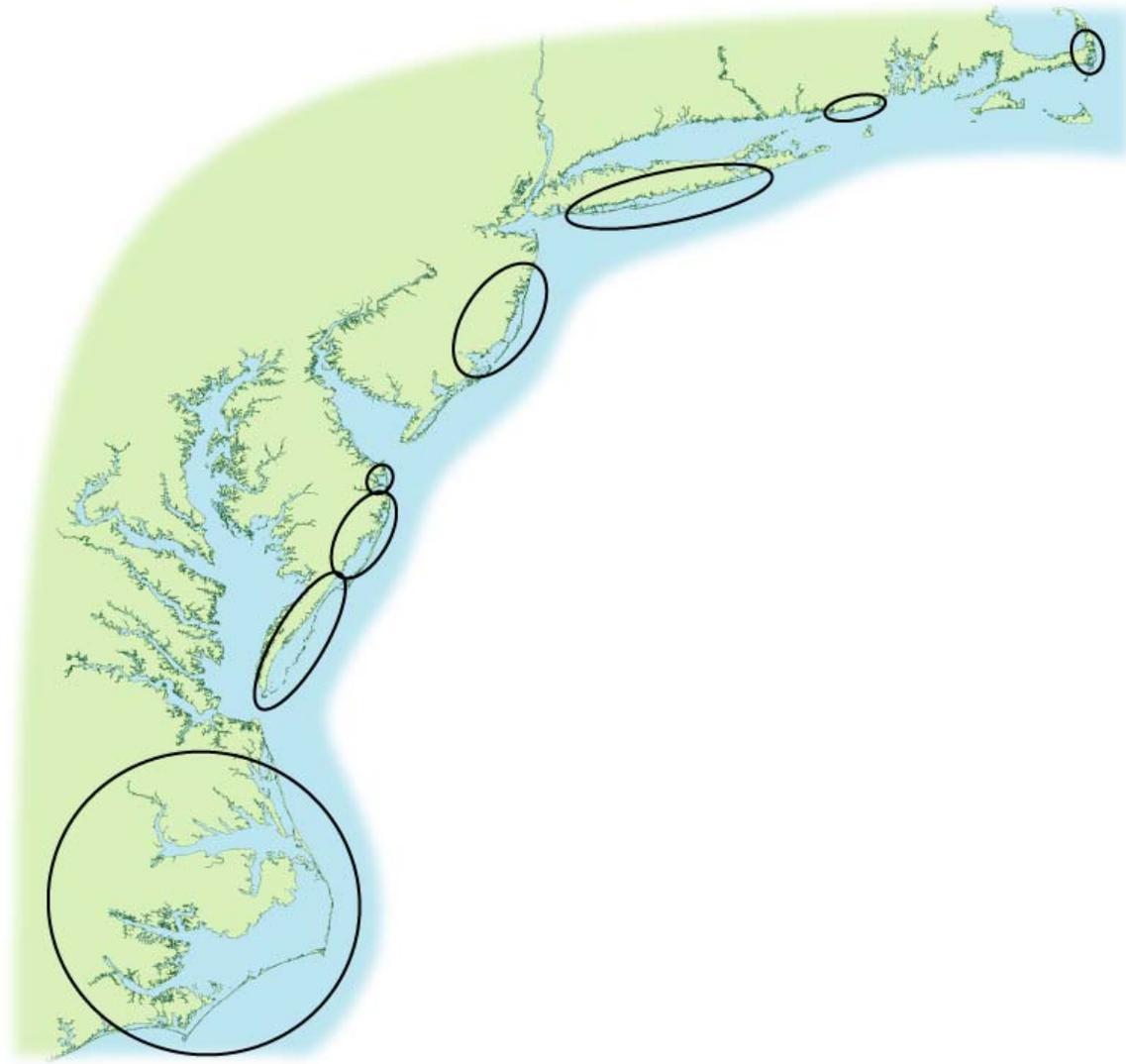
OVERVIEW OF ESTUARY CONDITION

- 1. Water Quality and Habitats**
- 2. Stressors and Drivers of Environmental Change**
- 3. Key Environmental Indicators in the Assessment**
- 4. Human and Natural Factors**
- 5. Top-Down and Bottom-Up Effects**
- 6. Ecosystem Structure and Function**

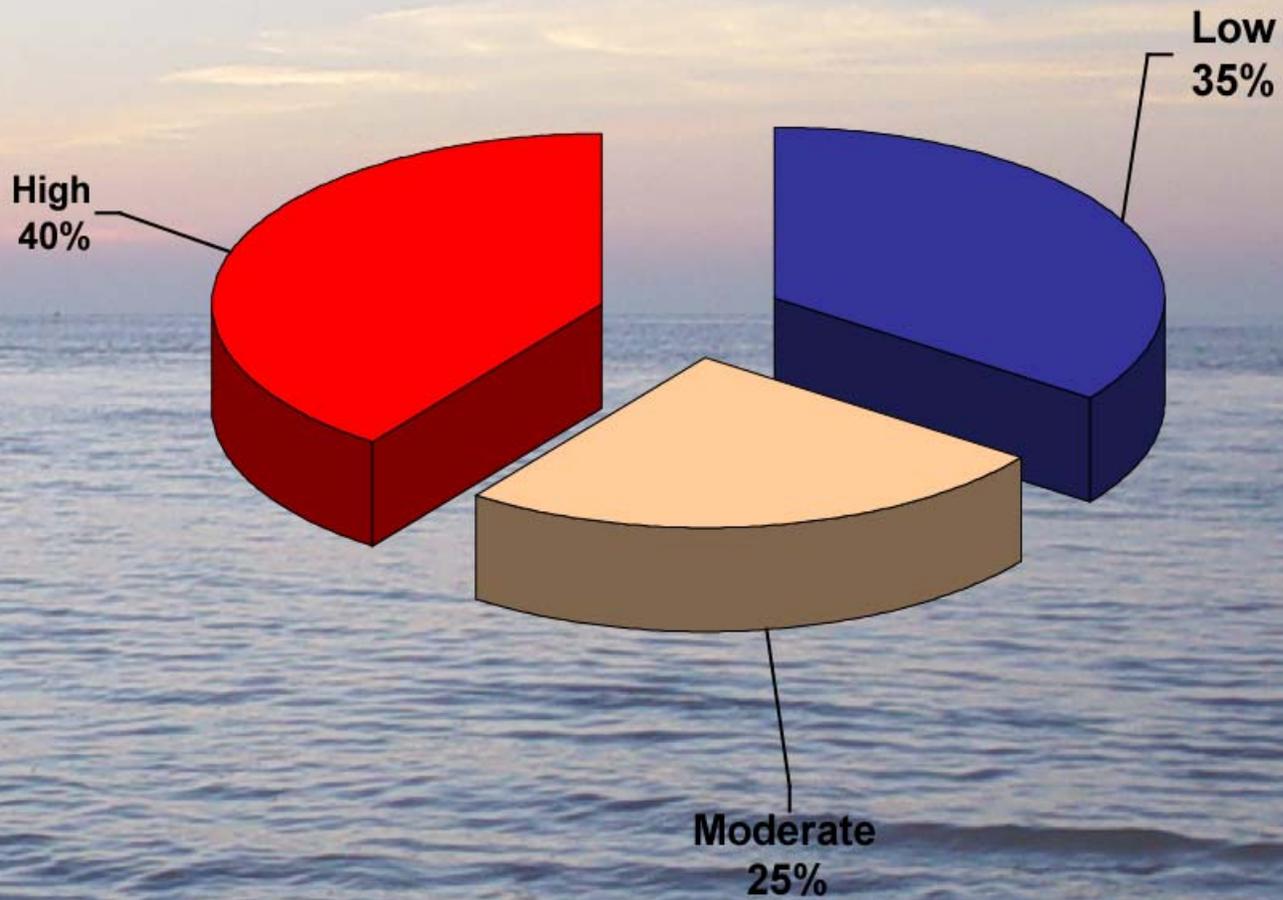


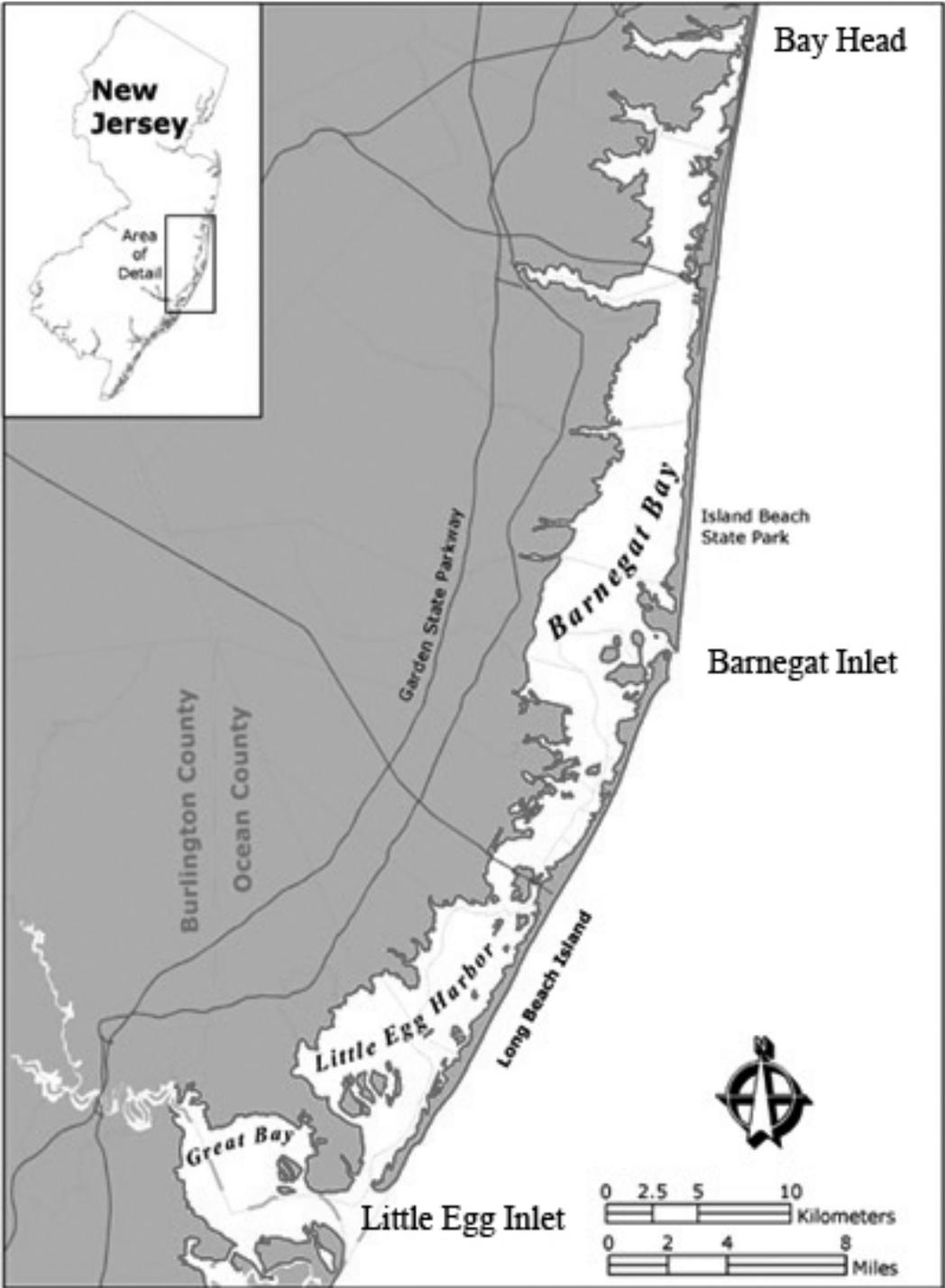
Coastal Lagoons

**Barnegat Bay-
Little Egg Harbor**



Eutrophication





ANTHROPOGENIC EFFECTS*

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 (Jivoff)
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/Floatable

***Estuary Impaired for Human Use and Aquatic Life Support**

Potato sponges

Seagrass loss

Brown tide

Phytoplankton blooms

PRIMARY PRODUCERS

Phytoplankton

0 – 500 g C m⁻² yr⁻¹

Seagrass

100-1500 g C m⁻² yr⁻¹

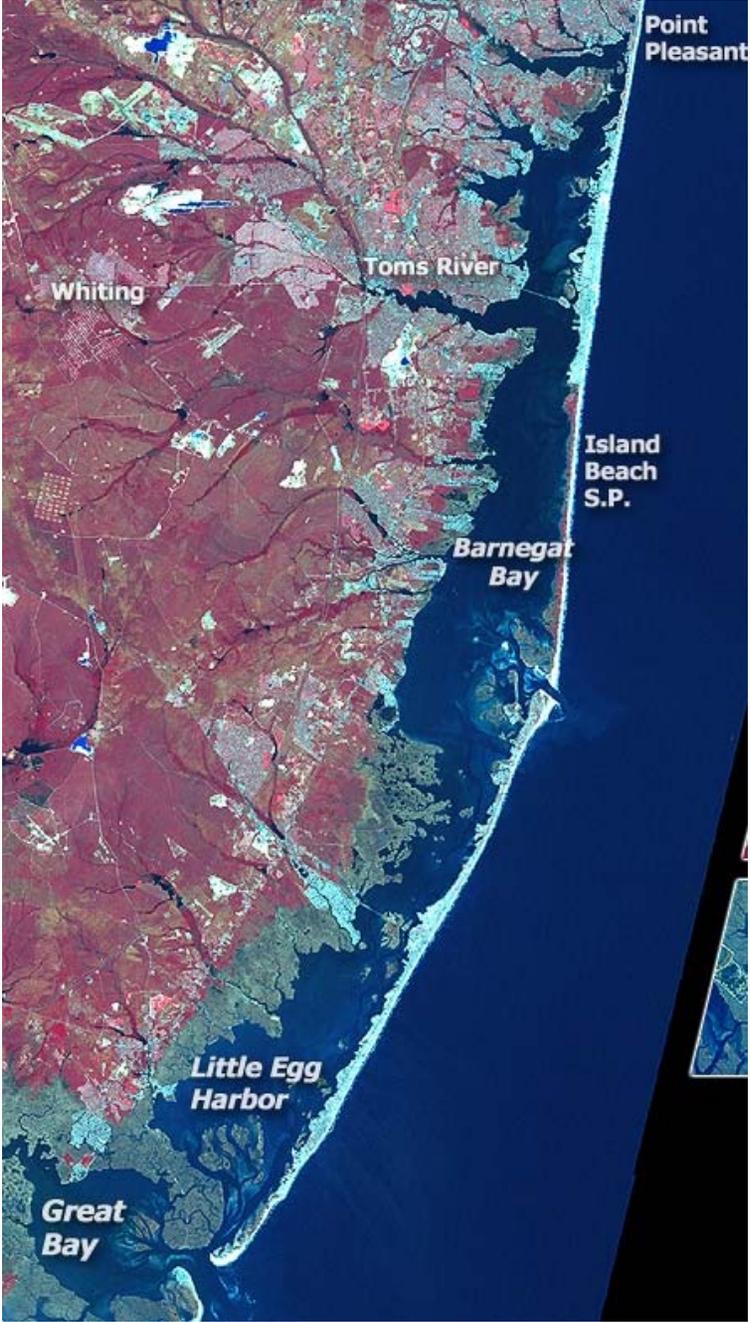
Macroalgae

<100->500 g C m⁻² yr⁻¹

Epiphytes (?)

Benthic Microalgae

25-250 g C m⁻² yr⁻¹



Point Pleasant

Whiting

Toms River

Island Beach S.P.

Barnegat Bay

Little Egg Harbor

Great Bay

BARNEGAT BAY WATERSHED

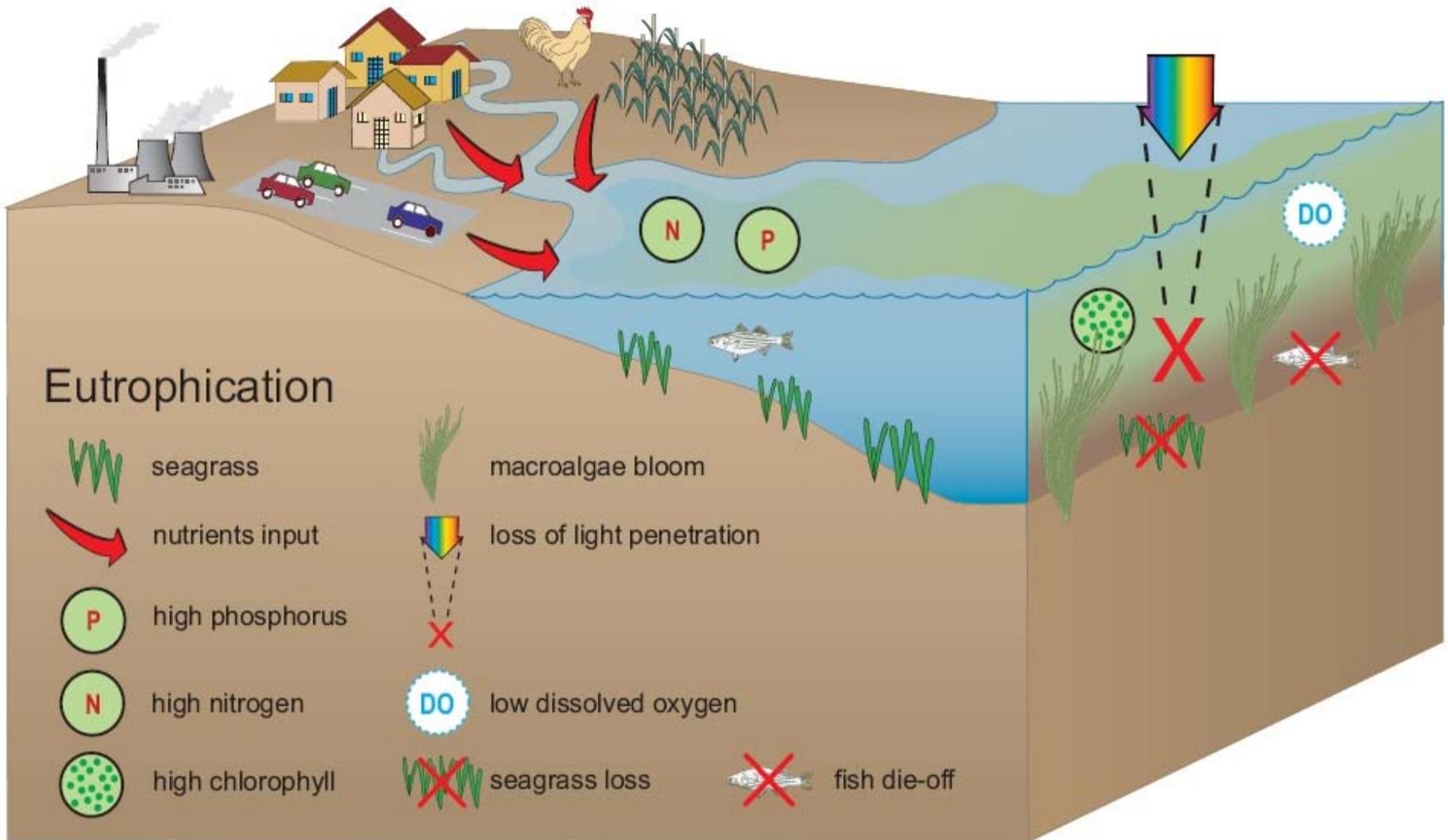
Population = 573,000 (~850,000 at buildout)

