Technical Seminar for In-House Staff

The Science of Barnegat Bay

July 14, 2010

NJDEP Public Hearing Room

Goal: to inventory the scientific work done to date related to the health of Barnegat Bay including land use trends, hydrology, biology, ongoing NJDEP research and monitoring, and background review of the Oyster Creek Nuclear Generating Station NJPDES permit.

Office of Science
New Jersey Department of Environmental Protection
428 East State Street
Trenton NJ 08625

Landscape Change
in the Barnegat Bay Watershed

NJDEP Office of Science Technical Seminar
The Science of Barnegat Bay

July 14, 2010

Richard G. Lathrop
Rutgers University

Grant F Walton CRSSA
Center for Remote Sensing & Spatial Analysis

CRSSA Grant F Walton Center for Remote Sensing & Spatial Analysis

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Rutgers, The State University of New Jersey

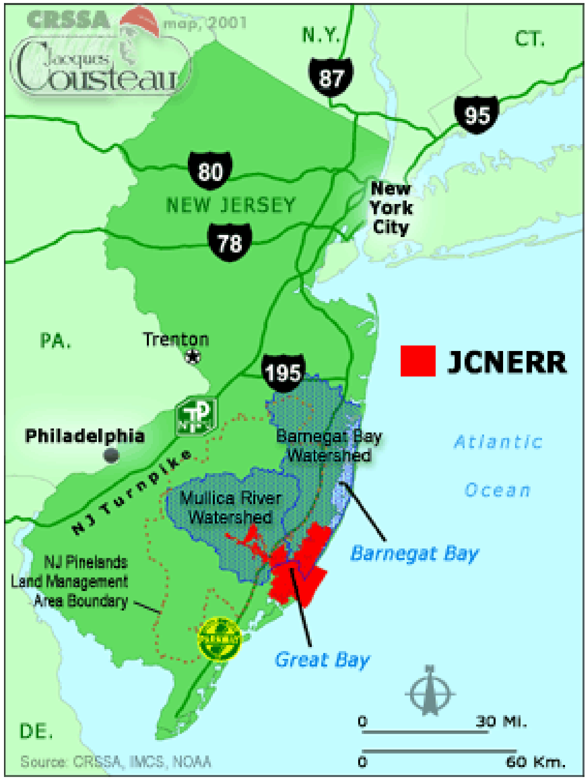
COASTAL STUDIES

@ CRSSA Grant F. Walton Center for Remote Sensing and Spatial Analysis

- New Jersey Coastal Conservation and Restoration Targets
- Vulnerability of New Jersey's Coastal Habitats to Sea Level Rise
- Horseshoe Crab Habitat Mapping
- Submerged Aquatic Vegetation Mapping
- Riparian Zone Assessment of the Barnegat Bay Watershed
- Barnegat Bay Resources Web Site
- Boater's Guides
- Jacques Cousteau National Estuarine Research Reserve GIS Support
- Brown Tide Monitoring in New Jersey

RUTGERS School of Environmental & Biological Sciences

Map showing the location of the Jacques Cousteau National Estuarine Research Reserve (JCNERR) within the greater New Jersey region (map composed at CRSSA, 2001). The reserve area appears in red.



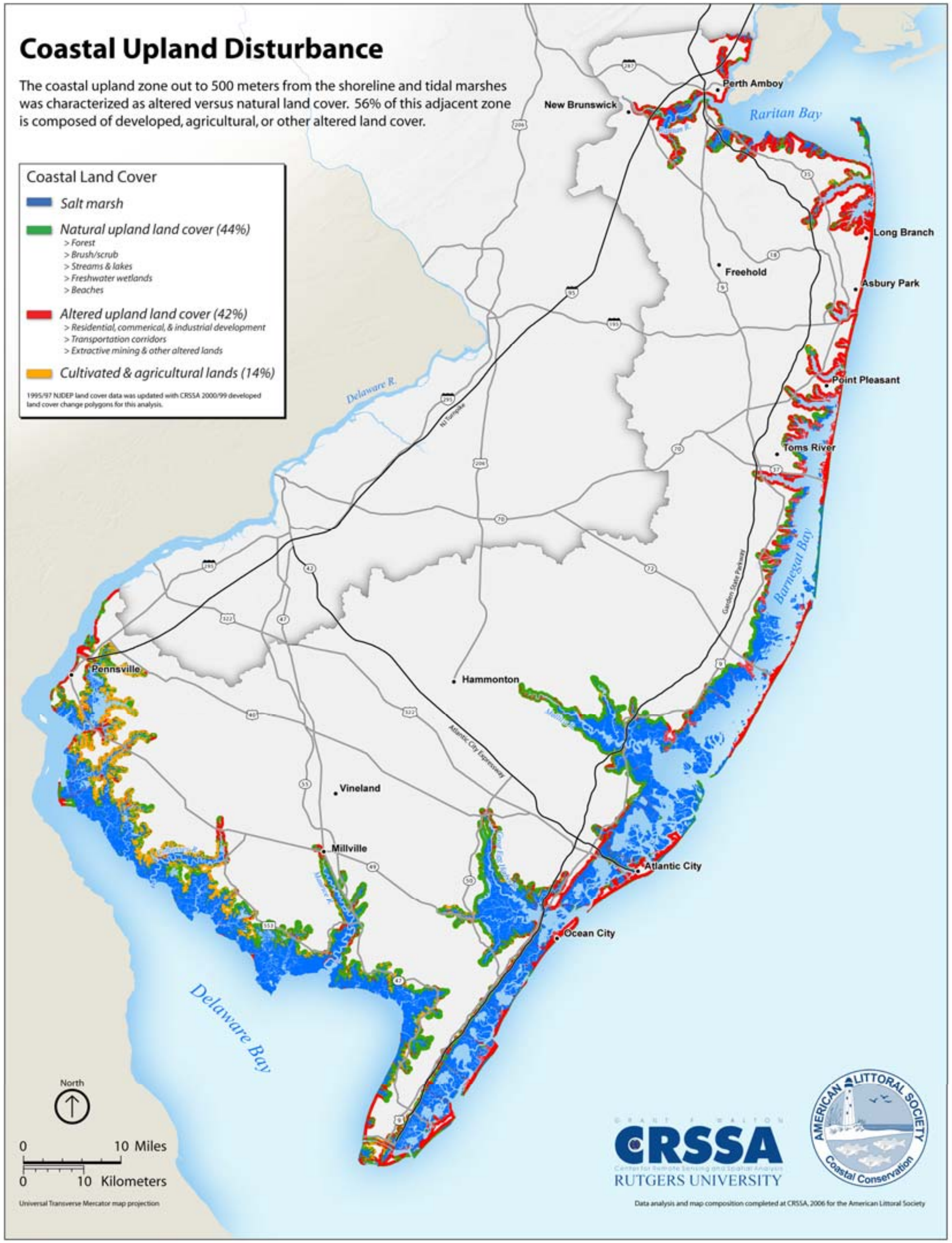
Concentration of Human Population and Development within NJ's Coastal Zone

Coastal Land Use within 500 m from coastal waters & wetlands

Urban: 42%

Agricultural: 14%

Natural Veg: 44%



Conceptual Model: Coast in a Vise

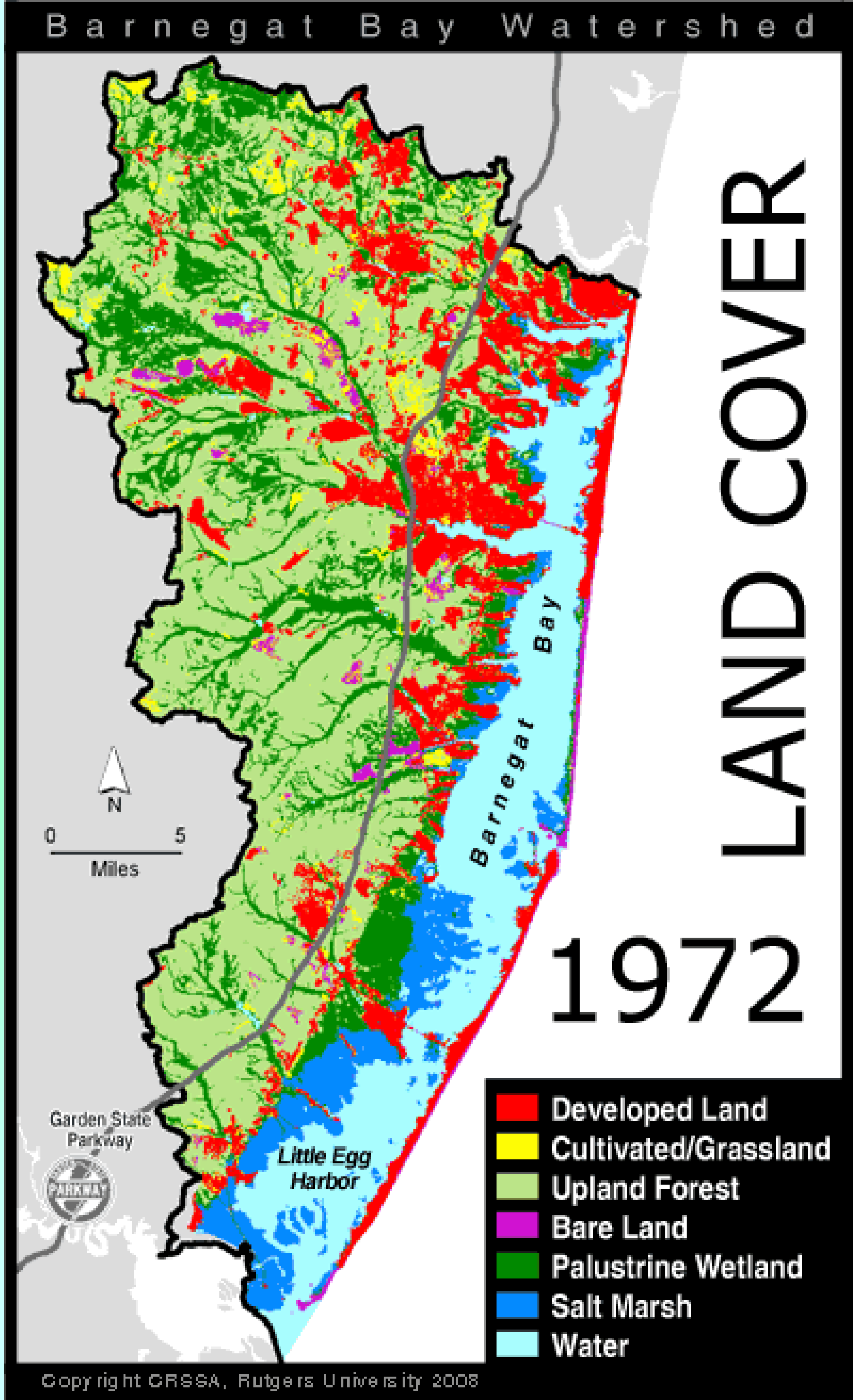
- Watershed → Coast Human land use intensity as a primary environmental stressor through direct land use/land cover change (LU/LCC) and indirectly via eutrophication (nutrient runoff)
- Sea Level Rise (SLR) impinging from other direction