Population > 1,400,000 (Summer Season)

~35% Developed Area; >10% Impervious Cover

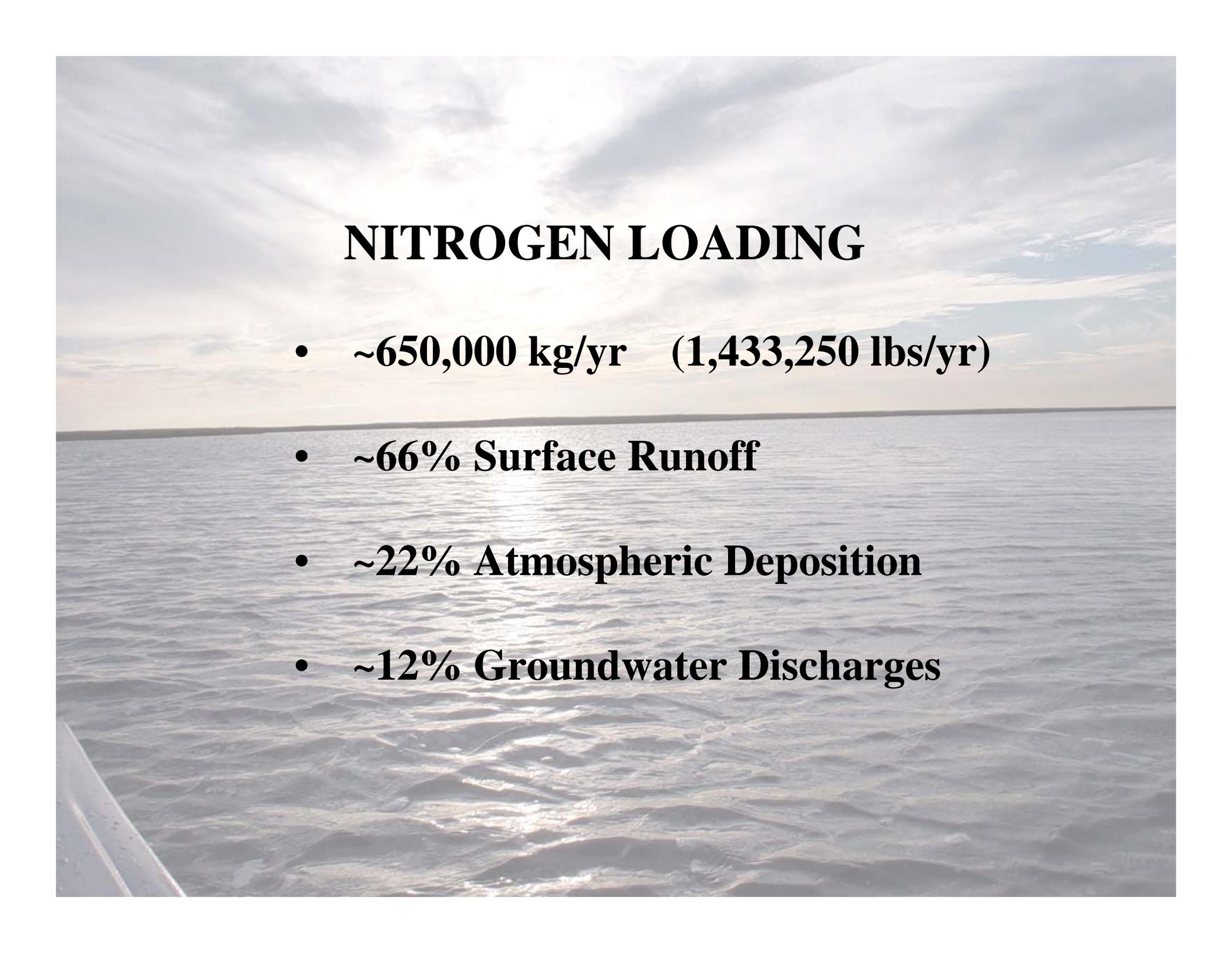
(LAND USE-LAND COVER CHANGE)

	<u>1995</u>	<u>2006</u>
Farmland	5302 ac	4205 ac (-1097 ac)
Urban Land	87,757 ac	103,746 ac (15,989 ac)
Forested Land Cover	1995 – 2006	(-14,248 ac)
Wetland Cover	1995 – 2006	(-325 ac)



Eutrophication

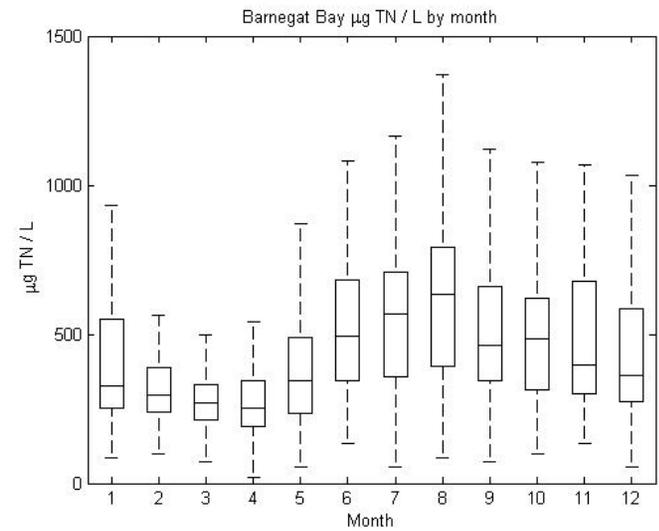
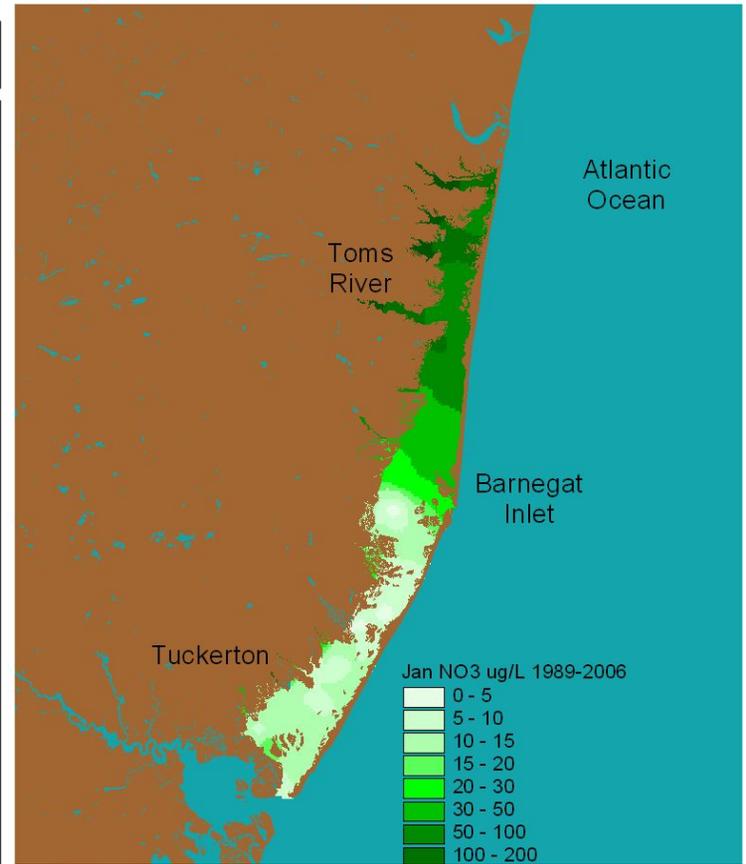
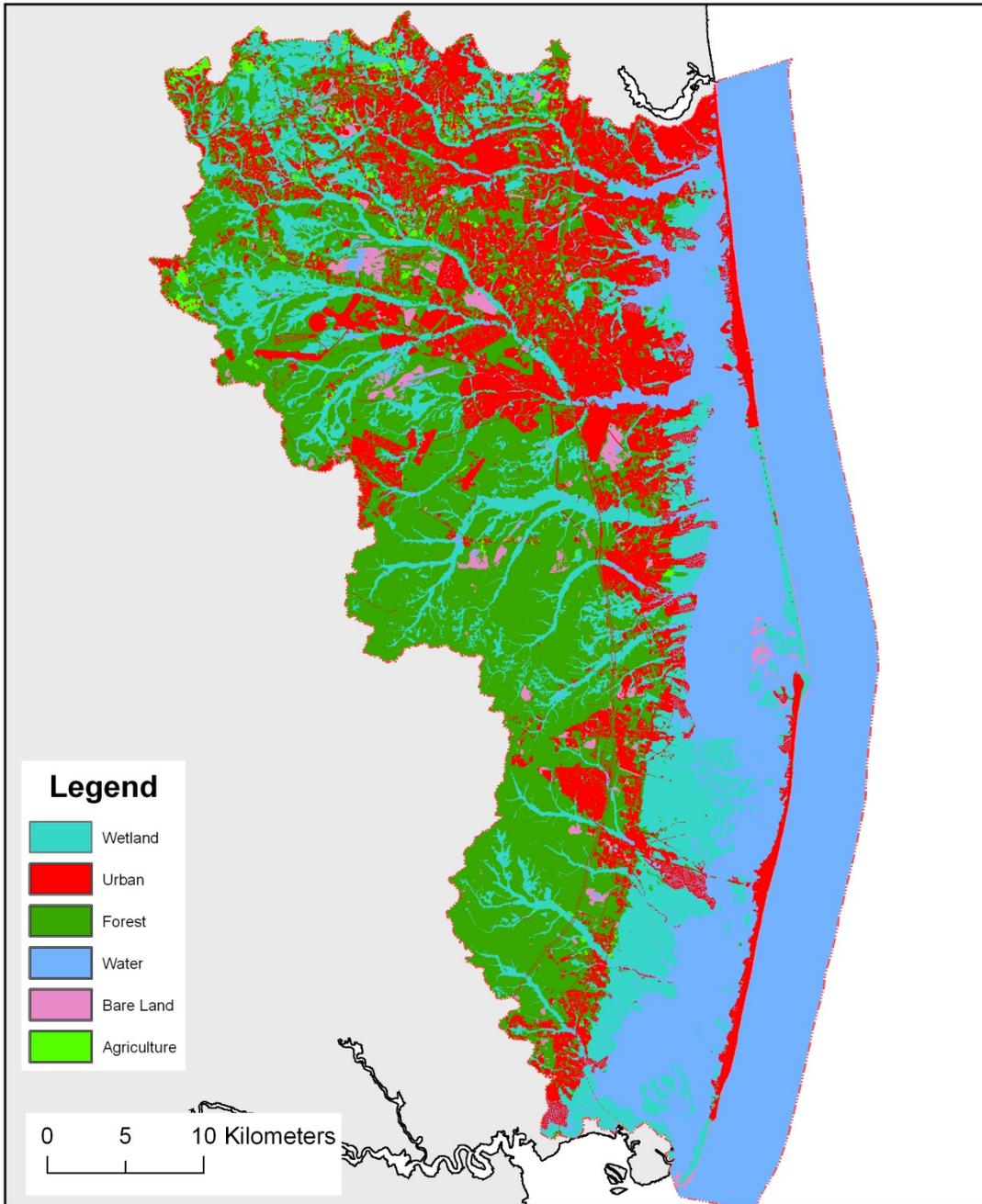
-  seagrass
-  macroalgae bloom
-  nutrients input
-  loss of light penetration
-  high phosphorus
-  high nitrogen
-  low dissolved oxygen
-  high chlorophyll
-  seagrass loss
-  fish die-off

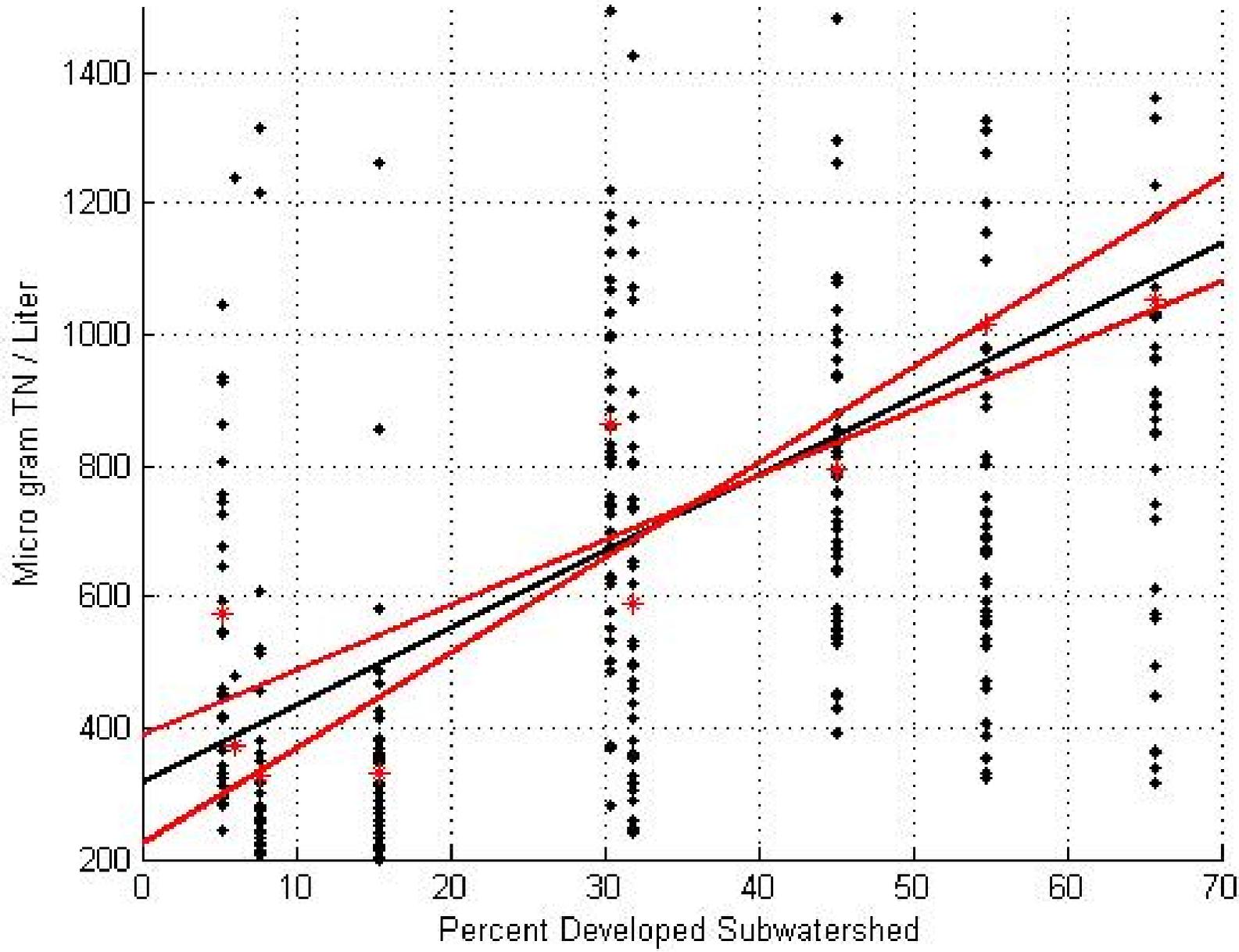


NITROGEN LOADING

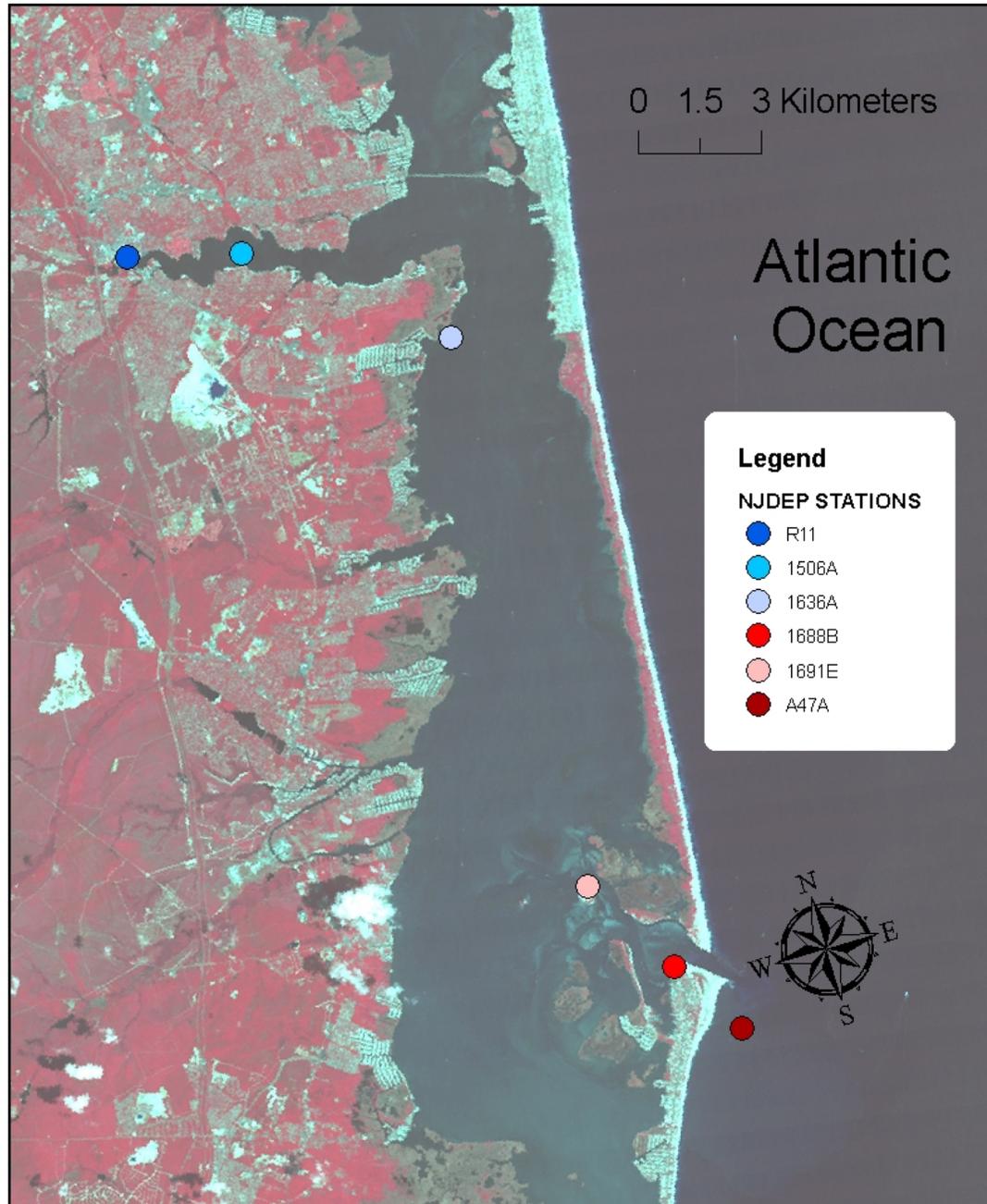
- **~650,000 kg/yr (1,433,250 lbs/yr)**
- **~66% Surface Runoff**
- **~22% Atmospheric Deposition**
- **~12% Groundwater Discharges**

Land Cover Type 2006 for the Barnegat Bay Watershed

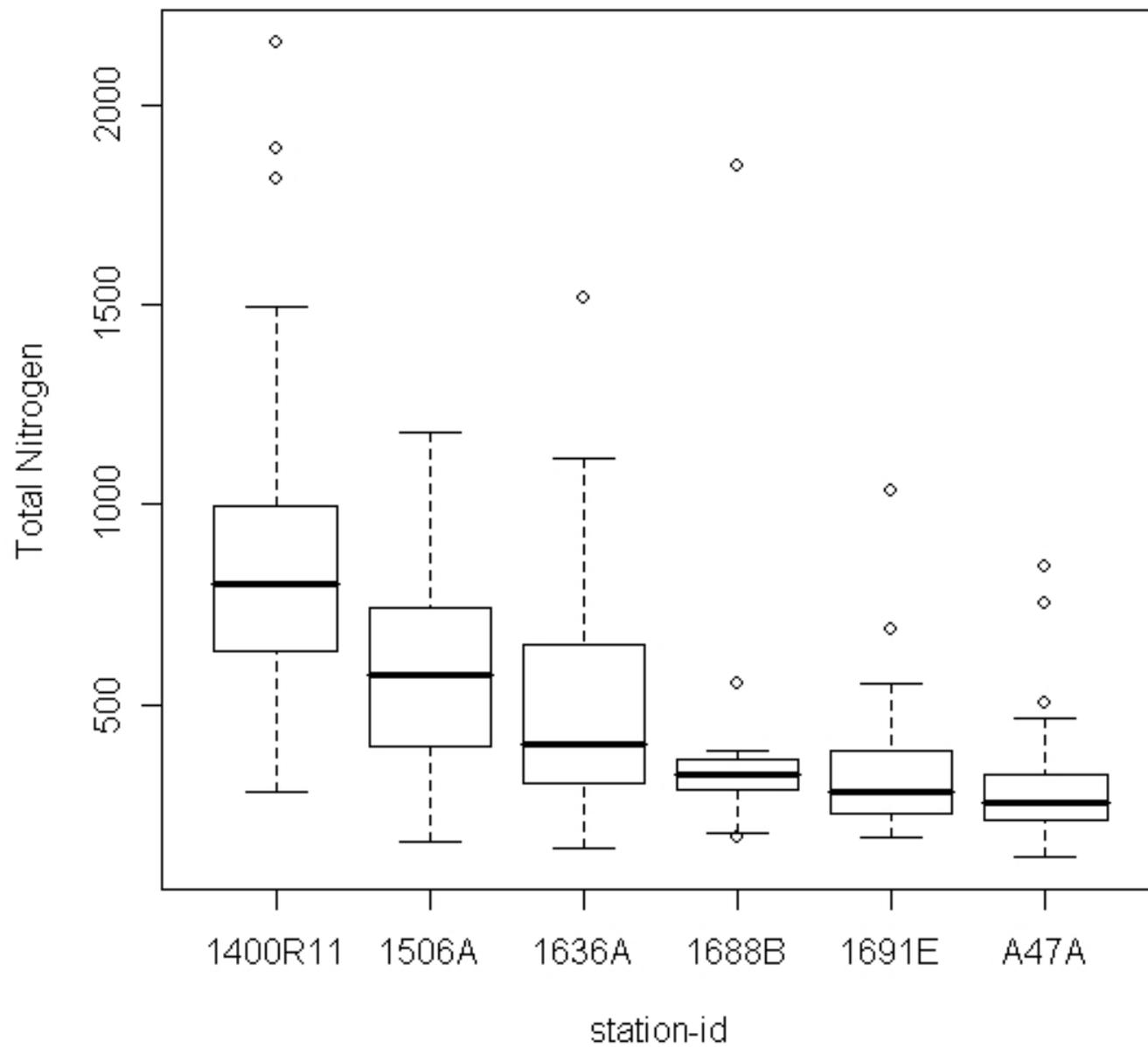




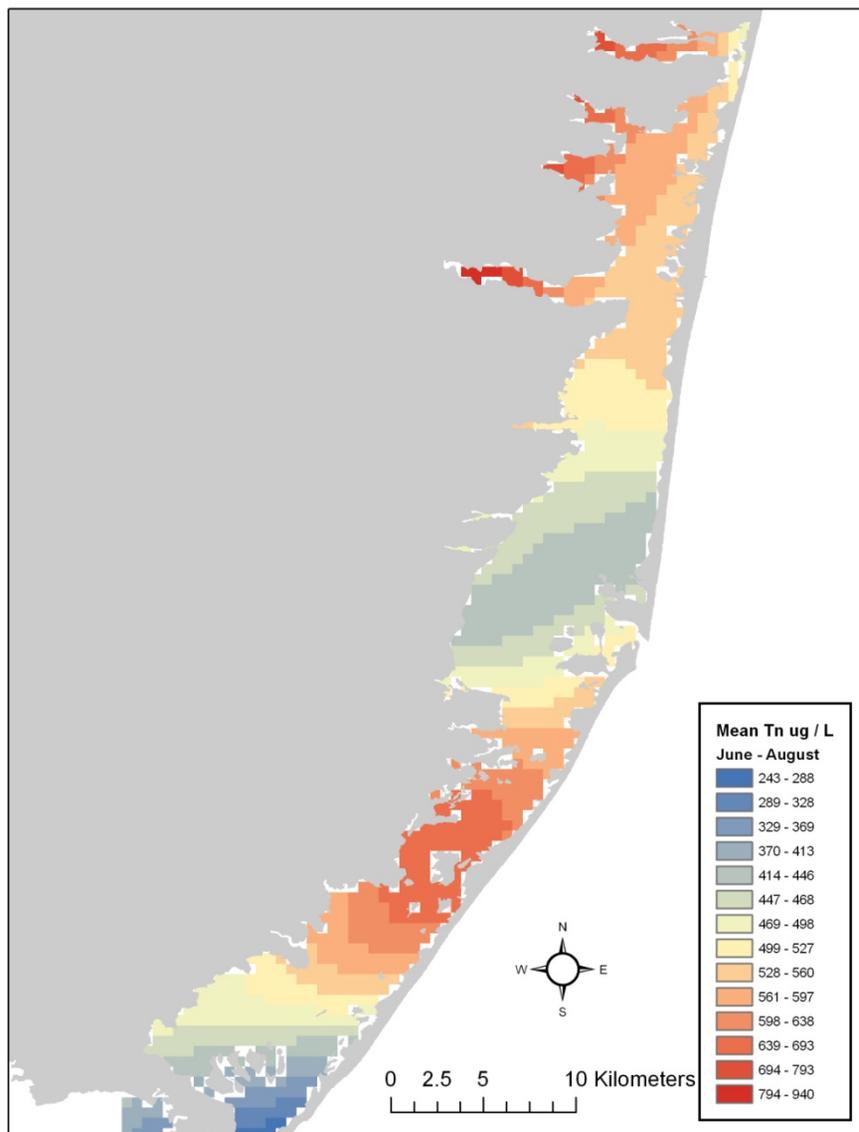
Select NJDEP Monitoring Points



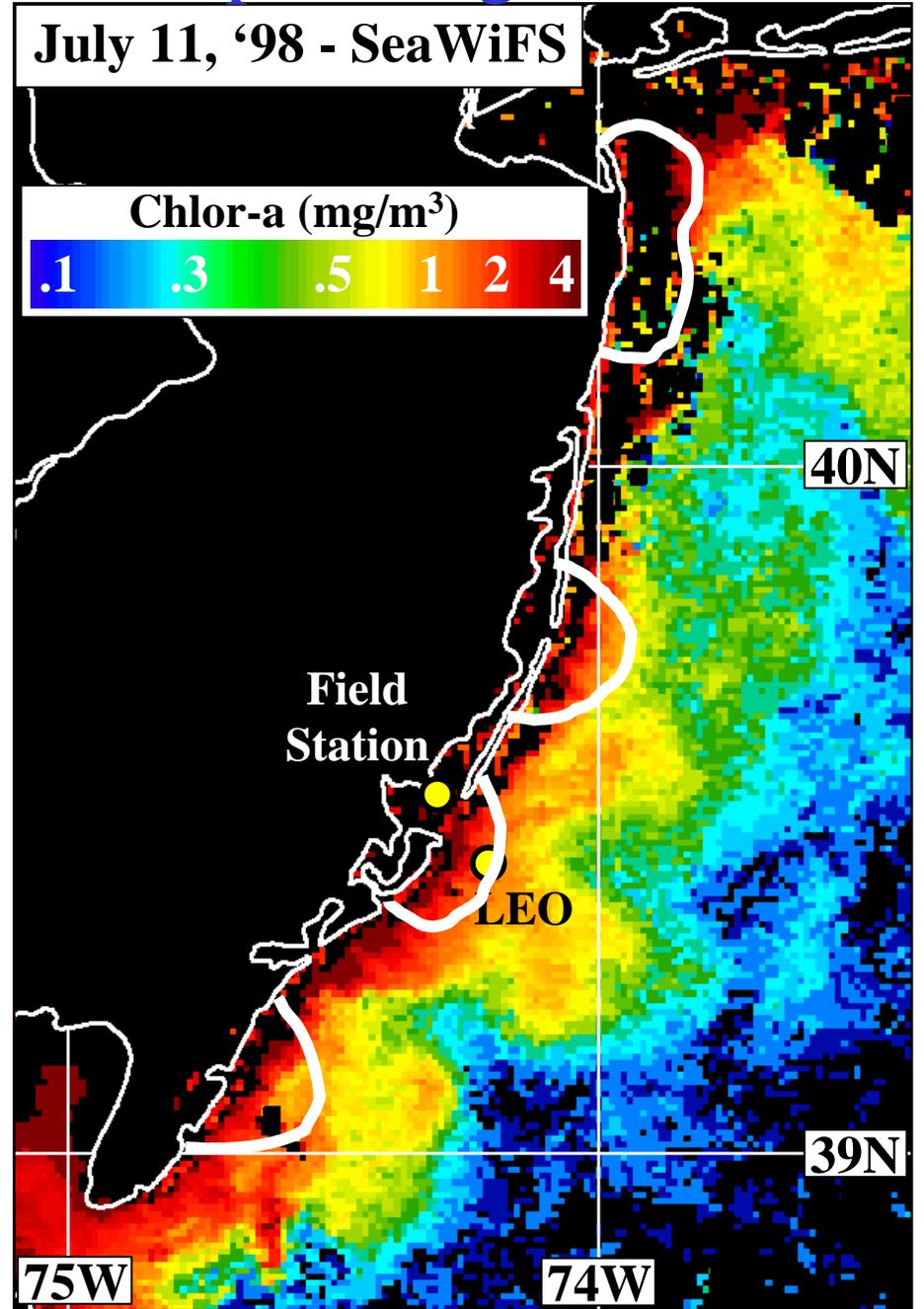
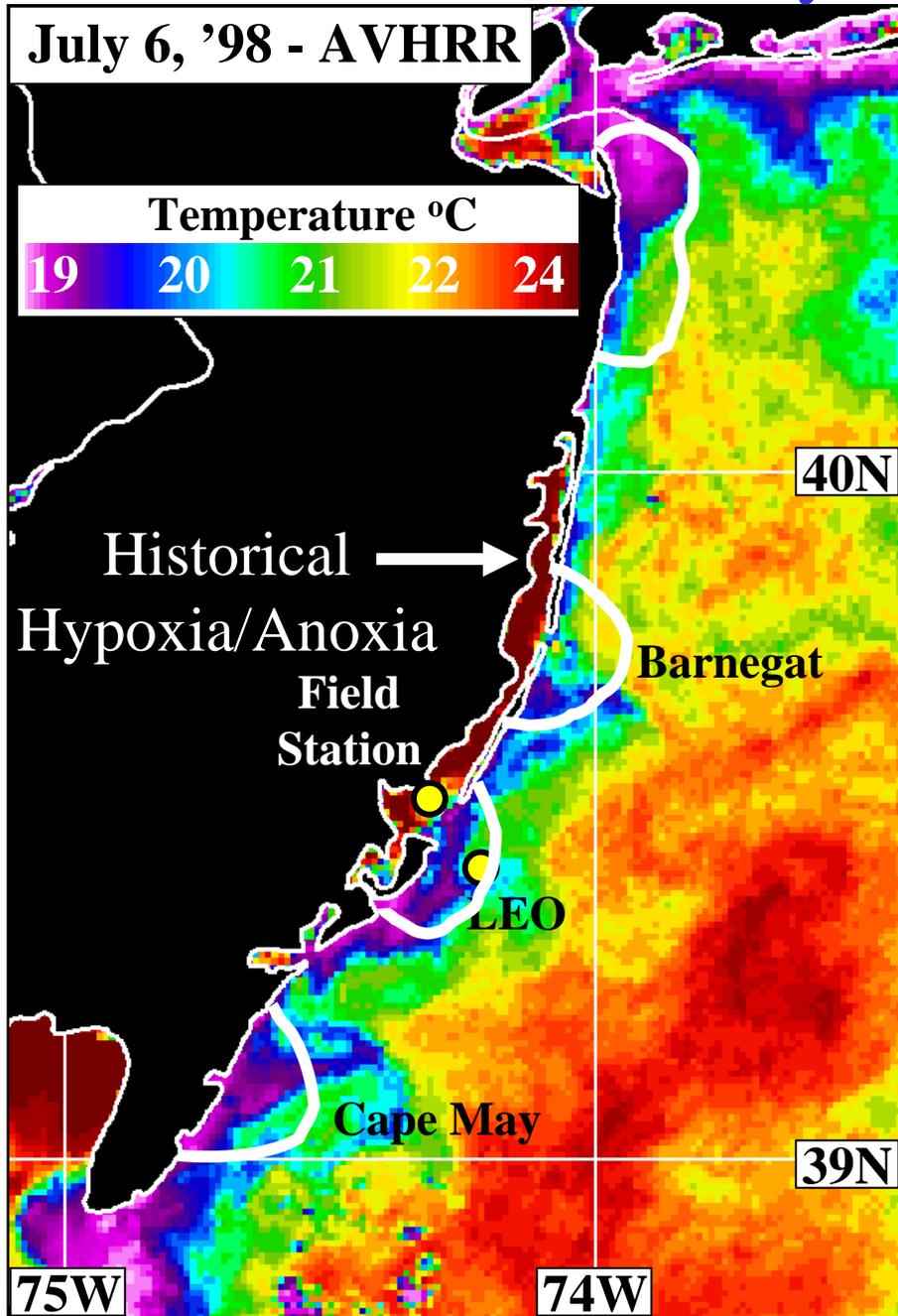
Total Nitrogen per Station



Mean Total Nitrogen by stations June - August 1989 2006



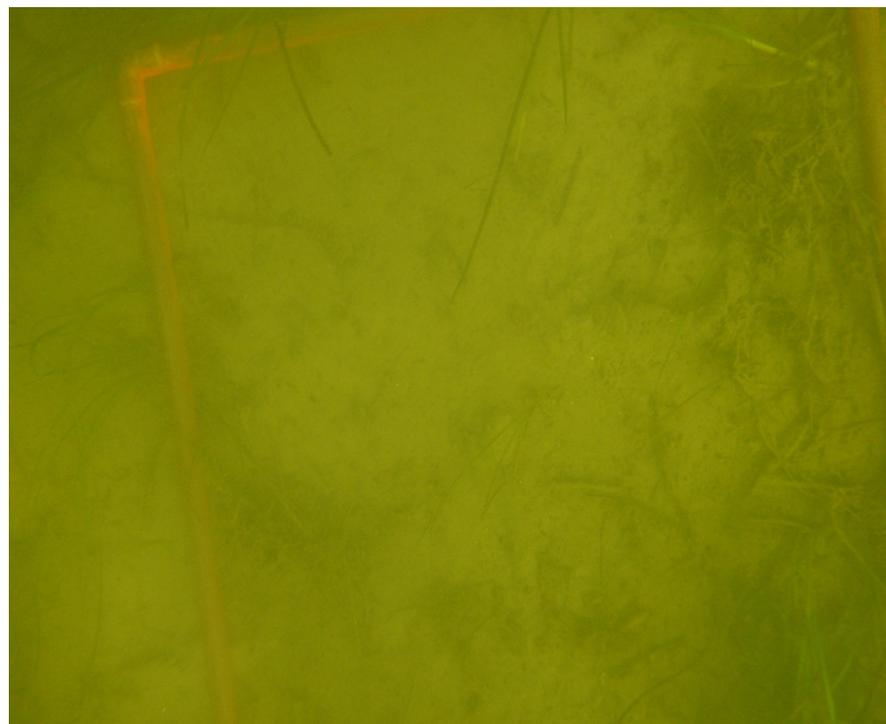
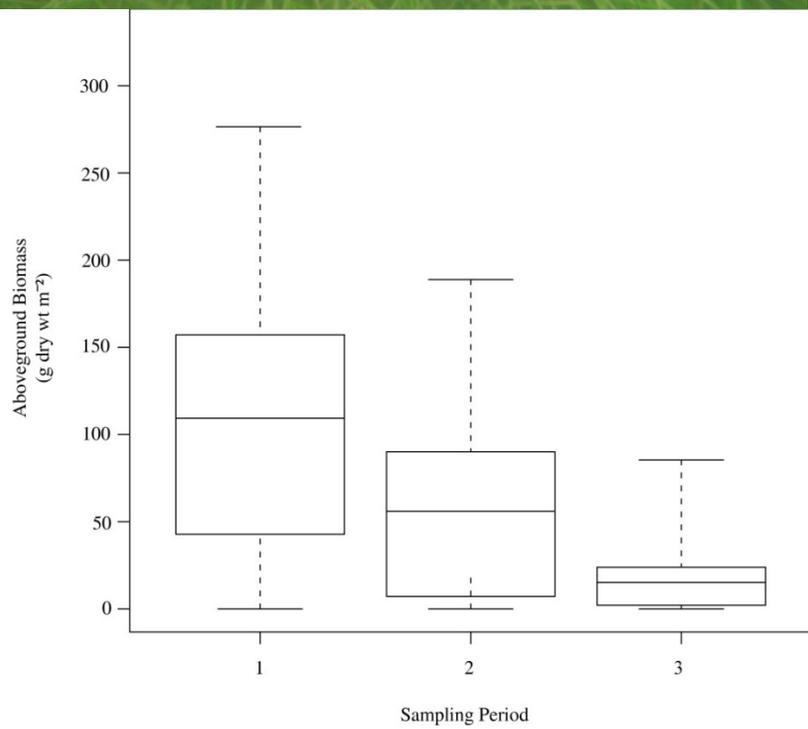
New Jersey Coastal Upwelling