- Key chokepoints: Drivers
  - Stormwater basins LU/LCC
  - Riparian Buffer Zones LU/LCC
  - Tidal Salt Marsh SLR & LU/LCC
  - Shorelines/Upland buffers SLR & LU/LCC
  - Benthic habitat LU/LCC(EUT) & SLR

Land Use Change as Driving Coastal Stressor

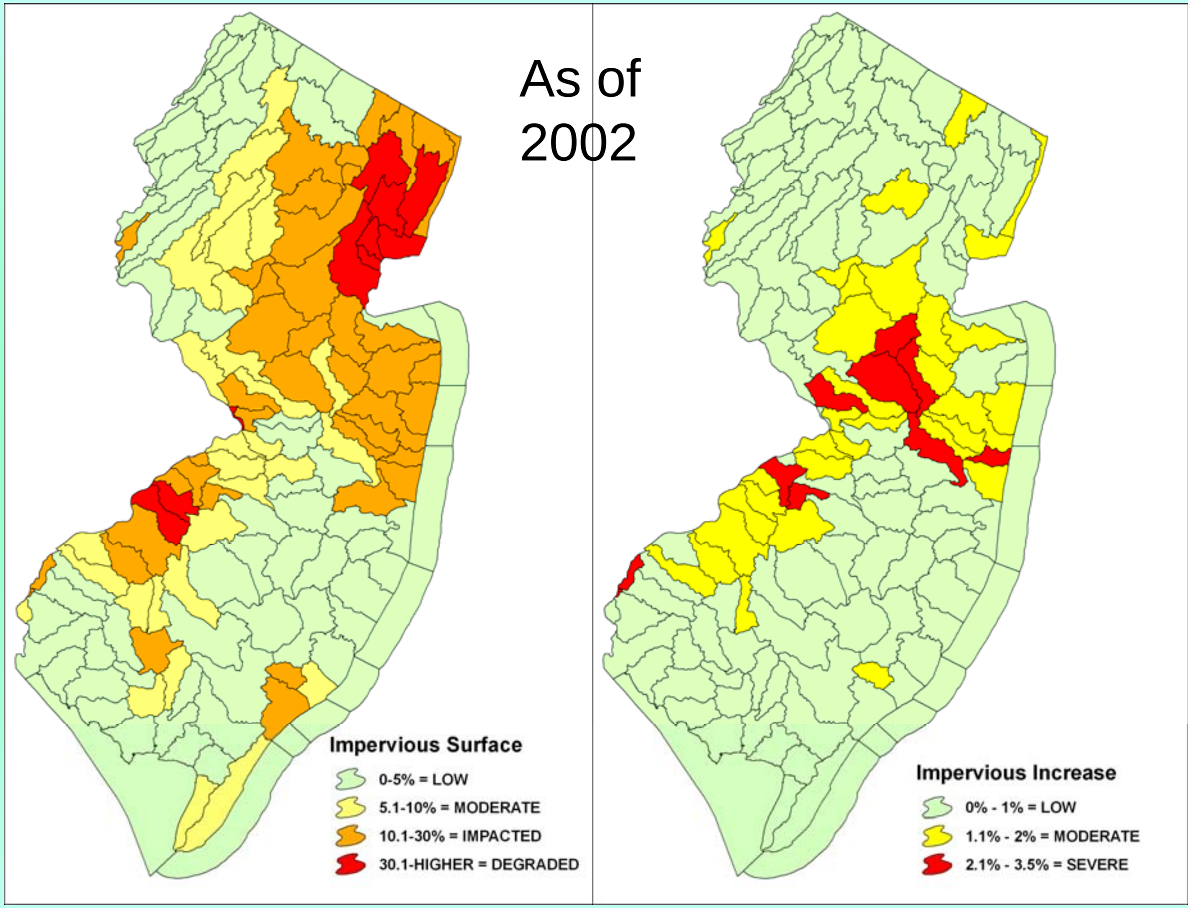
Over 1/3 of the BBEP watershed is developed or otherwise altered

- Changing surface runoff and groundwater flows
- Increased nutrient, chemical & sediment inputs
- Habitat loss, alteration and fragmentation



% Impervious Surface Cover

Impervious Surface has seen widespread adoption here in NJ and nationwide as an EI that links watershed urban land use to surface water quality

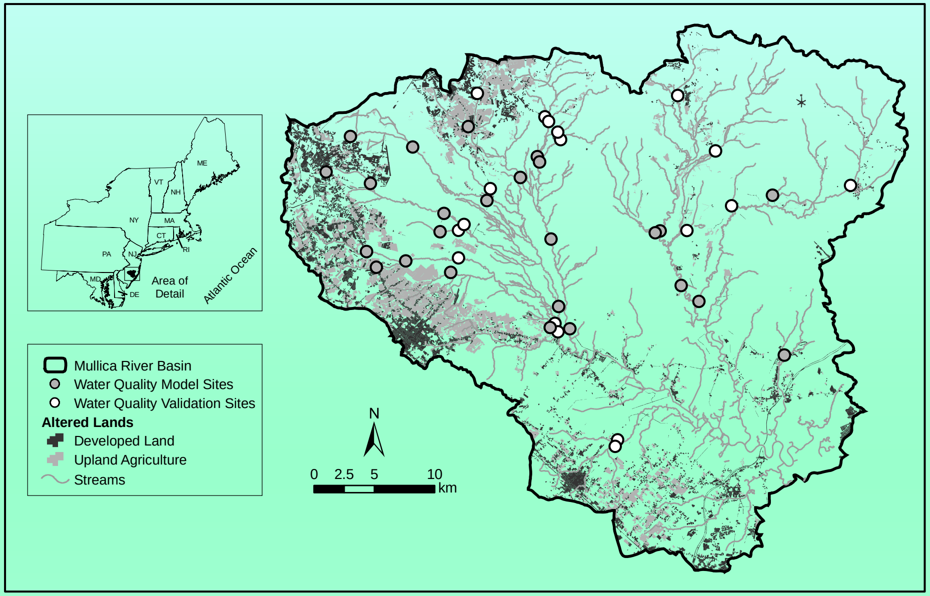


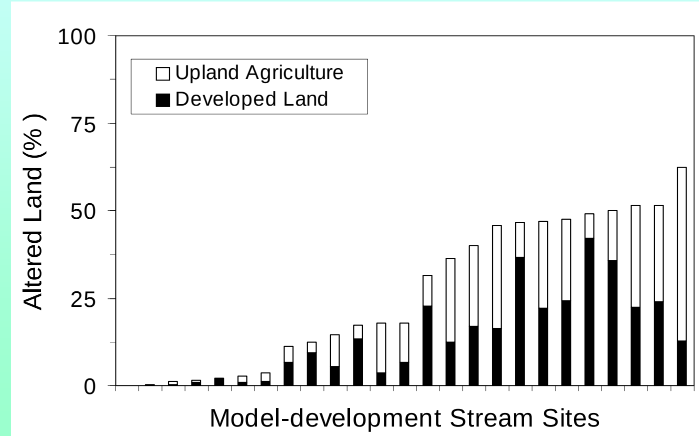
Hasse, J.* and **R.G. Lathrop**. 2003. Land resource impact indicators of urban sprawl. Applied Geography. 23:159-175.

Hasse, J.* and **R.G. Lathrop**. 2008. Tracking New Jersey's Dynamic Landscape.

http://www.crssa.rutgers.edu/projects/lc/download/urbangrowth86_95_02/HasseLathrop_njluc_final_report_07_14_08.pdf

LU/LCC: Implications for Surface Water Quality

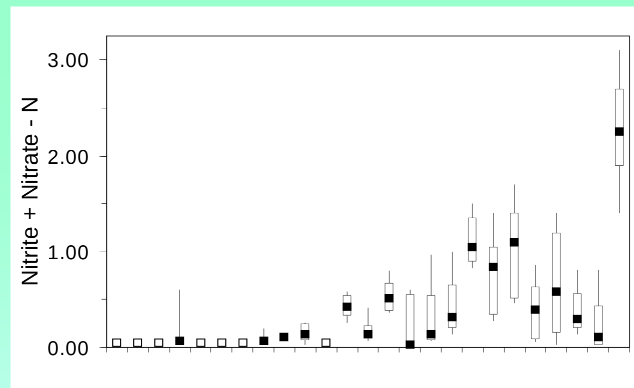




Altered Land:

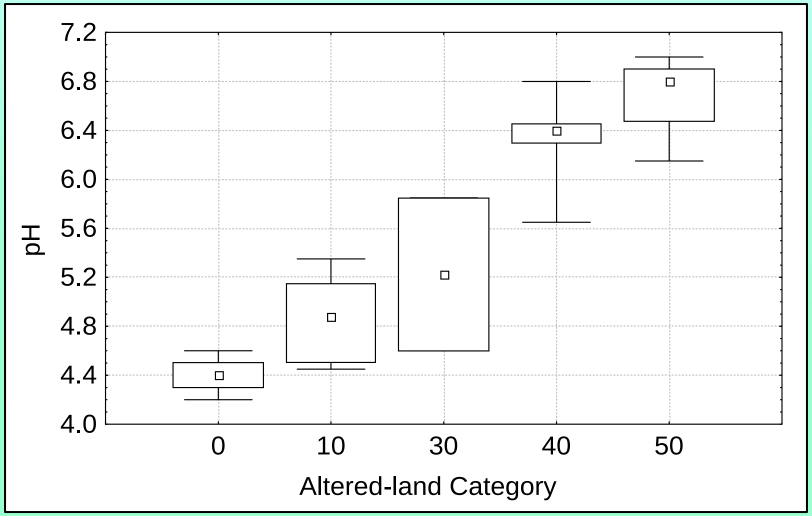
Urban Developed

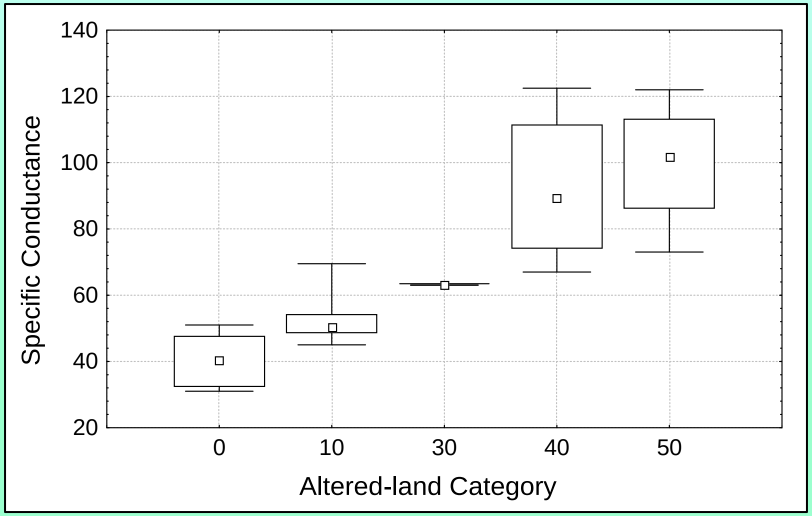
Upland Agriculture



Zampella, R.A., N.A. Procopio, R.G. Lathrop and C.L. Dow. 2006. Relationship of Land-Use/land Cover-Cover Patterns and Surface Water Quality in the Mullica River Basin. AWRA 43(3):594-604.

Thresholds for Pinelands Streams





<10% Altered: Characteristic Pinelands quality

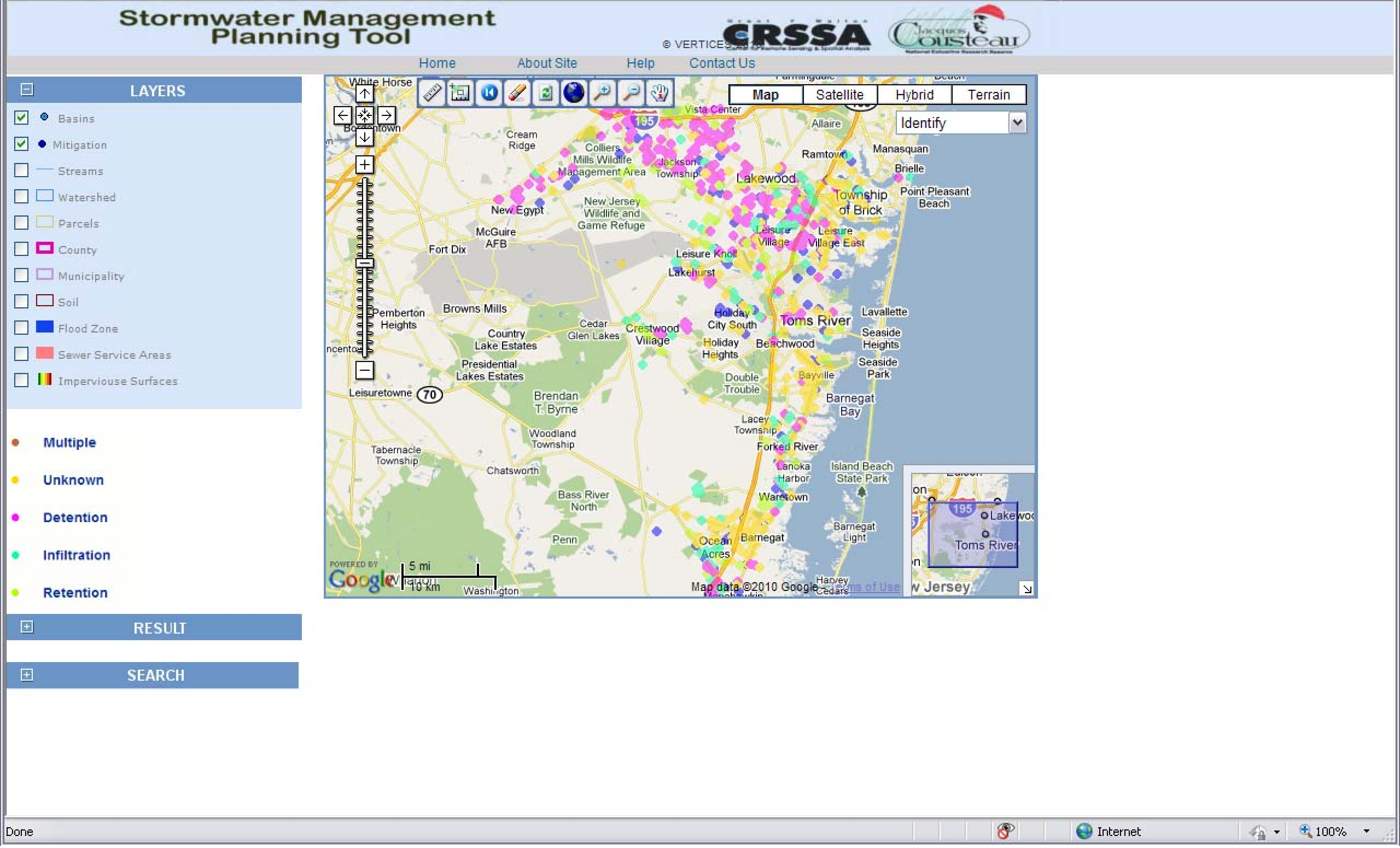
10-30% Altered: In transition

>30% Altered: Degraded

Zampella, R.A., N.A. Procopio, **R.G. Lathrop** and C.L. Dow. 2006. Relationship of Land-Use/land Cover-Cover Patterns and Surface Water Quality in the Mullica River Basin. AWRA 43(3):594-604

StormWater Management Systems

- Effective and properly engineered storm water management systems (SWMS) represent one of the most important water resource protection strategies available to counter the most deleterious impacts of nonpoint source pollution and surface runoff associated with development.
- There is general agreement that our present SWMS infrastructure isn’t up to the task.
- Under climate change, SWMS infrastructure will be even more greatly stressed.



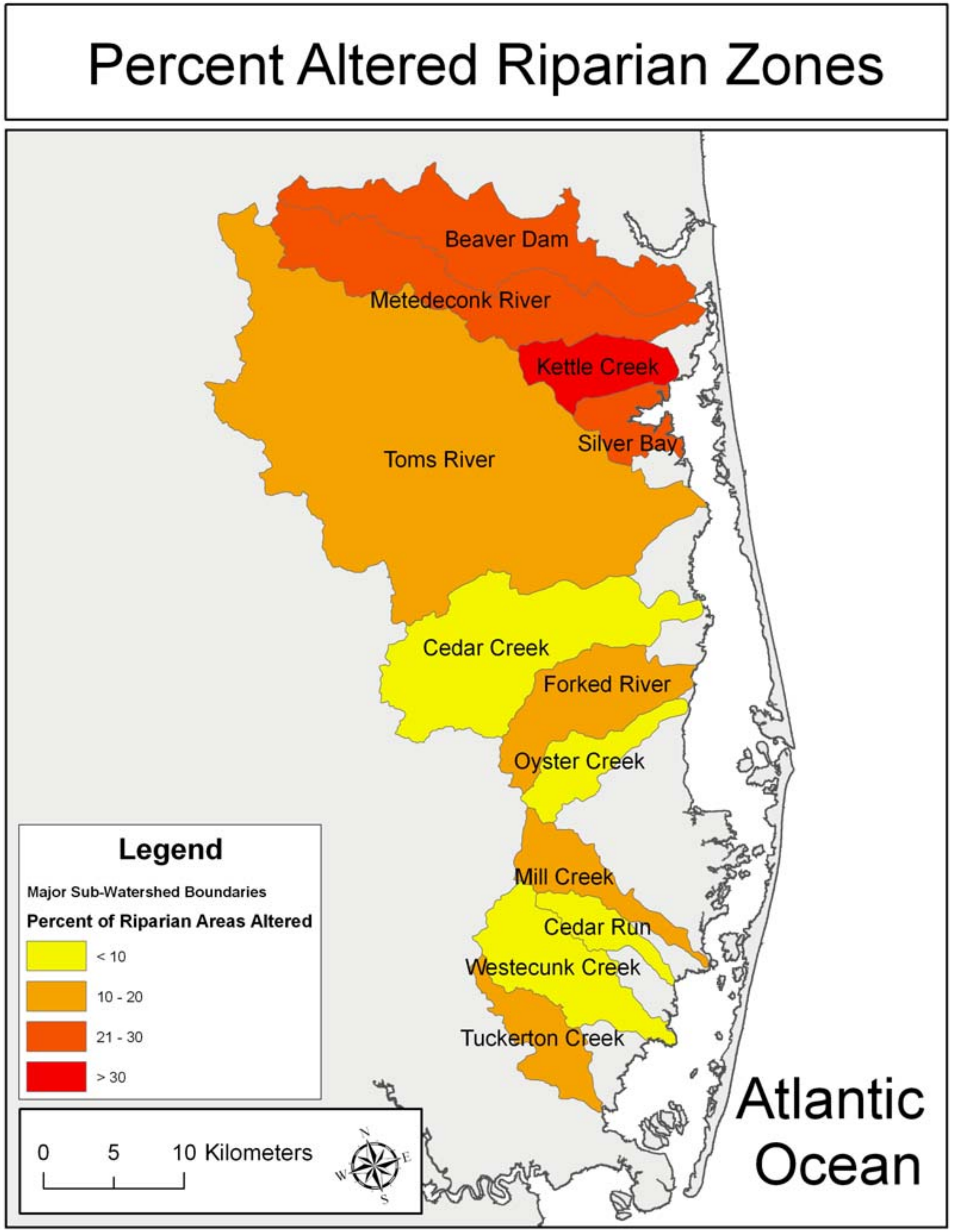
http://vertices.gismap.us/crssa/

Loss of Riparian Buffer Zones

Riparian Zone Alteration

- Riparian buffers help reduce nonpoint source pollution and serve as vital habitat for both upland and wetland-dependent species.
- 20% of the riparian corridor buffer zones around Barnegat Bay's freshwater tributaries are in Altered Land use
- Some subwatersheds have over 50% riparian zone alteration.