Algal Blooms

- Phytoplankton
> Chl *a* 10-18 $\mu\text{g l}^{-1}$
- *Zostera marina* (Biomass)
50-200 g AFDW m^{-2}
- Macroalgae (Blooms)
> 400 g AFDW m^{-2}
- Benthic Microalgae





Sea Lettuce





Phytoplankton Production

(Up to $\sim 500 \text{ g C m}^{-2} \text{ yr}^{-1}$)

Nixon Trophic Classification

Brown Tide Blooms

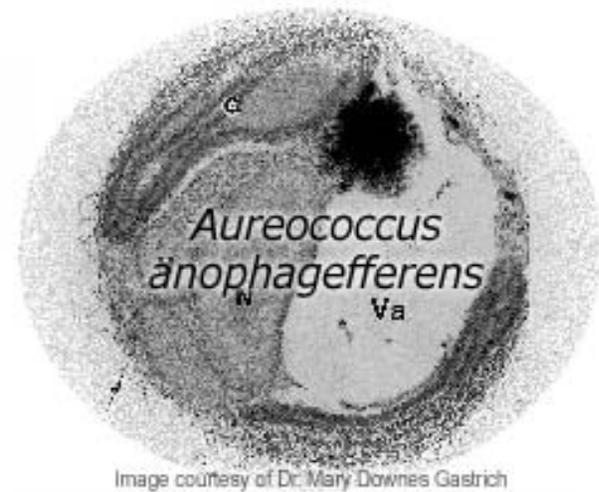
1-2 million cells ml^{-1}

(1995, 1997, 1999-2002)

Phytoplankton Species Shift

Diatoms to Microflagellates

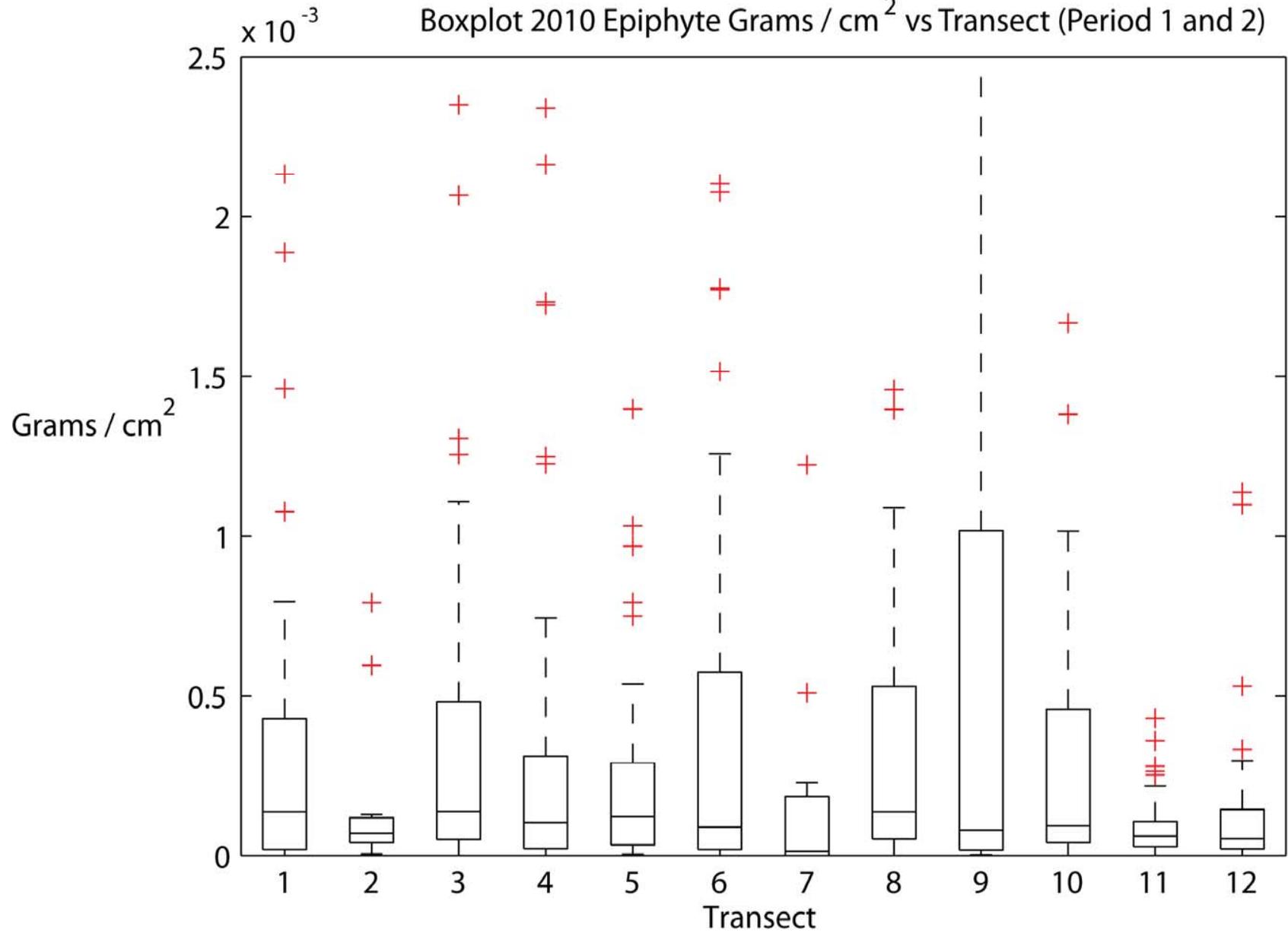
Raphidophytes, Pelagophytes







Boxplot 2010 Epiphyte Grams / cm² vs Transect (Period 1 and 2)

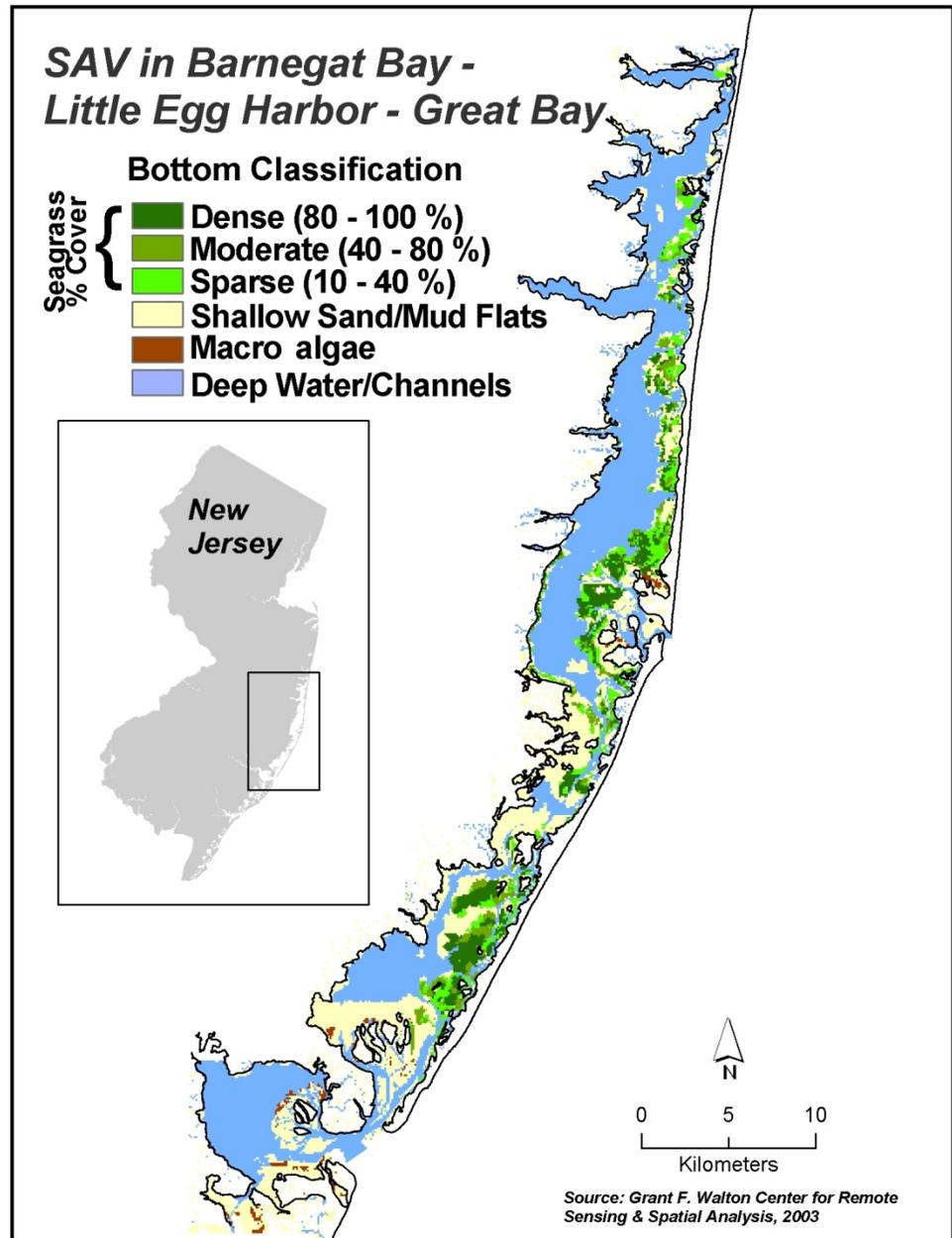


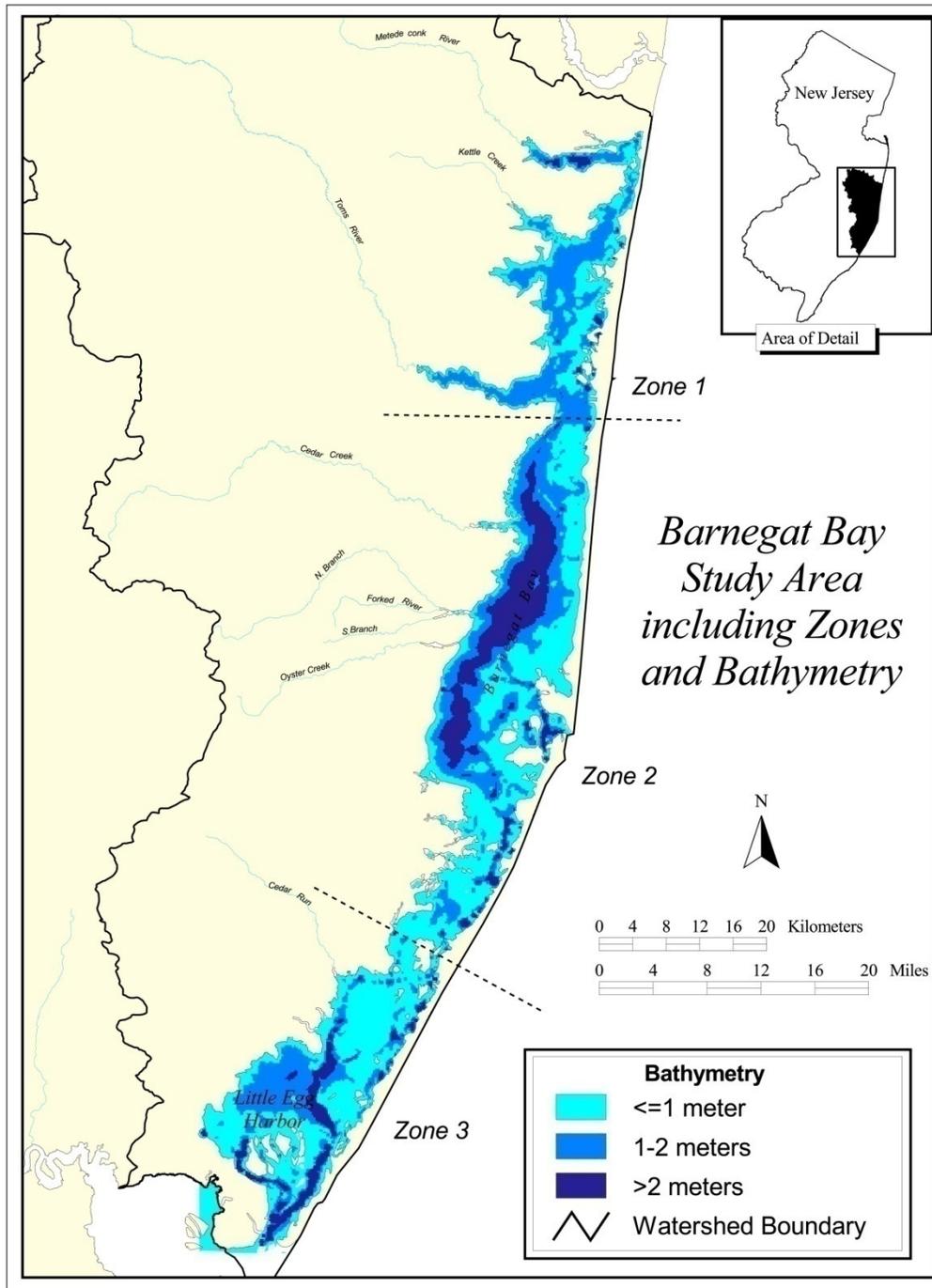
Eelgrass Decline

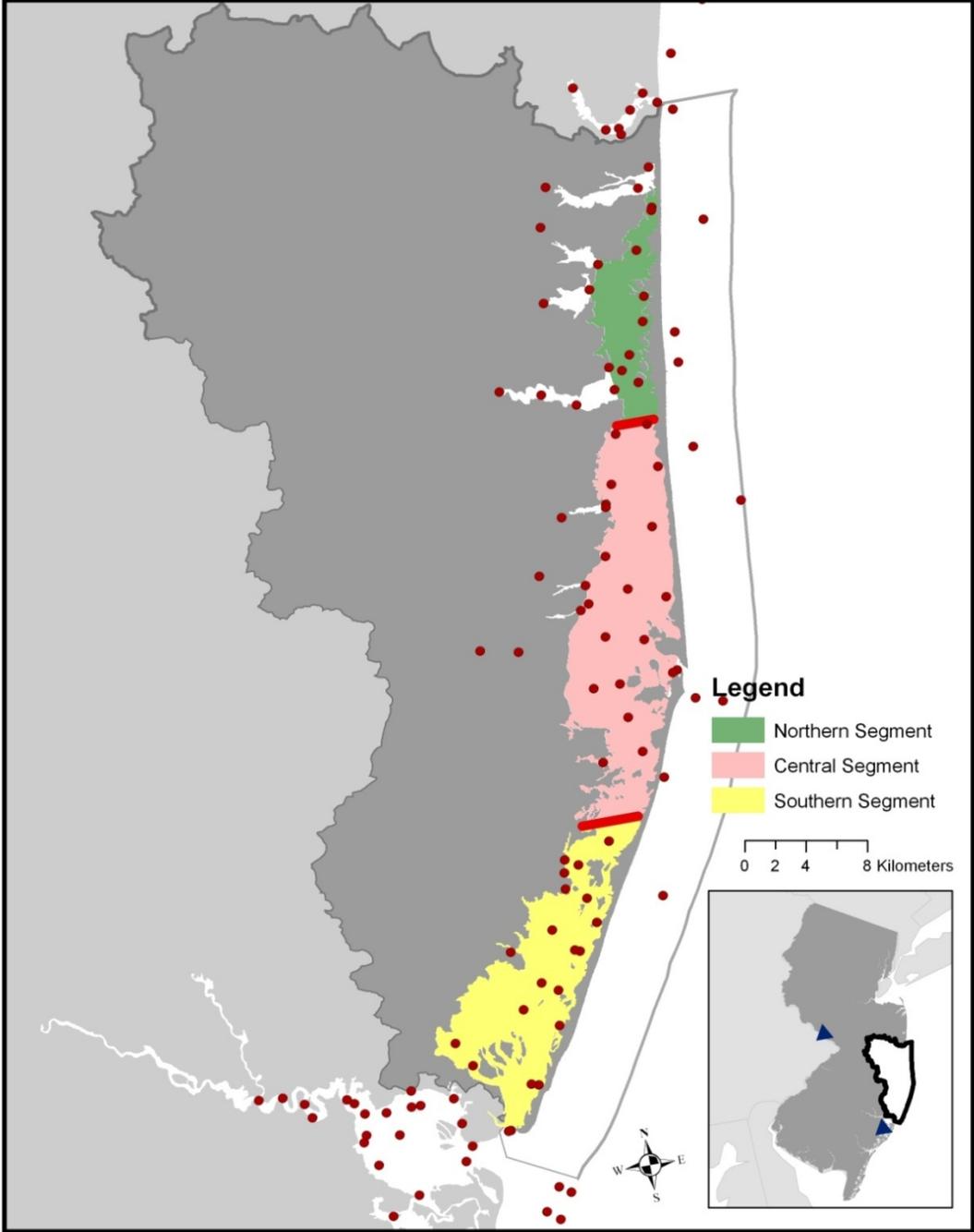
>60% in Little Egg Harbor (1975-2000)

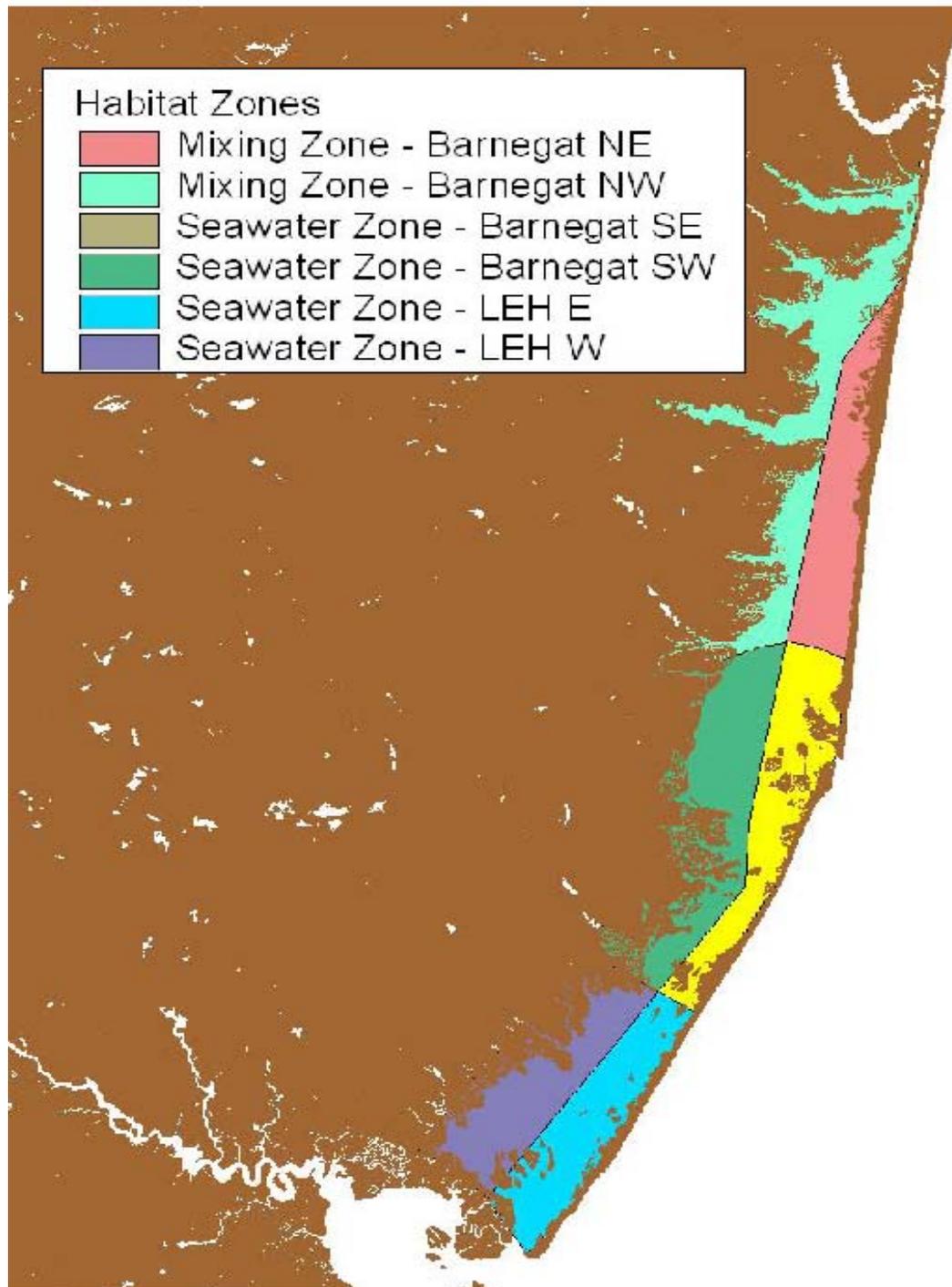
>30% in Entire Estuary

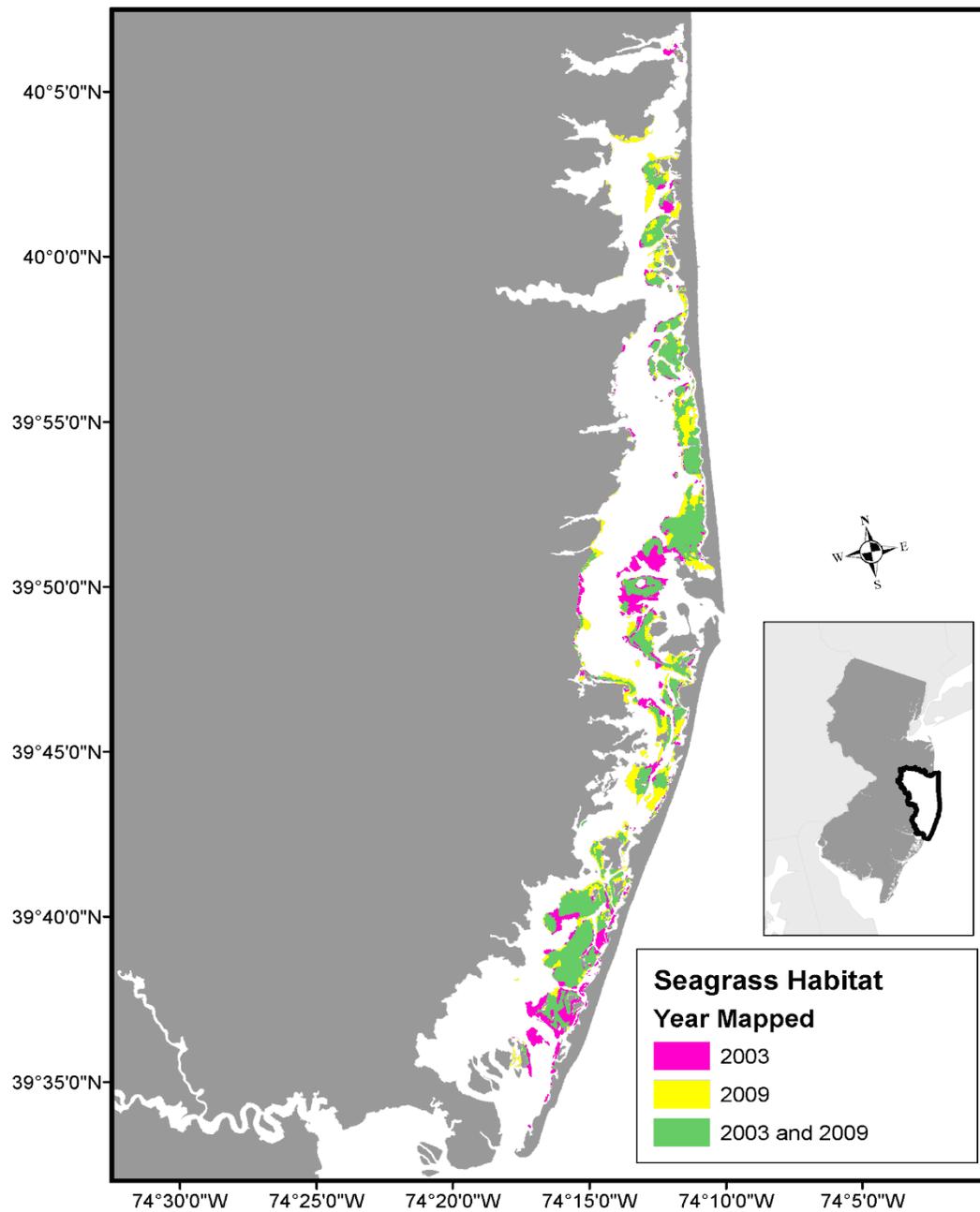
(Data Source: Paul Bologna)