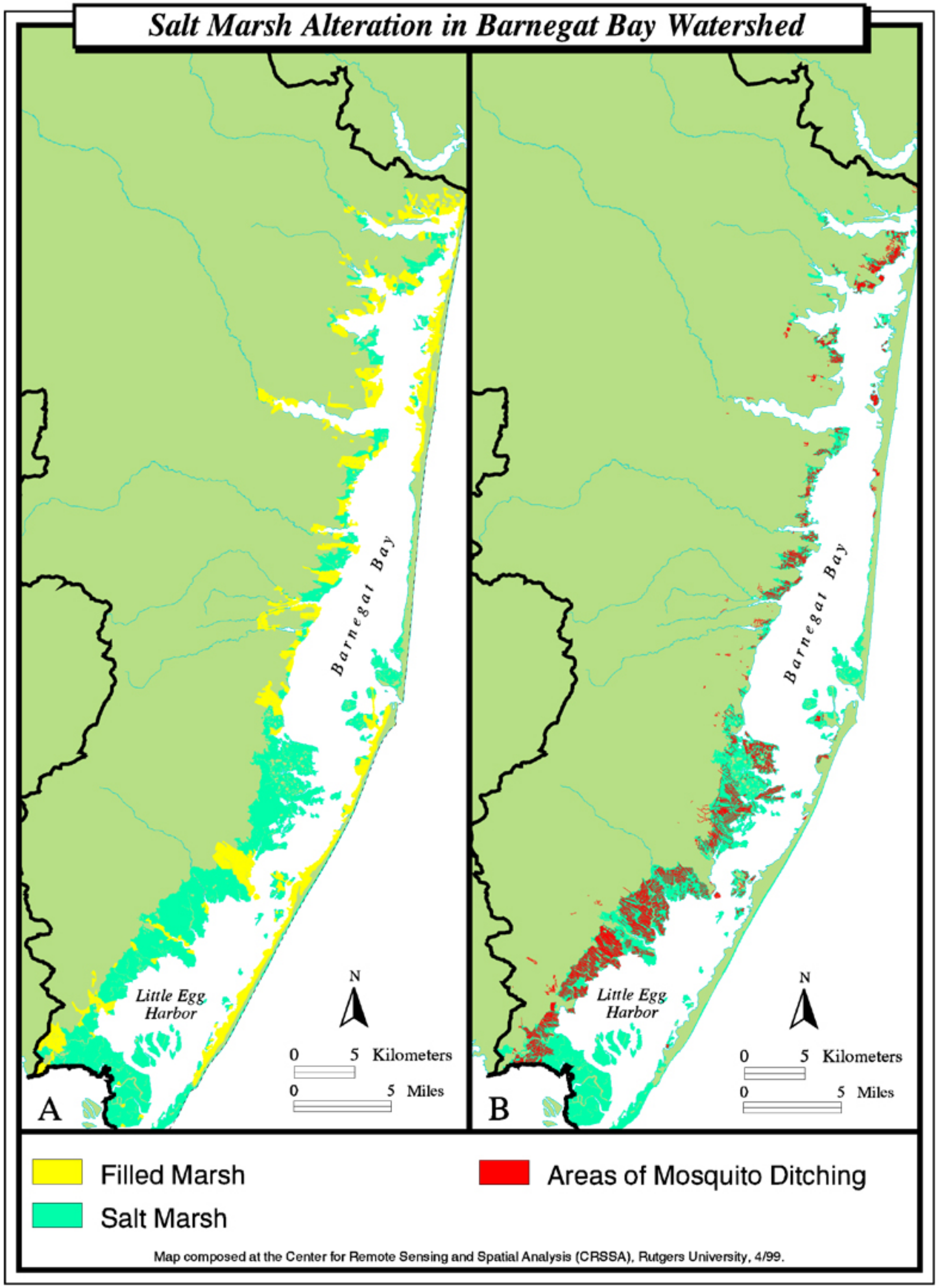
Lathrop, R.G. , J.A. Bognar. 2001. Habitat Loss and Alteration in the Barnegat Bay Region. J. Coastal Res. SI 32:212-228.
Lathrop, R.G. and S. Haag. 2007. Assessment of Land Use Change and Riparian Zone status in the Barnegat Bay and Little Egg Harbor Watershed: 1995-2002-2006. CRSSA Technical Report, Rutgers University, New Brunswick, NJ, 27 p. http://crssa.rutgers.edu/projects/coastal/riparian/report/CRSSA__BB_LULCC_Riparian_study_2007_revised.pdf



Tidal Salt Marsh Conversion/Alteration

•Barnegat Bay has lost more than one quarter of its tidal salt marshes over the past century due to filling and development.

•A large proportion of Barnegat Bay's remaining salt marshes were grid ditched or OMWM'd as a means of mosquito control.



Lathrop, R.G., M. B. Cole,* and R.D. Showalter*. 2000. Quantifying the habitat structure and spatial pattern of New Jersey (USA) salt marshes under different management regimes. Wetlands Ecology Manage. 8:163-172.

Upland Fringe of the salt marsh

Ghost trees – evidence of sea level rise and storm surge impacts

Jake’s Landing, Dennis Township, Cape May

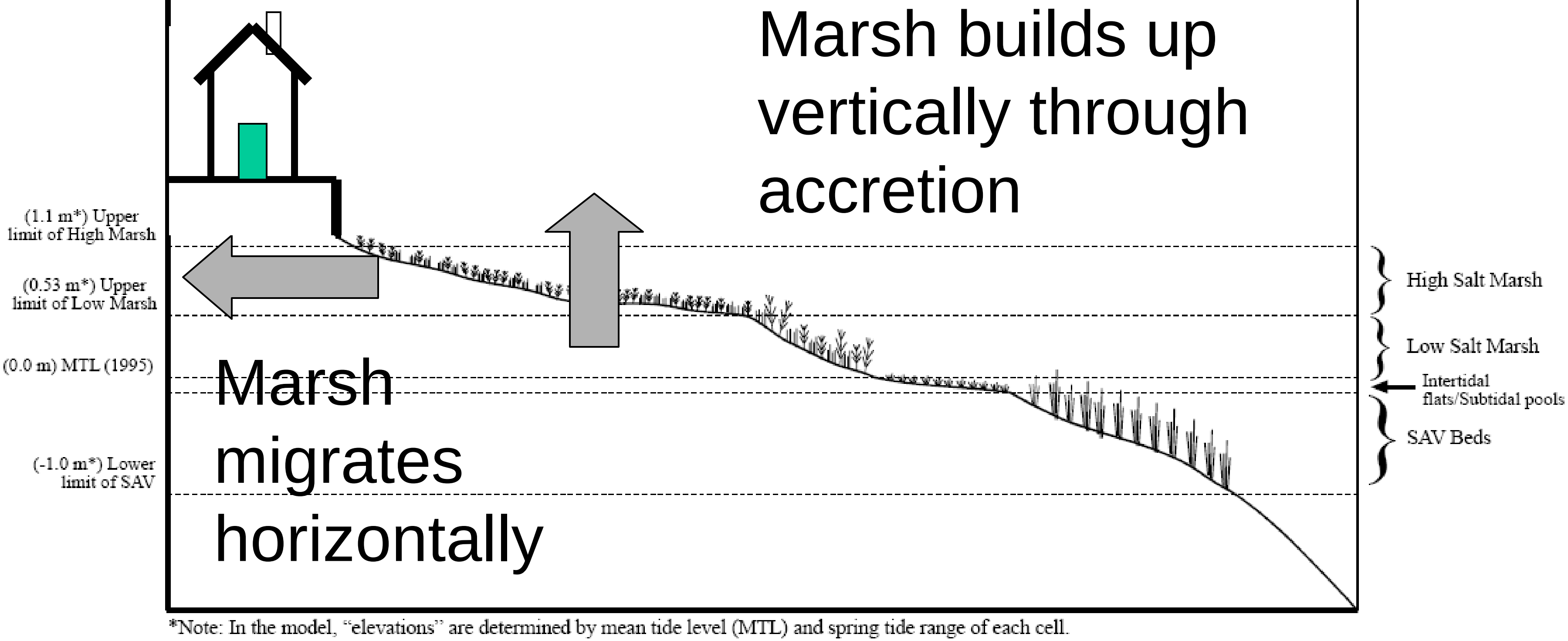
Grant F. Walton Center for Remote Sensing and Spatial Analysis,
Rutgers, The State University of New Jersey

CRSSA RUTGERS

crssa > projects > coastal > *sea level rise*

Vulnerability of New Jersey's Coastal Habitats to Sea Level Rise

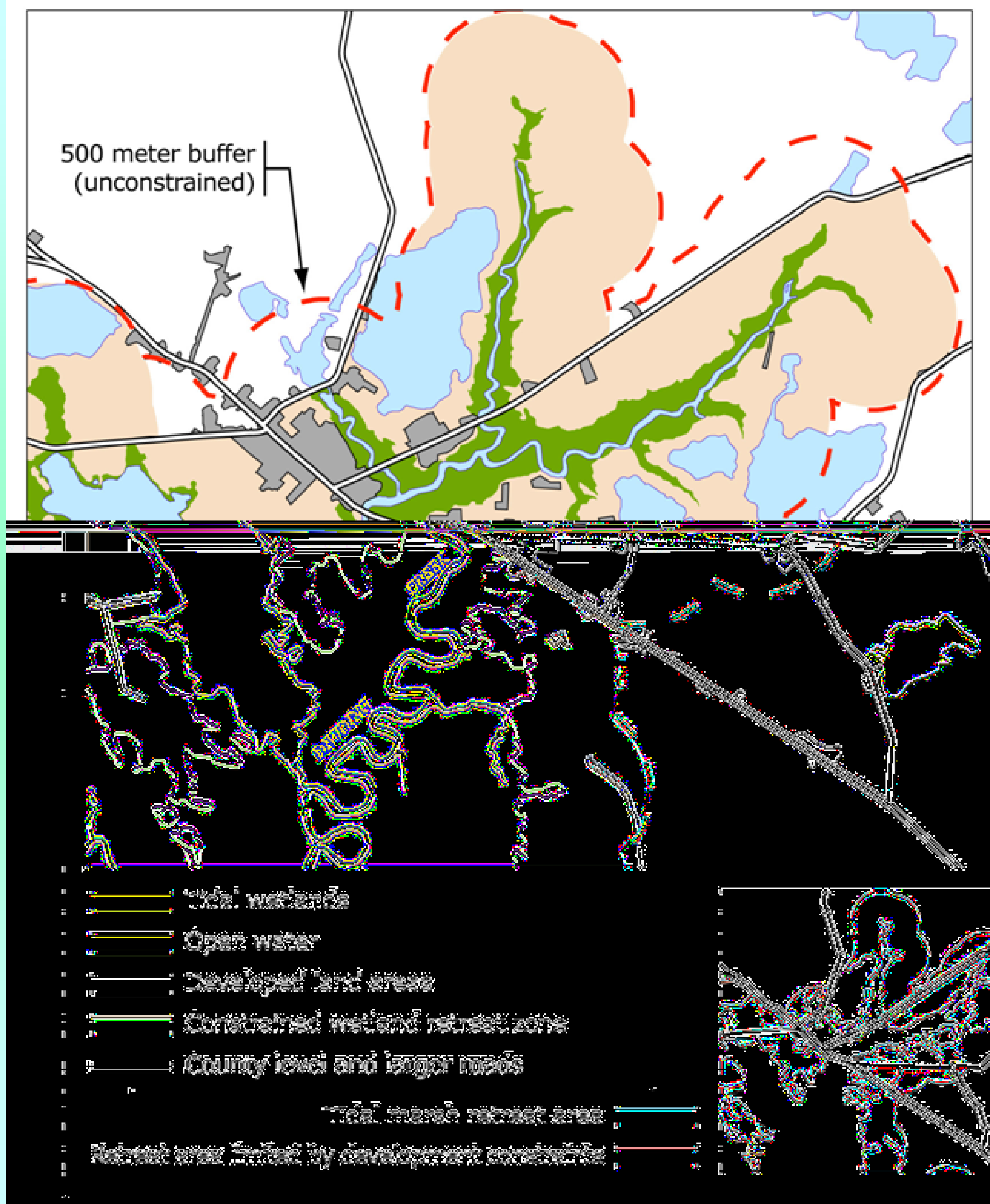
Tidal Marsh Retreat



Hypothetical shoreline profile

Graphic from http://www.epa.gov/climatechange/effects/downloads/section3_20.pdf

Objective:
identify where roads, bulkheads and urban development restricts marsh retreat



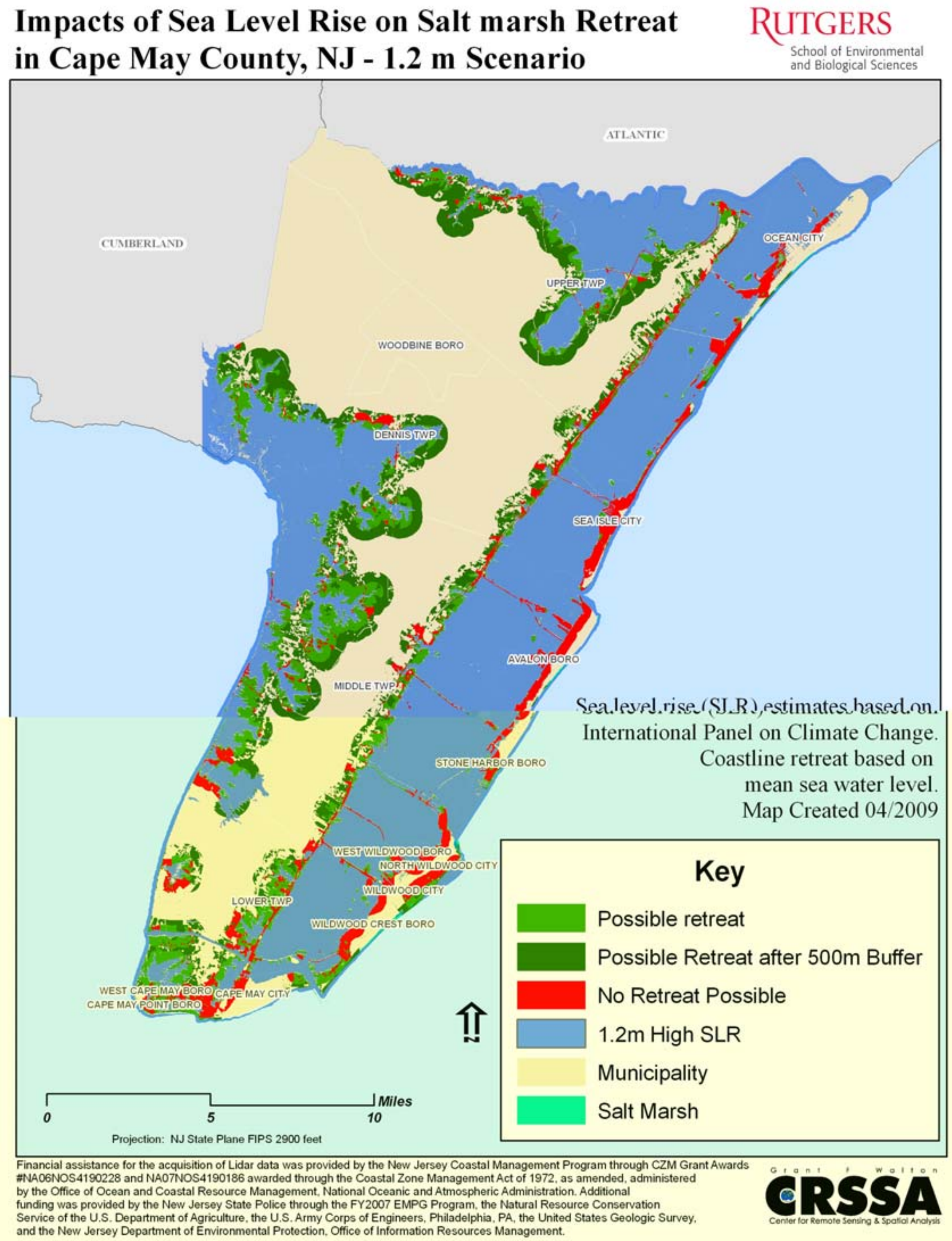
GIS methodology for determining Tidal Marsh Retreat Zones

Tidal Marsh Retreat Zones

29% of potential tidal marsh retreat area in presently limited by developed features and roads

Restoration Priorities: Remove impinging structures

http://www.crssa.rutgers.edu/projects/coastal/sealevel/index.html



Shoreline Alteration: Hardening of ocean and bay beaches

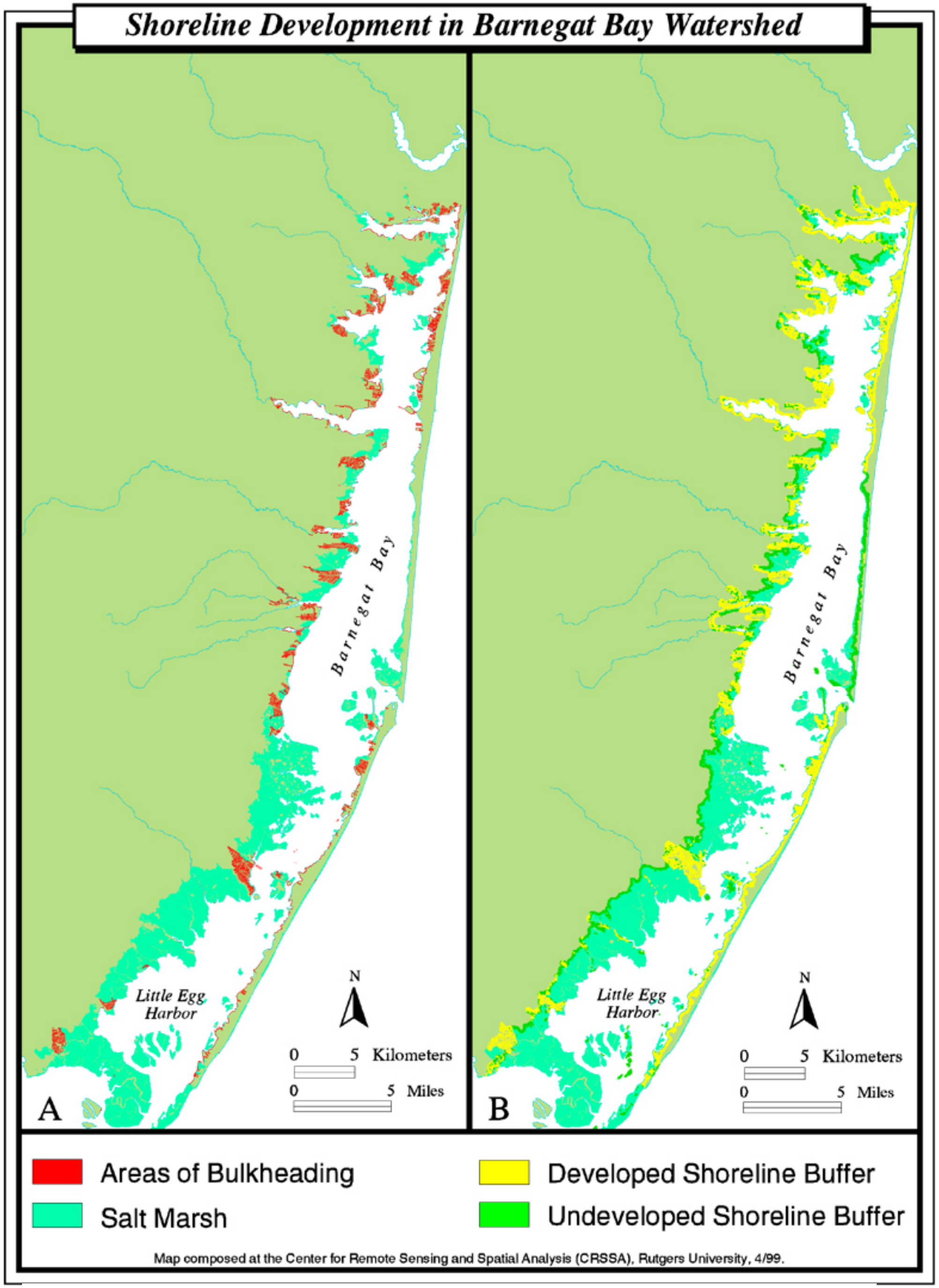
Disappearing beaches due to the combined effects of sea level rise, beach erosion and inappropriate shoreline development

This near-shore development has resulted in the loss and alteration of vital shoreline and shallow-water habitats.

Shoreline Alteration

- Barnegat Bay has a heavily altered shoreline with approximately 45% of the total length bulkheaded and more than 70% of the adjacent upland shores developed.

- This near-shore development has resulted in the loss and alteration of vital shoreline and shallow-water habitats.