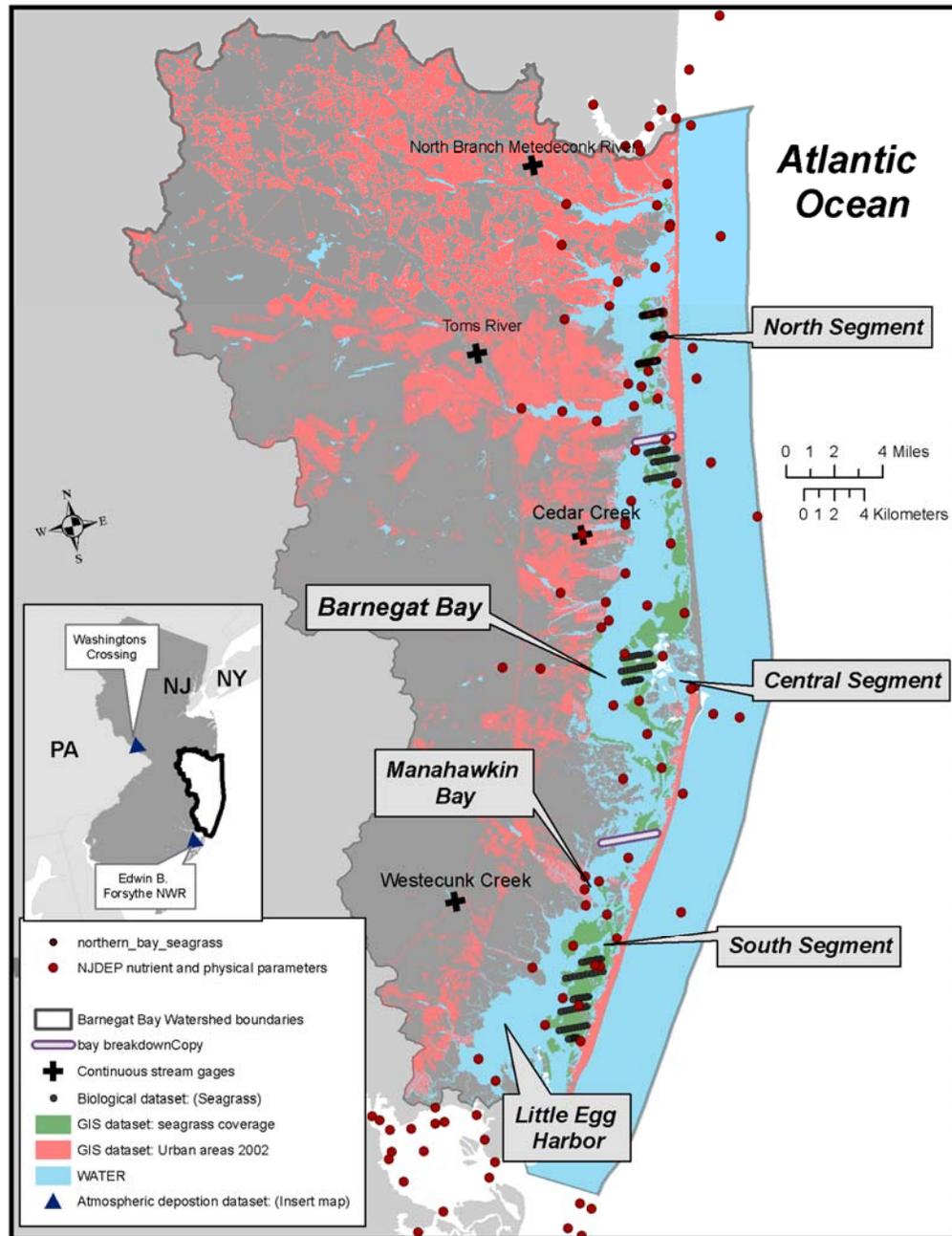




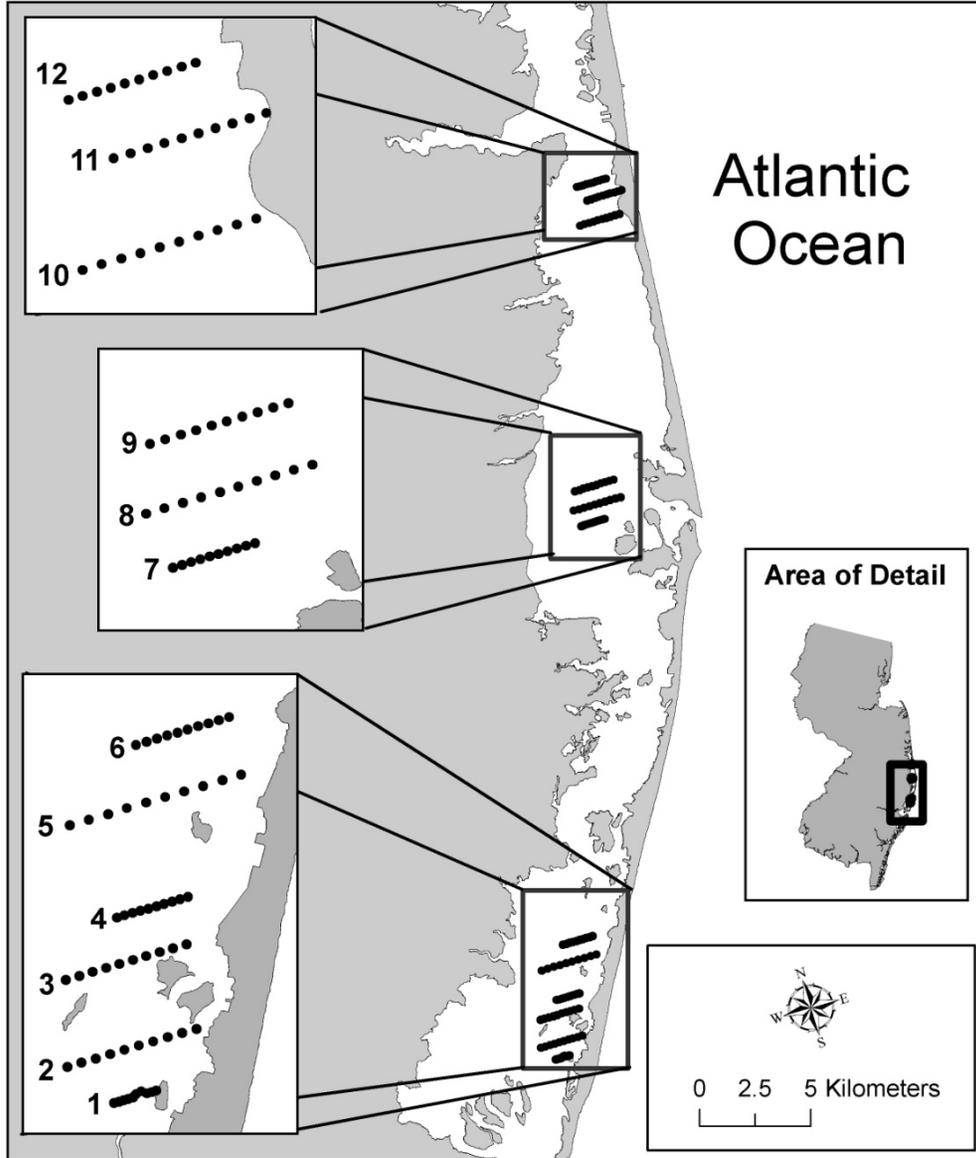




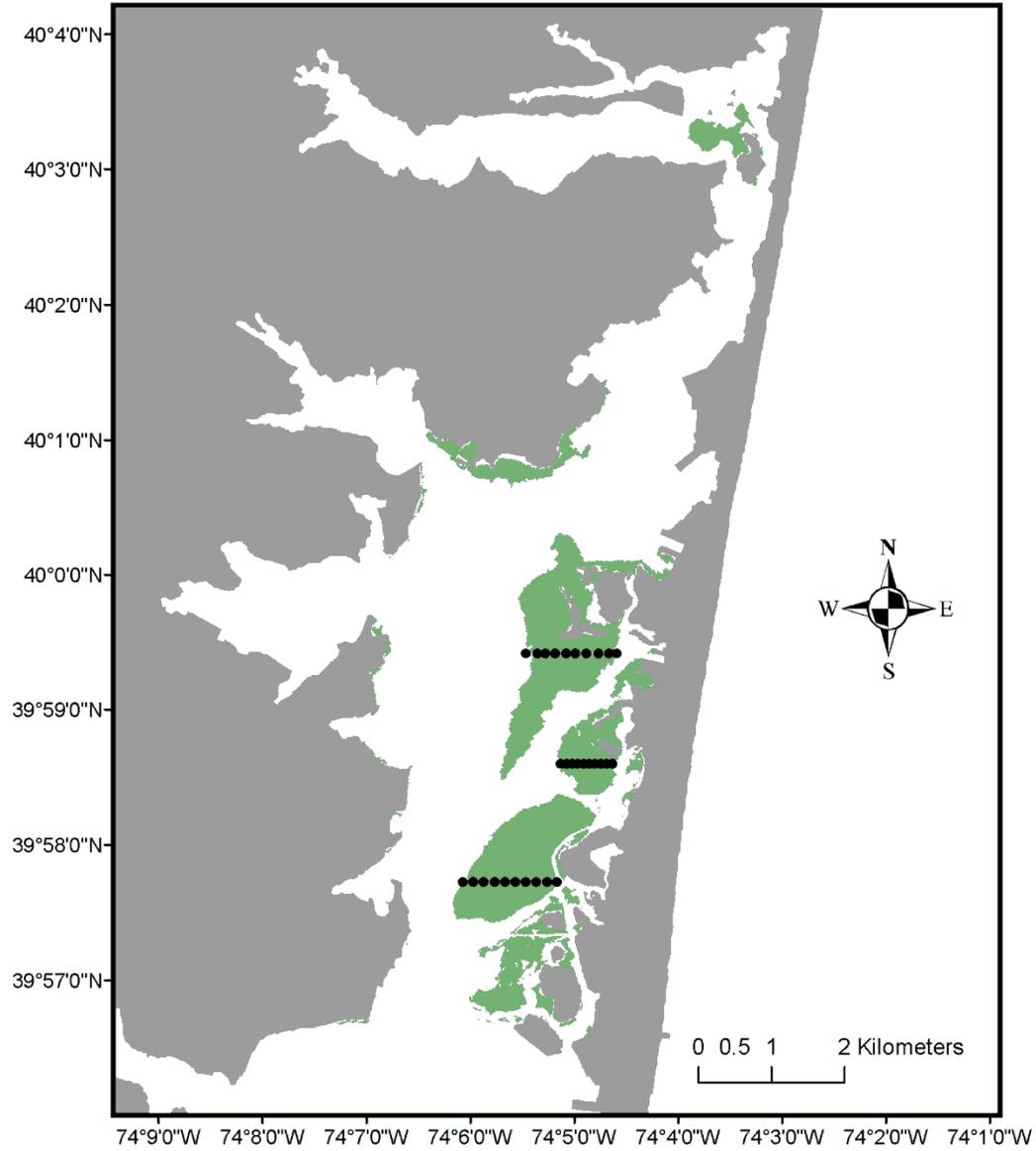


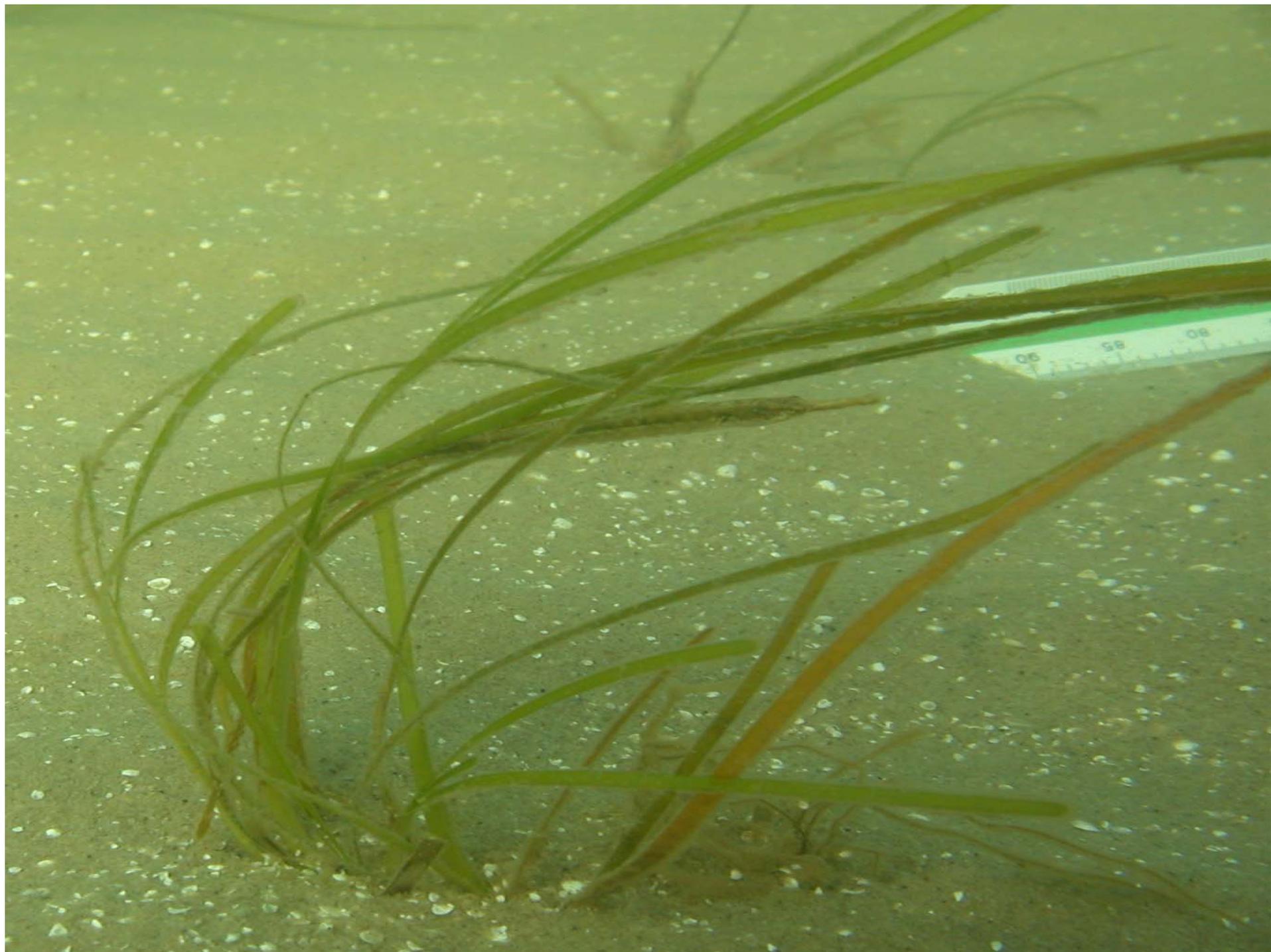


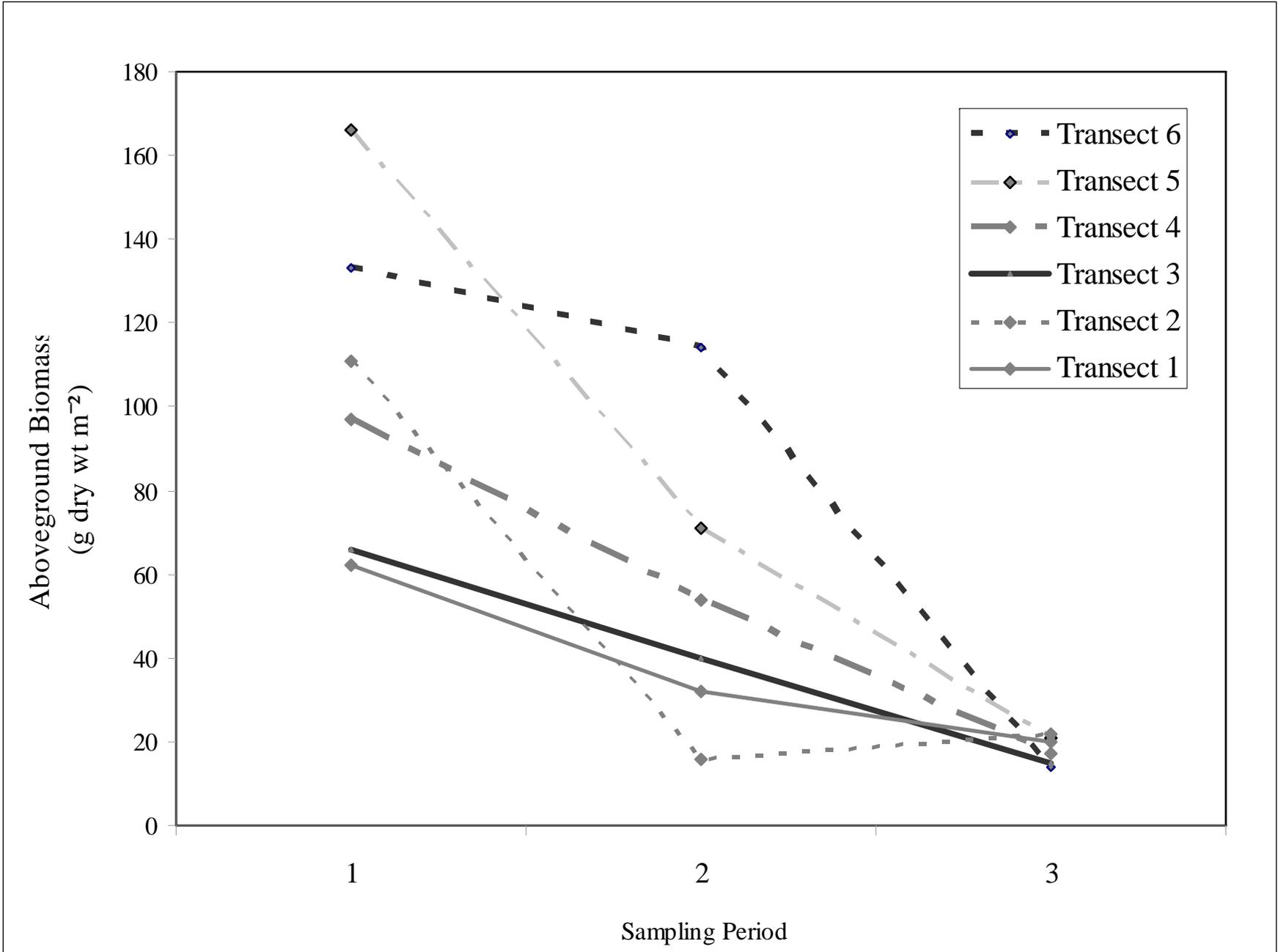
Transects and Sampling Sites

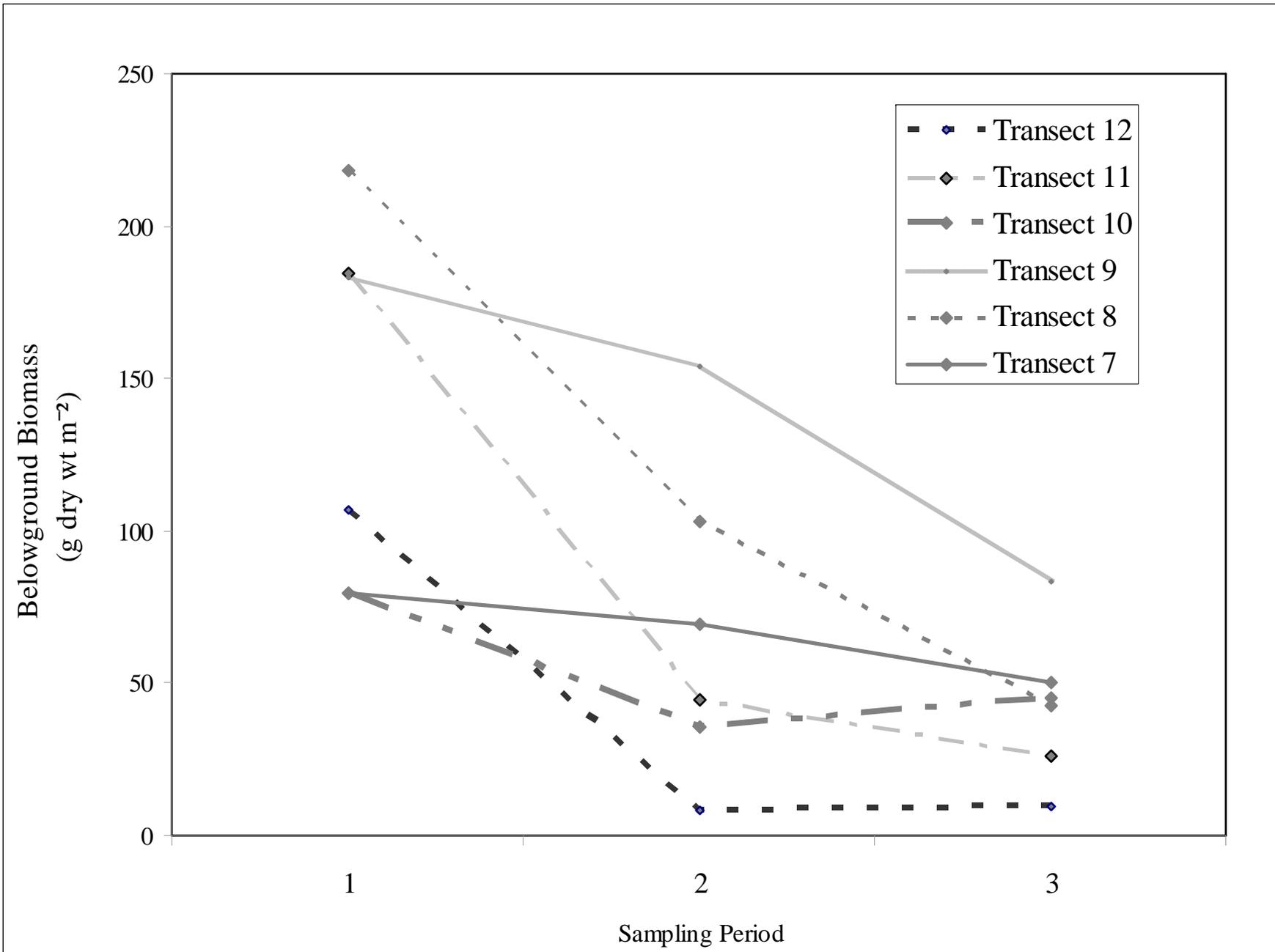


Seagrass Sampling Locations in Northern Barnegat Bay



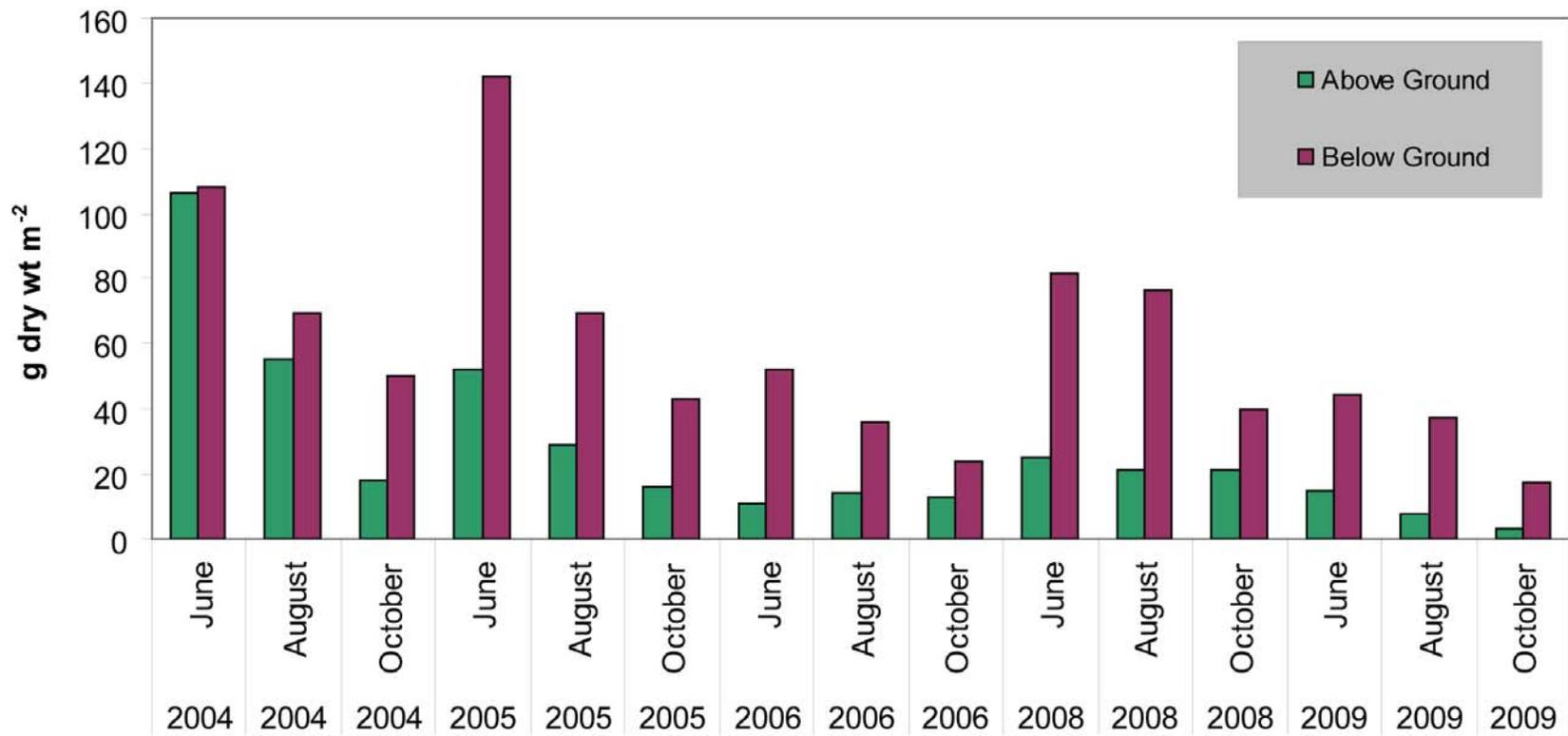






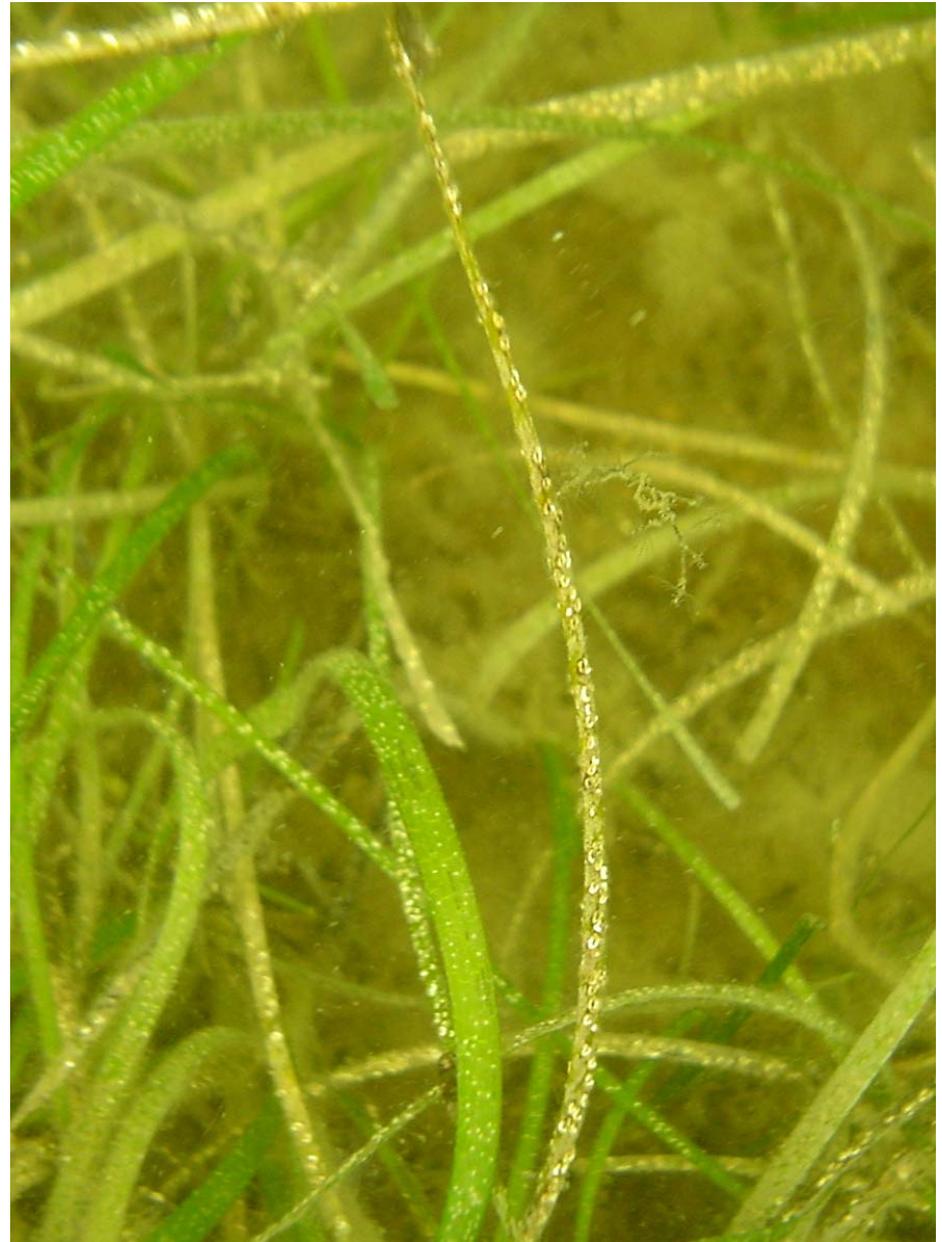
SEAGRASS BIOMASS (g dry wt m⁻²)

	<u>Jun</u>	<u>Aug</u>	<u>Oct</u>
2004	104 110	55 69	18 50
2005	52 142	29 69	16 43
2006	11 54	14 50	13 33
2008	25 81	31 76	23 40
2009	15 44	8 37	3 17



SEAGRASS LOSS 2004-2009

- Aboveground Biomass
(Reduced ~50-88%)
- Belowground Biomass
(Reduced ~50-59%)
- Percent Cover
(Decreased 28.9%)
- Shoot Density
(Decreased 21.1%)
- Blade Length
(Decreased 42.2%)