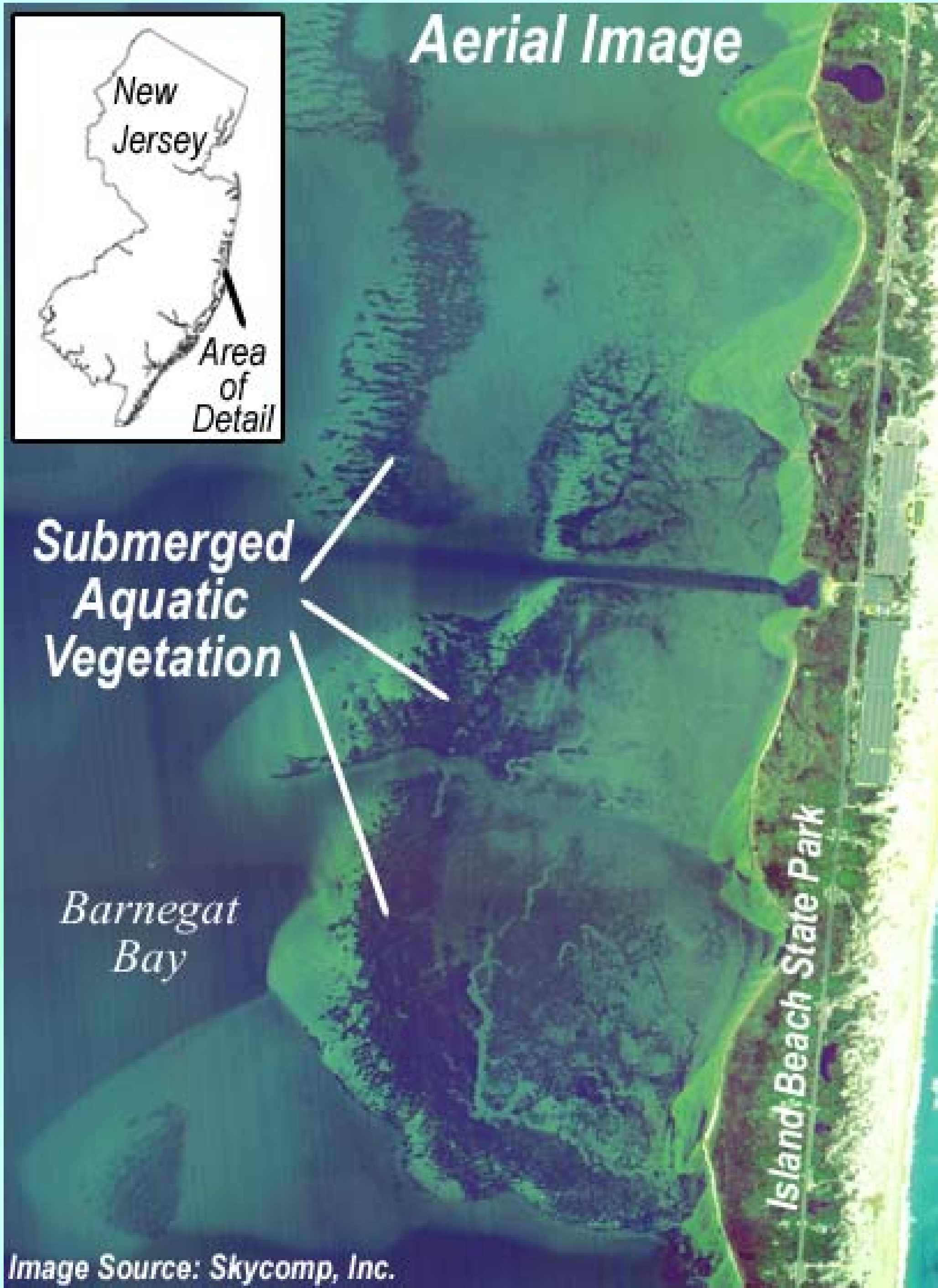
Seagrass: Critical Estuarine Habitat

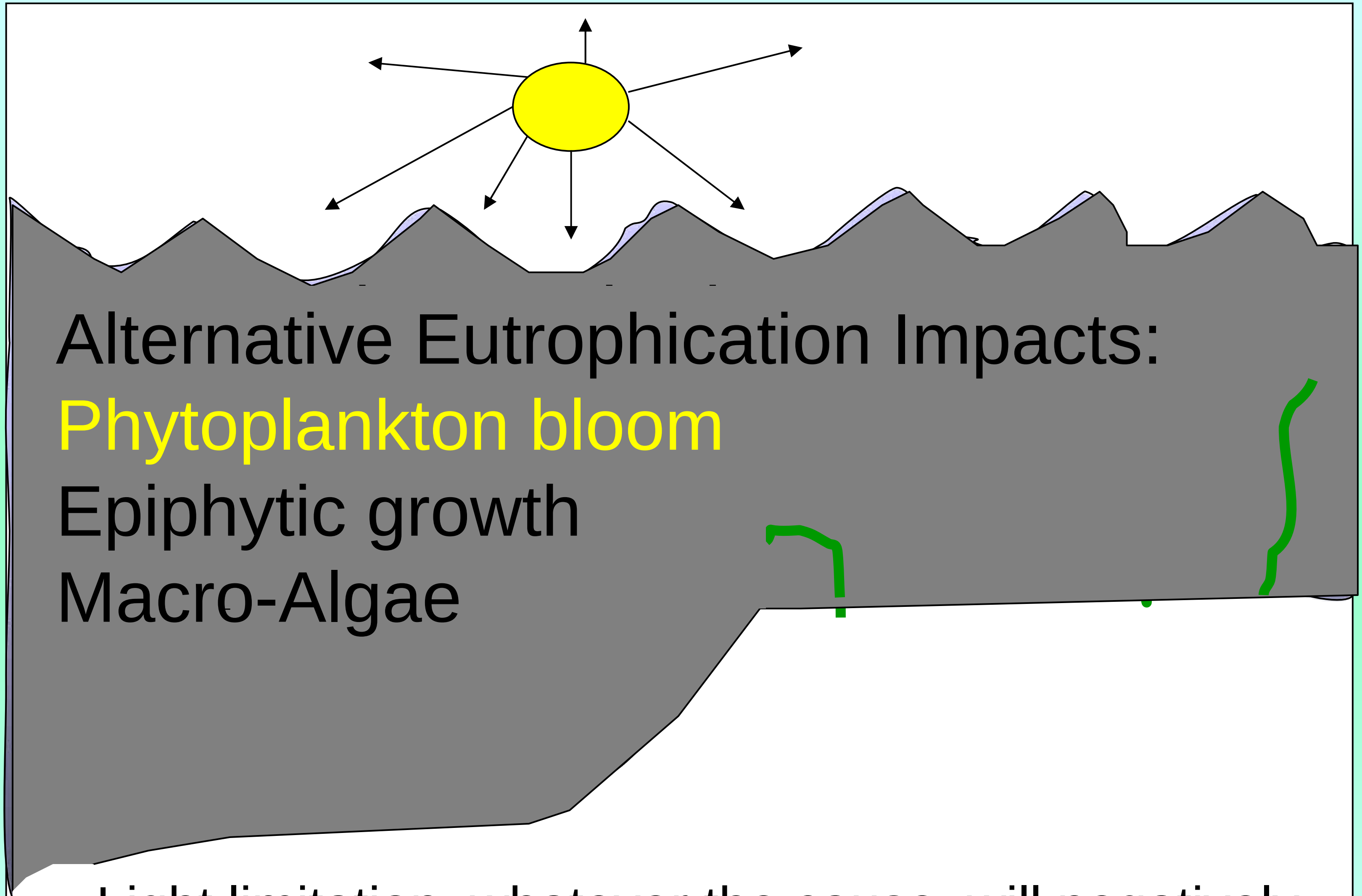
•Due to their ecological importance and recent indications of disease and dieback, seagrasses are considered as an important ecological indicator of overall estuarine health

•BB contains >75% of NJ's seagrass habitat

•Subject to declines globally

•Part of a nationwide NERR monitoring effort





Light limitation, whatever the cause, will negatively impact seagrass photosynthesis, productivity and abundance

Mean Total Nitrogen by stations
June - August 1989 2006

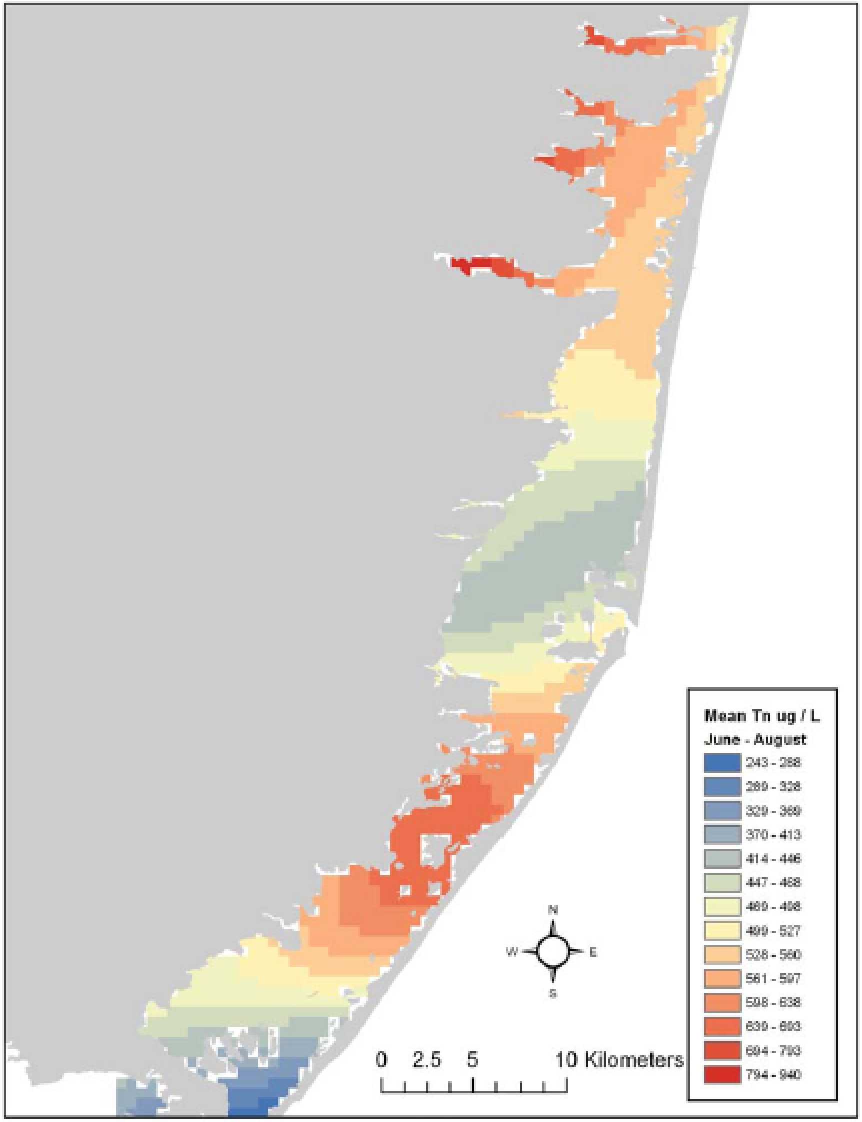
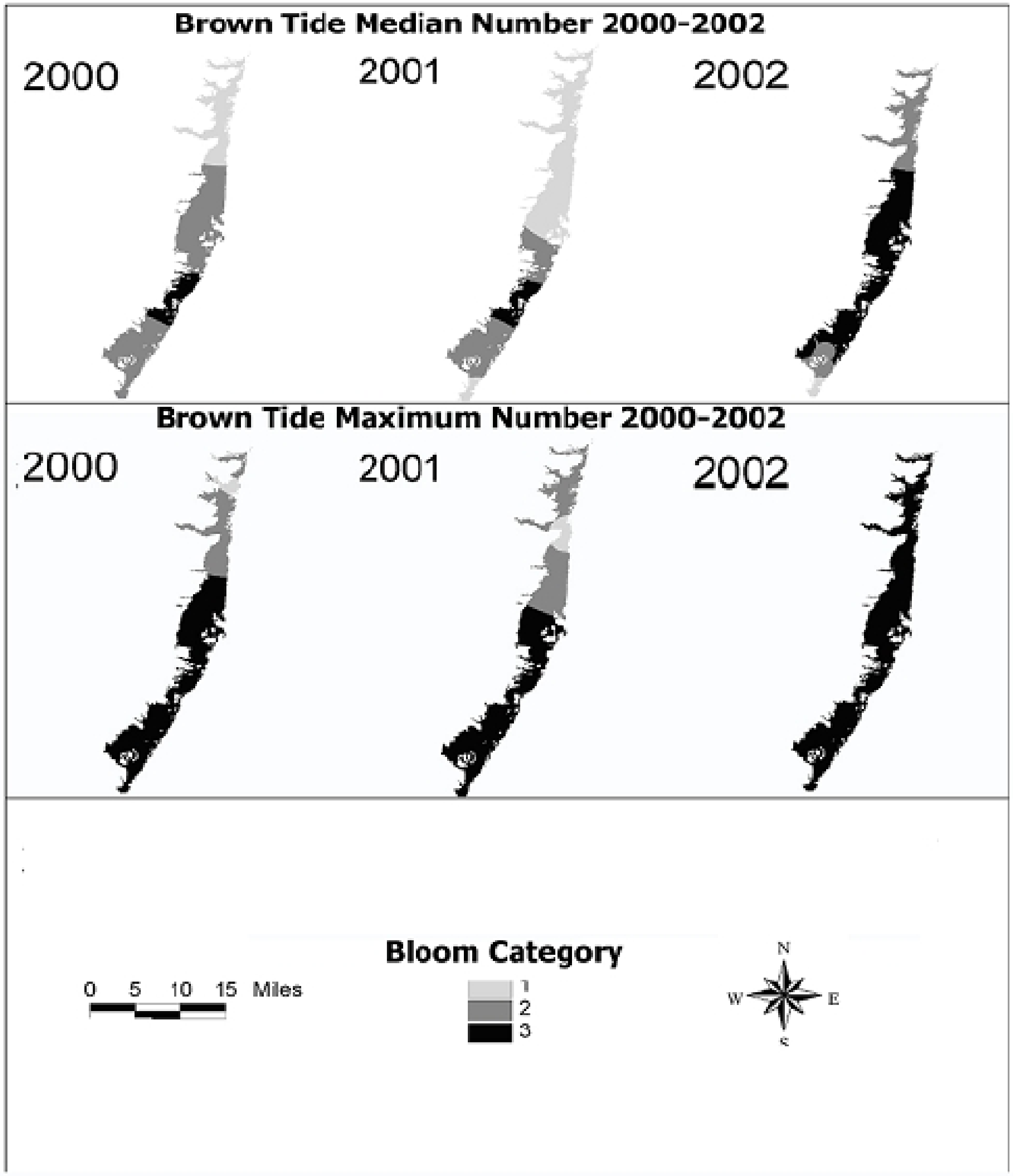


Figure 6. Gridded mean total nitrogen in the Barnegat Bay-Little Egg Harbor estuary from June-August between 1998-2006.

Graphic provided by Scott Haag 2010

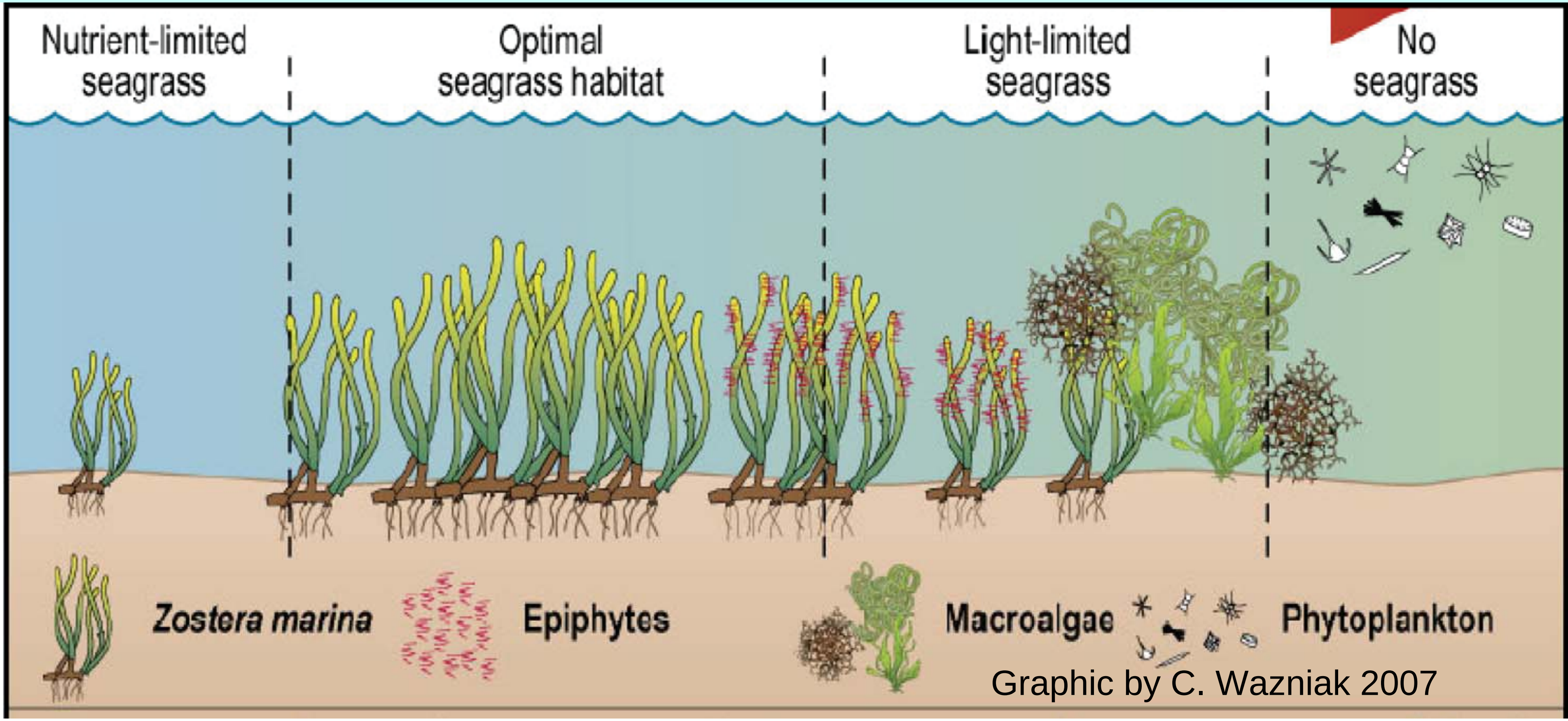
Brown Tide Blooms 2000-2002

Associated with lower freshwater inflow, higher salinities and higher temperatures



Downes Gastrich, M., R.G. Lathrop, S. Haag, M.P. Weinstein, M. Danko, D.A. Caron, and R. Schaffner. 2004. Assessment of brown tide blooms, caused by <u>Aureococcus anophagefferens</u>, and contributing factors in New Jersey coastal bays: 2000-2002. Harmful Algae 3:305-320.