Reported landings for hard clams in Ocean County

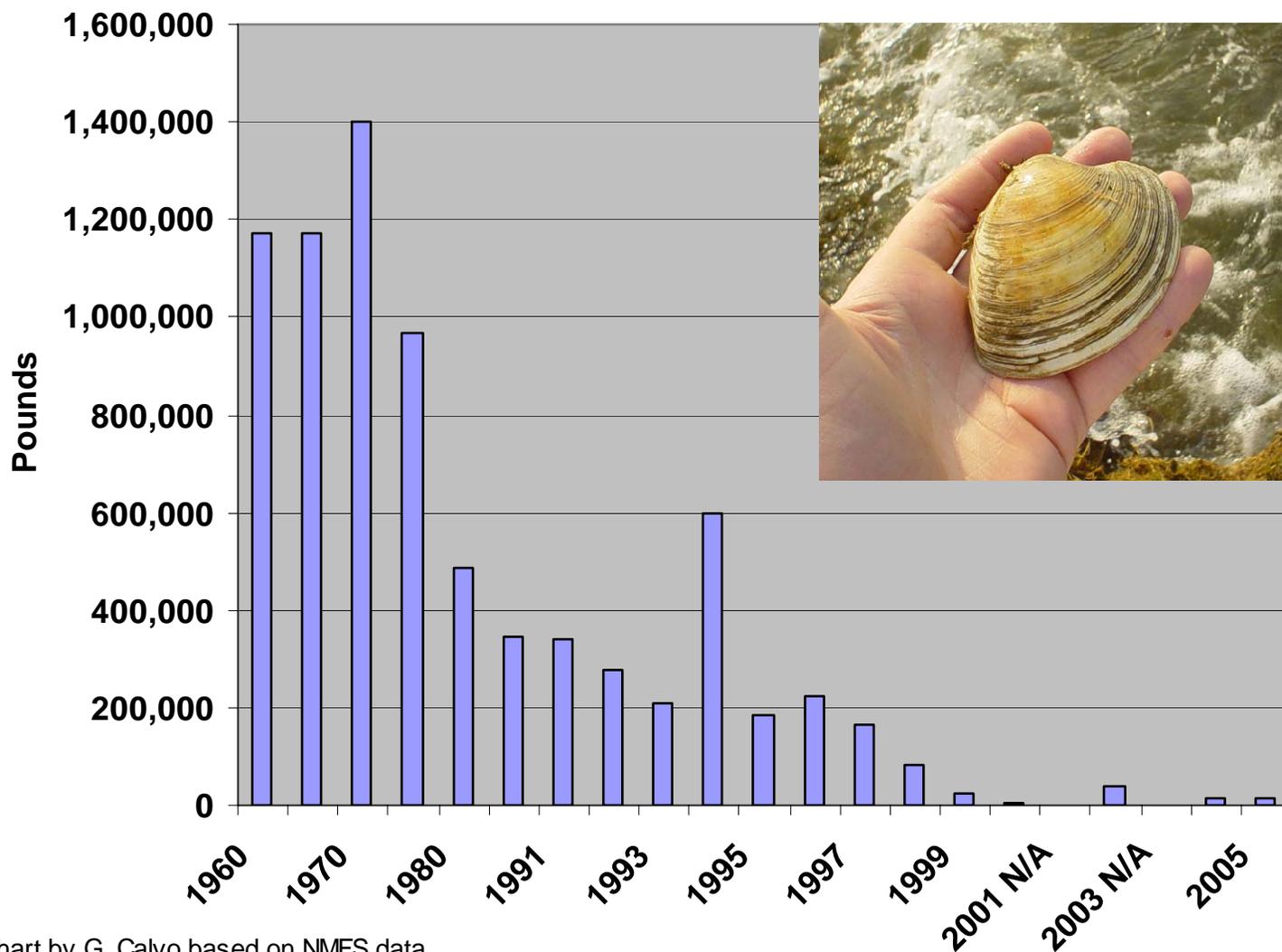
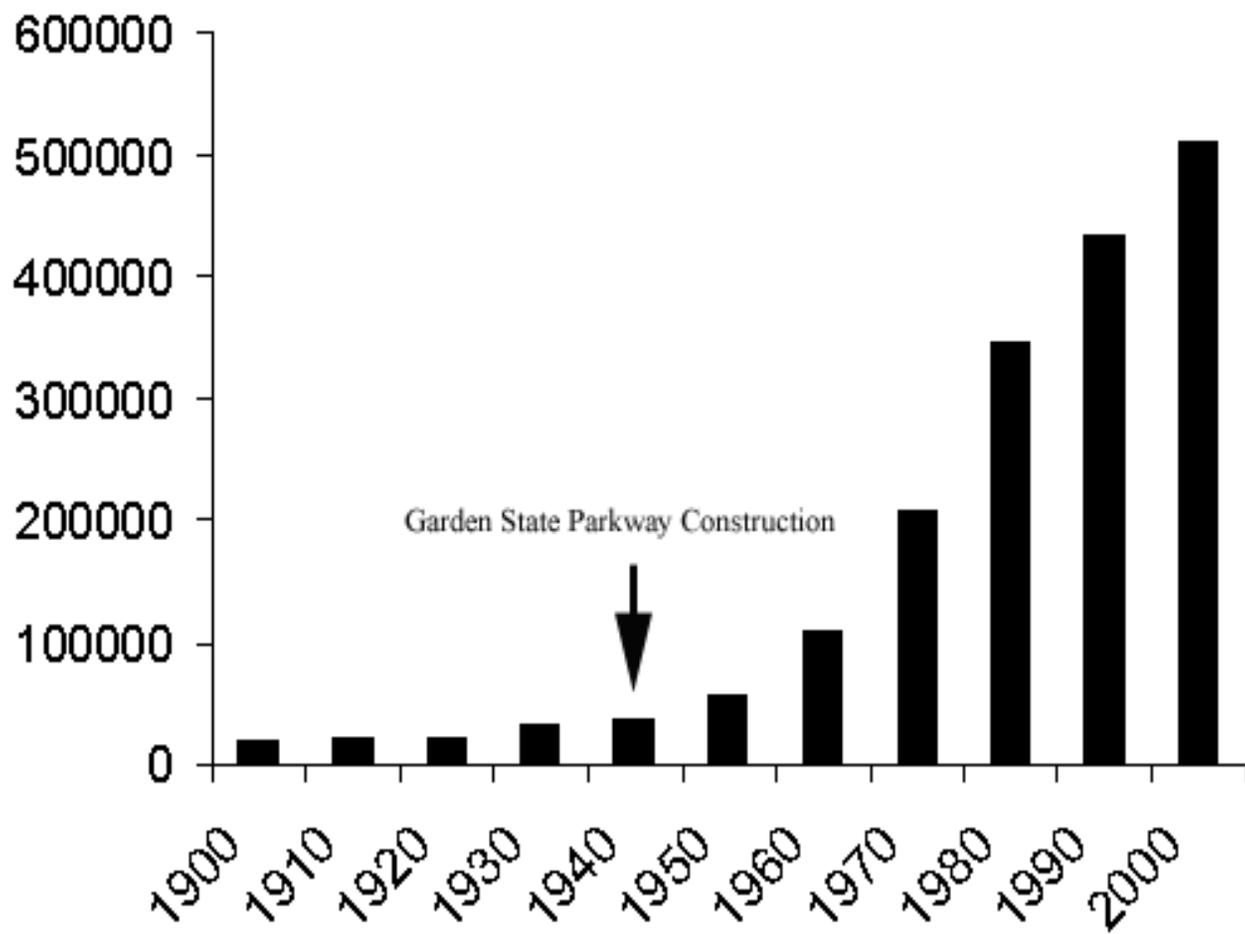
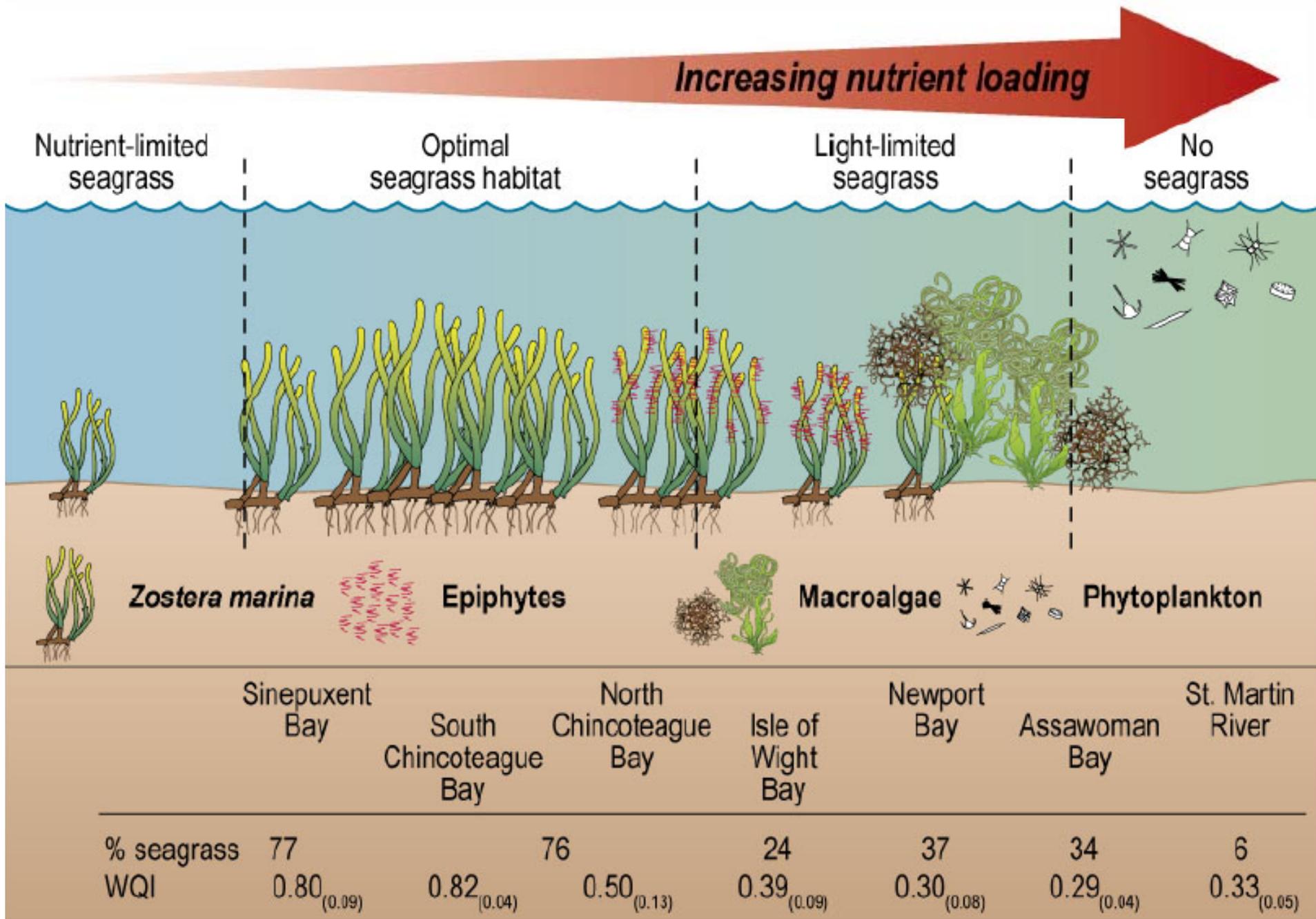
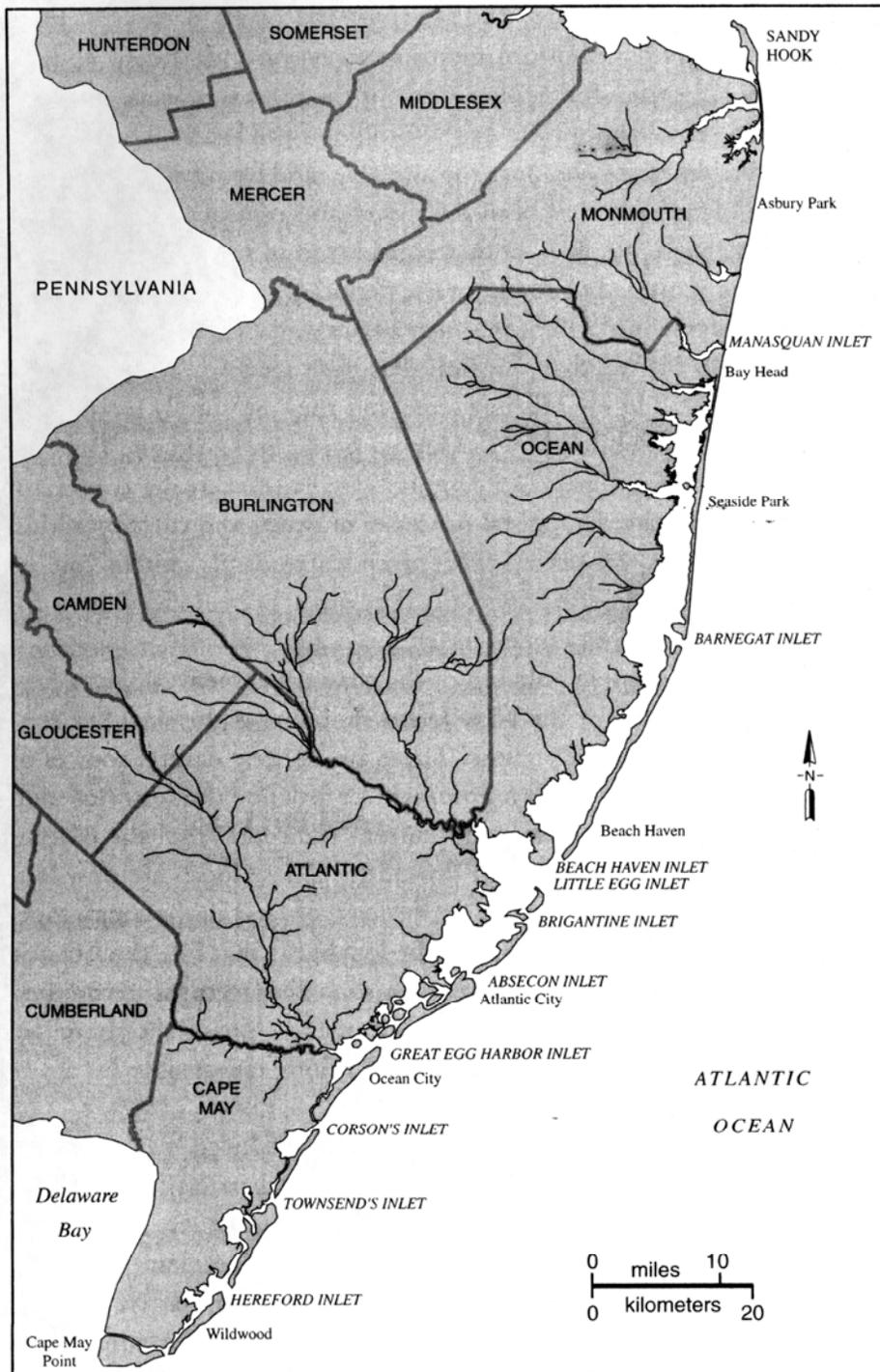


Chart by G. Calvo based on NMFS data

Population Ocean County 1900-2006 US Census Bureau







CURRENT RESEARCH

(Collaboration: RUTGERS, NJDEP, USGS, EPA, NEIWPCC)

- 1. Biotic Index of Ecosystem Condition (RMAP)**
- 2. Cause and Effect: Biotic Responses to Nutrient Loading**
- 3. Nitrogen Threshold Levels of Biotic Impairment**
- 4. Biotic Index of Eutrophic Condition (NEIWPCC)**
- 5. Water Quality Indicators (DO, Chl *a*, N-L, Secchi Depth)**
- 6. Bioindicators (Seagrass, Algae, Epiphytes, Shellfish)**
- 7. Nuisance and Toxic (Brown Tide) Algal Blooms**
- 8. SAV Demographics (Seagrass, Macroalgae)**
- 9. Epiphytic Tracking**
- 10. Shellfish Resources (Hard Clams, Bay Scallops)**
- 11. Benthic Invertebrates**
- 12. Residence Time/Flushing Rate (Susceptibility)**

INDICATORS (Eutrophic Condition)

DO, Chl *a*, Secchi Depth, TN Loading

Seagrass (Biomass, Shoot Density, Areal Cover, Blade Length)

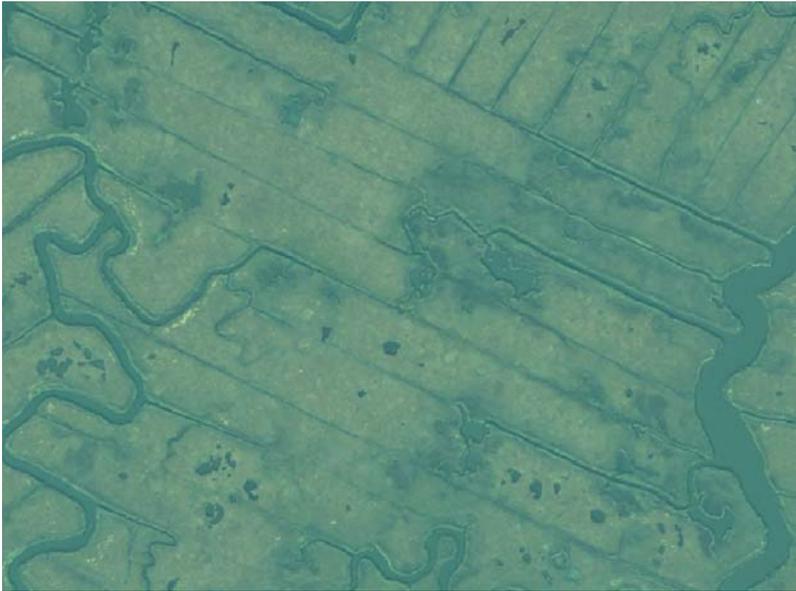
Epiphytes (Biomass and Overgrowth)

Macroalgae (Abundance, Areal Cover)

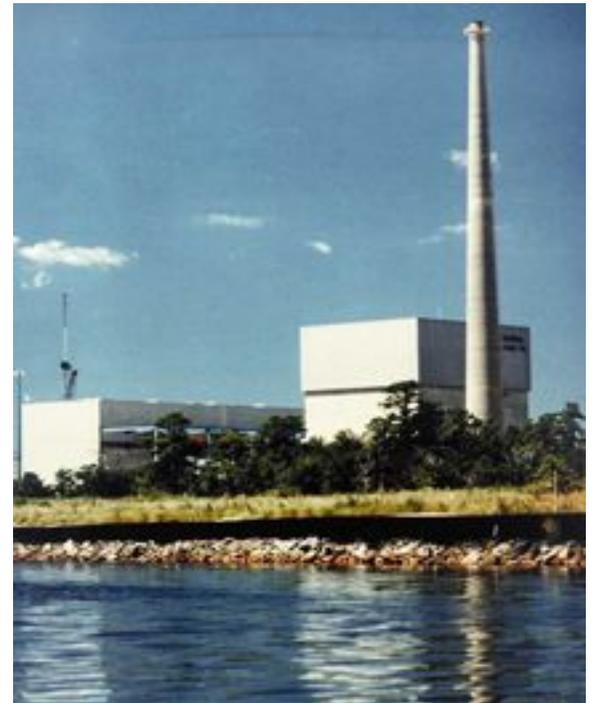
Phytoplankton Blooms (Brown Tide)

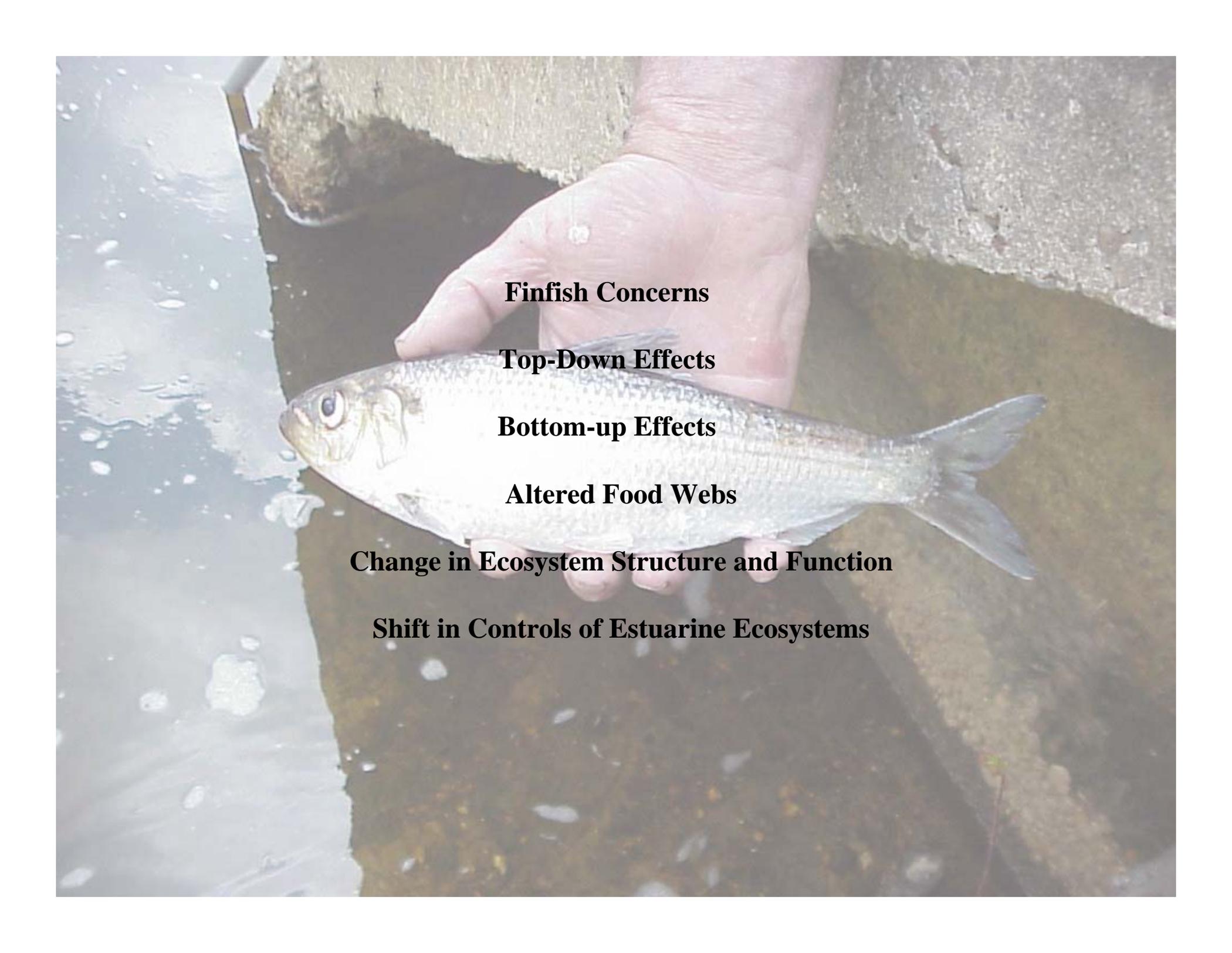
Shellfish Abundance (Scallops, Hard Clams)





IMPACTS



A photograph of a person's hand holding a silver fish, likely a striped bass, in a concrete channel. The fish is held horizontally, facing left. The background shows the concrete walls of the channel and some water. The text is overlaid on the image.

Finfish Concerns

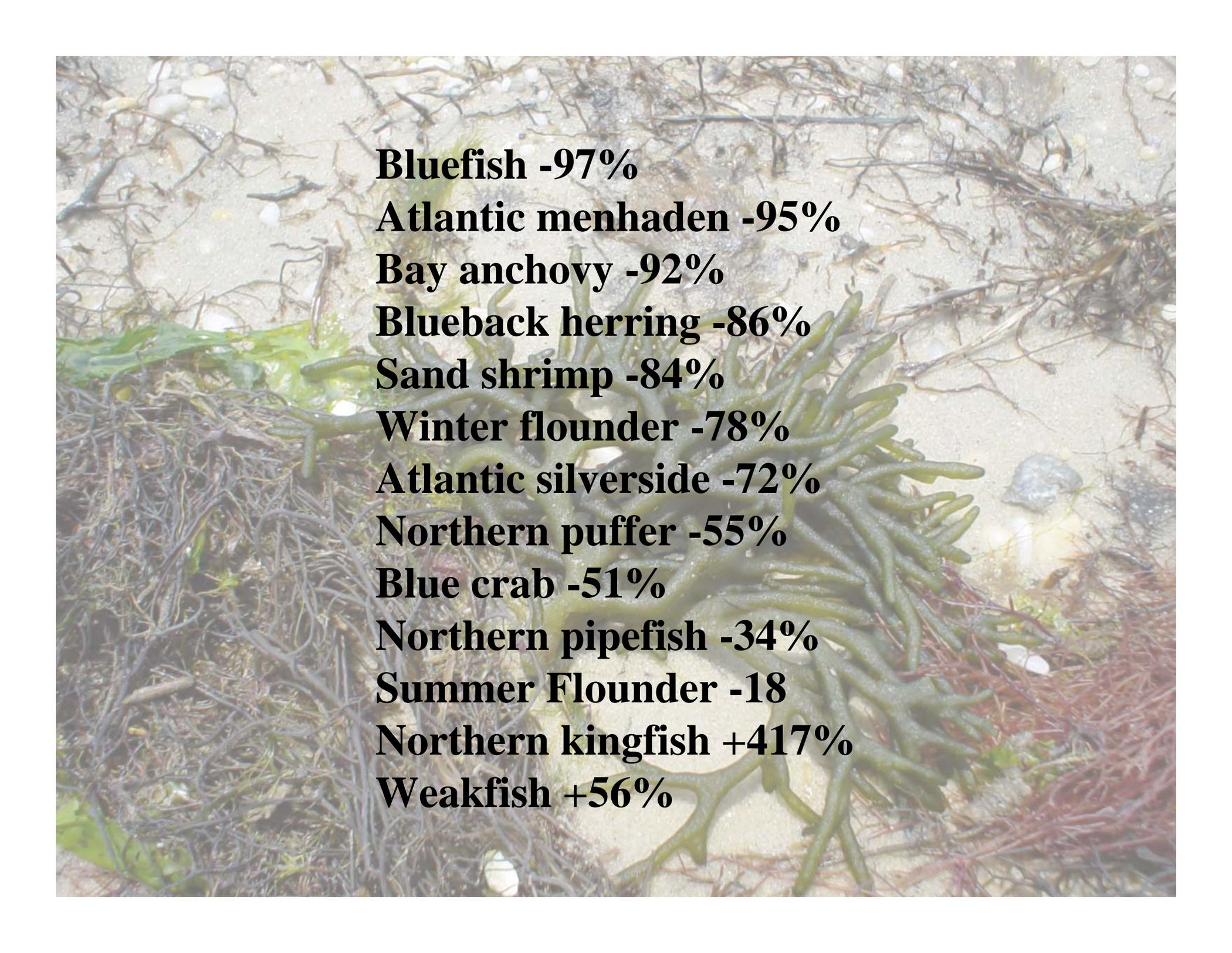
Top-Down Effects

Bottom-up Effects

Altered Food Webs

Change in Ecosystem Structure and Function

Shift in Controls of Estuarine Ecosystems

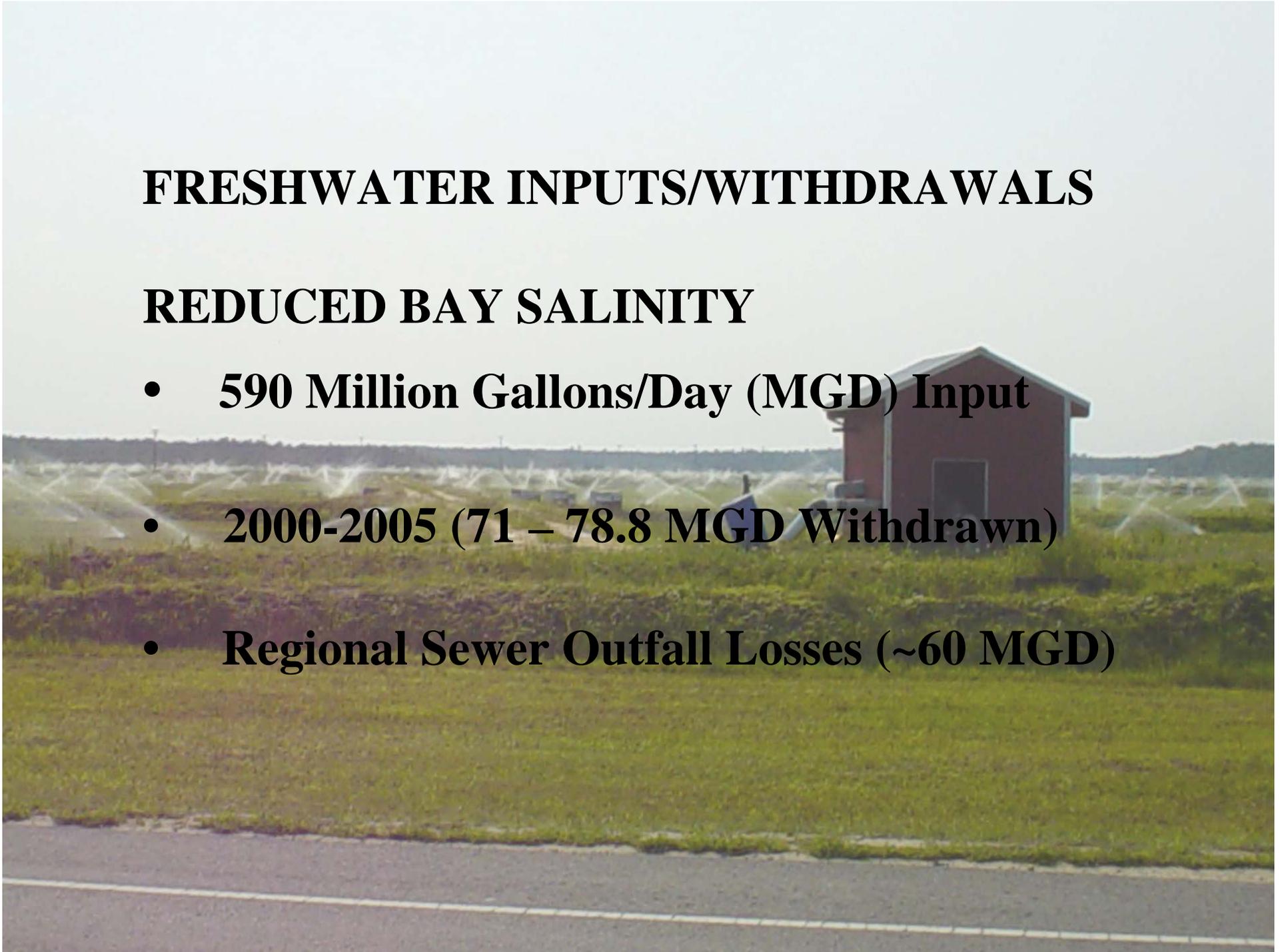
The background of the slide is a photograph of a sandy beach. In the foreground, there is a large pile of green seaweed, possibly sea purslane, with some reddish-brown seaweed to the right. Scattered across the sand are pieces of dark driftwood and several white, egg-shaped objects, likely bird eggs. The overall scene is a natural, coastal environment.

Bluefish -97%
Atlantic menhaden -95%
Bay anchovy -92%
Blueback herring -86%
Sand shrimp -84%
Winter flounder -78%
Atlantic silverside -72%
Northern puffer -55%
Blue crab -51%
Northern pipefish -34%
Summer Flounder -18
Northern kingfish +417%
Weakfish +56%

FRESHWATER INPUTS/WITHDRAWALS

REDUCED BAY SALINITY

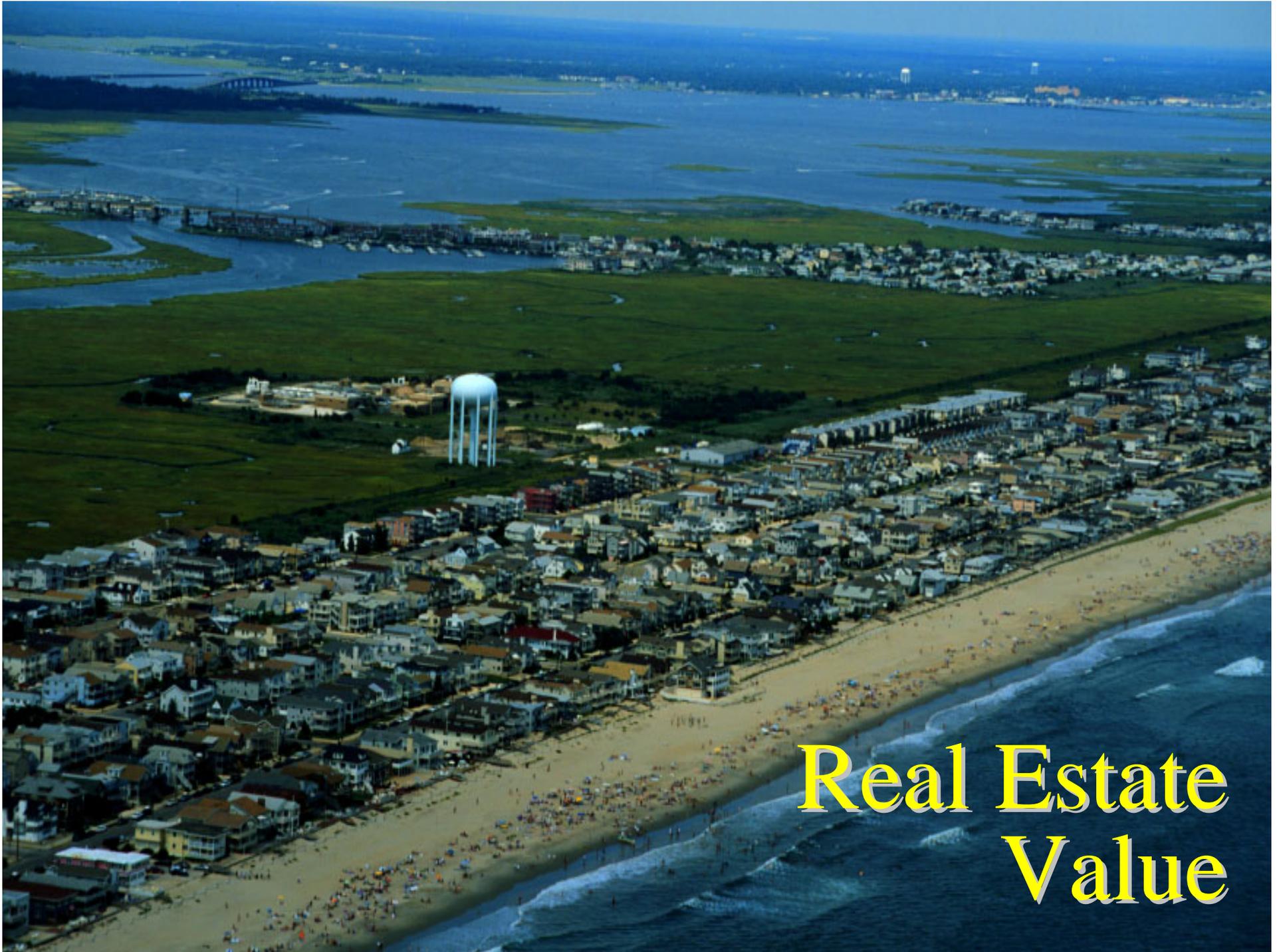
- **590 Million Gallons/Day (MGD) Input**
- **2000-2005 (71 – 78.8 MGD Withdrawn)**
- **Regional Sewer Outfall Losses (~60 MGD)**











Real Estate Value

COUNTY BEACH CLOSURES

Pathogens

- **Highest and Lowest Beach Closures**

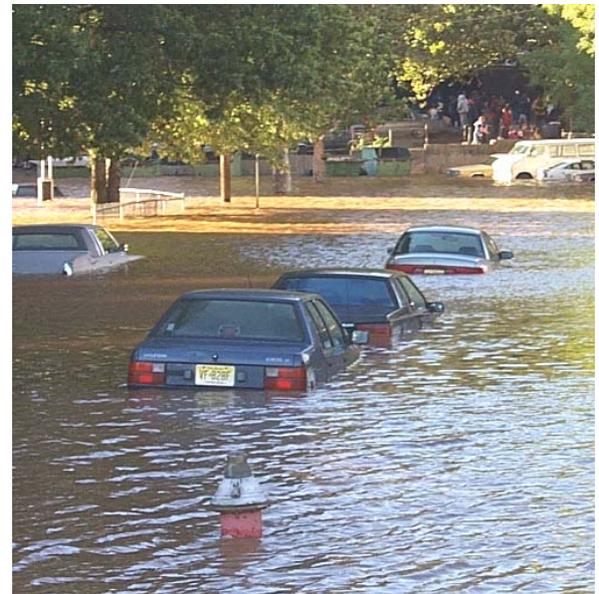
18 (2002) to 135 (2004)

- **Wreck Pond (Spring Lake)**



MANAGEMENT ACTIONS

- **Limit Development and Population Growth**
- **Open Space Preservation, Maintain Buffers**
- **Improve Stormwater Controls**
- **Address Septic Systems**
- **Best Management Practices (BMPs)**
- **Landscaping/Natural Vegetation**
- **Impervious Cover Reduction , Smart Growth**
- **Air Pollution Controls**
- **Policy Controls: Nutrient Criteria/TMDLs**





The End