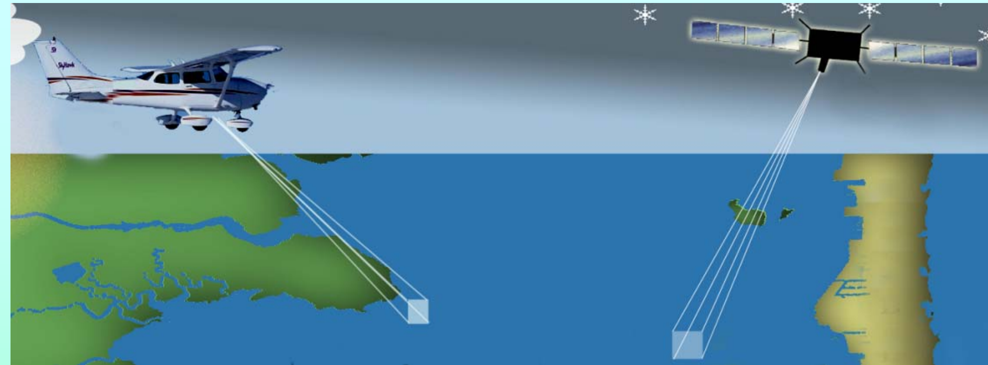
Eutrophication Gradient



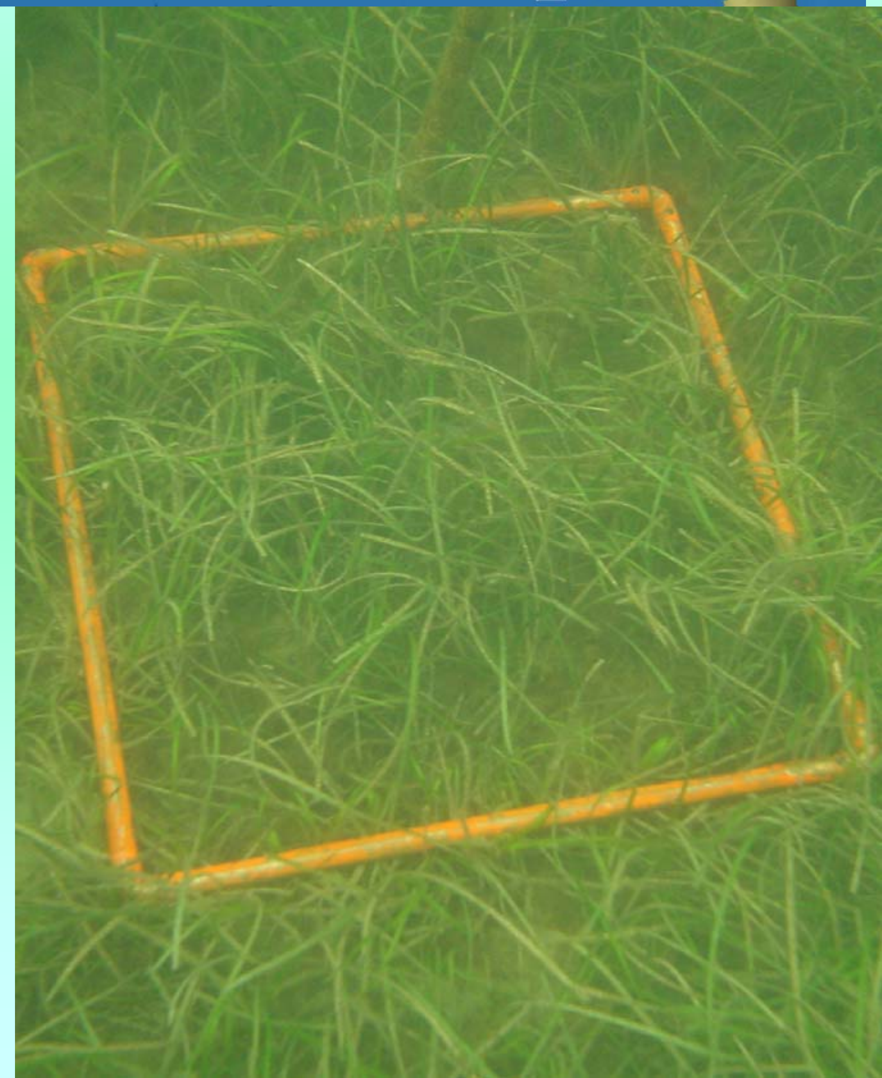
Increased watershed nutrient and sediment runoff will lead to eutrophication, resulting in phytoplankton and macroalgal blooms.

Light limitation, whatever the cause, will negatively impact seagrass photosynthesis, productivity and abundance

Remote Sensing Methods for Characterizing & Mapping Seagrass

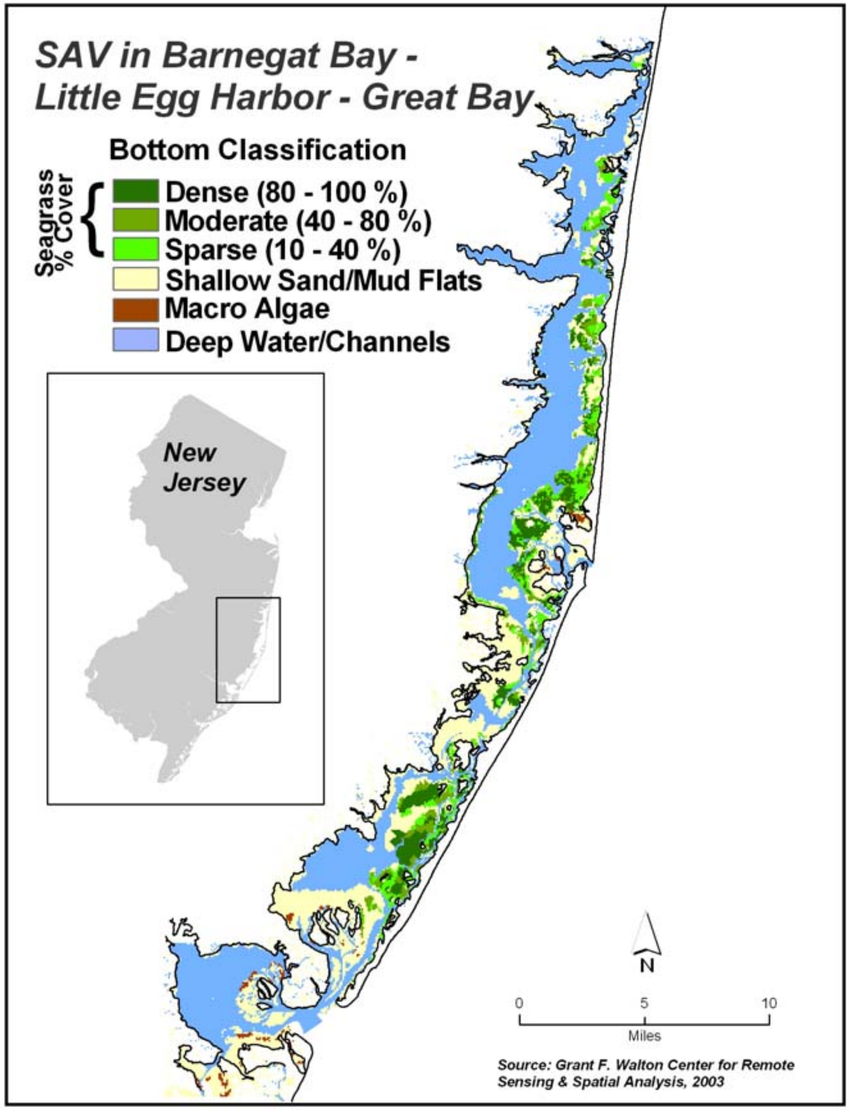


- High spatial resolution digital airborne and satellite visible imagery for water depth penetration
- Image Segmentation techniques
- In situ field data



Multi-Scale Image Segmentation

of airborne digital camera imagery



Lathrop, R.G., P. Montesano, and S. Haag. 2006. A multi-scale segmentation approach to mapping submerged aquatic vegetation using airborne digital camera imagery. Photogrammetric Engineering and Remote Sensing 72(6):665-675. .

Comparing 2009 vs. 2003 Seagrass mapping

2009: 5,253 ha
- sparse -2,256ha
- moderate -2,527ha
- thick - 470ha

2003: 5,184 ha

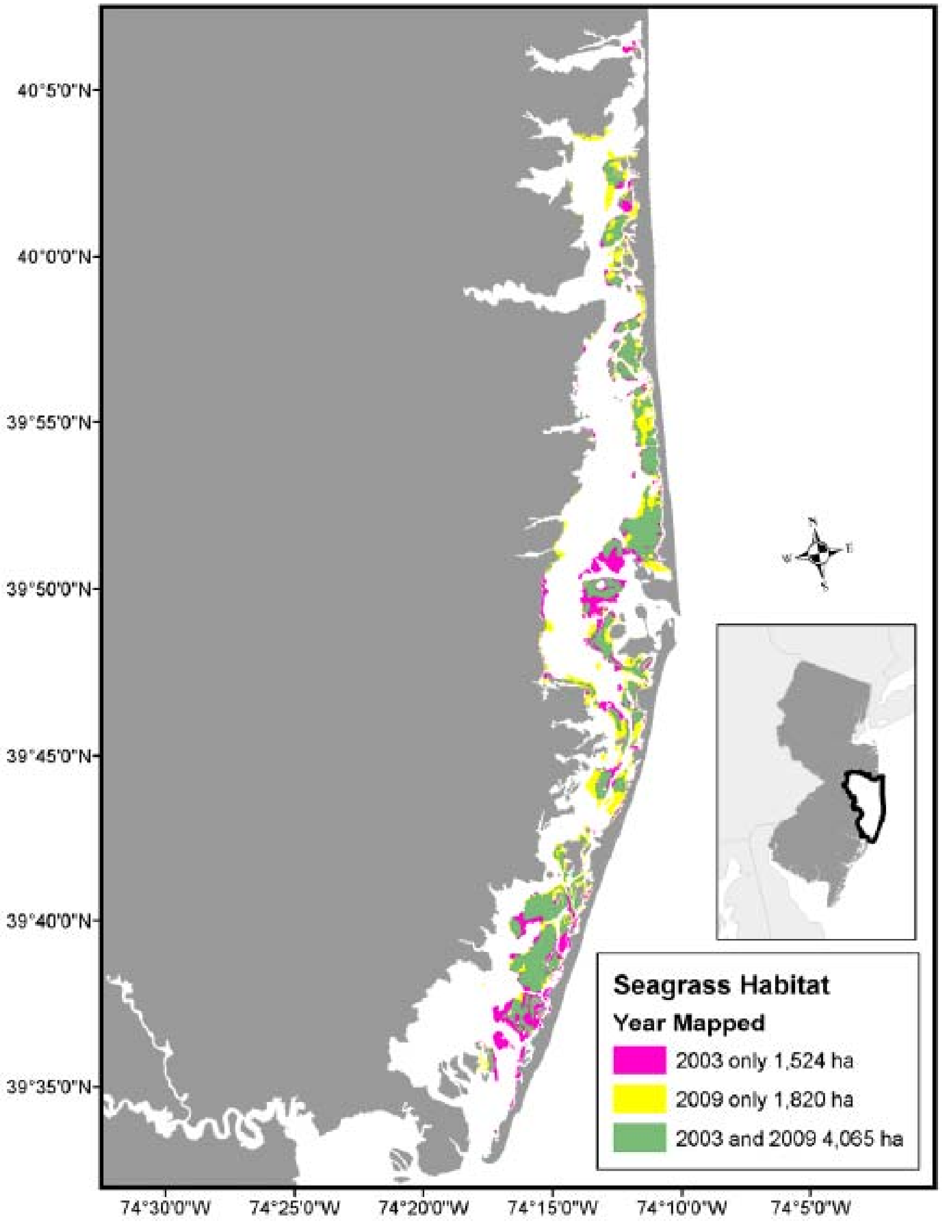


Figure 11. Distribution of seagrass mapped during the 2003 and 2009 surveys.

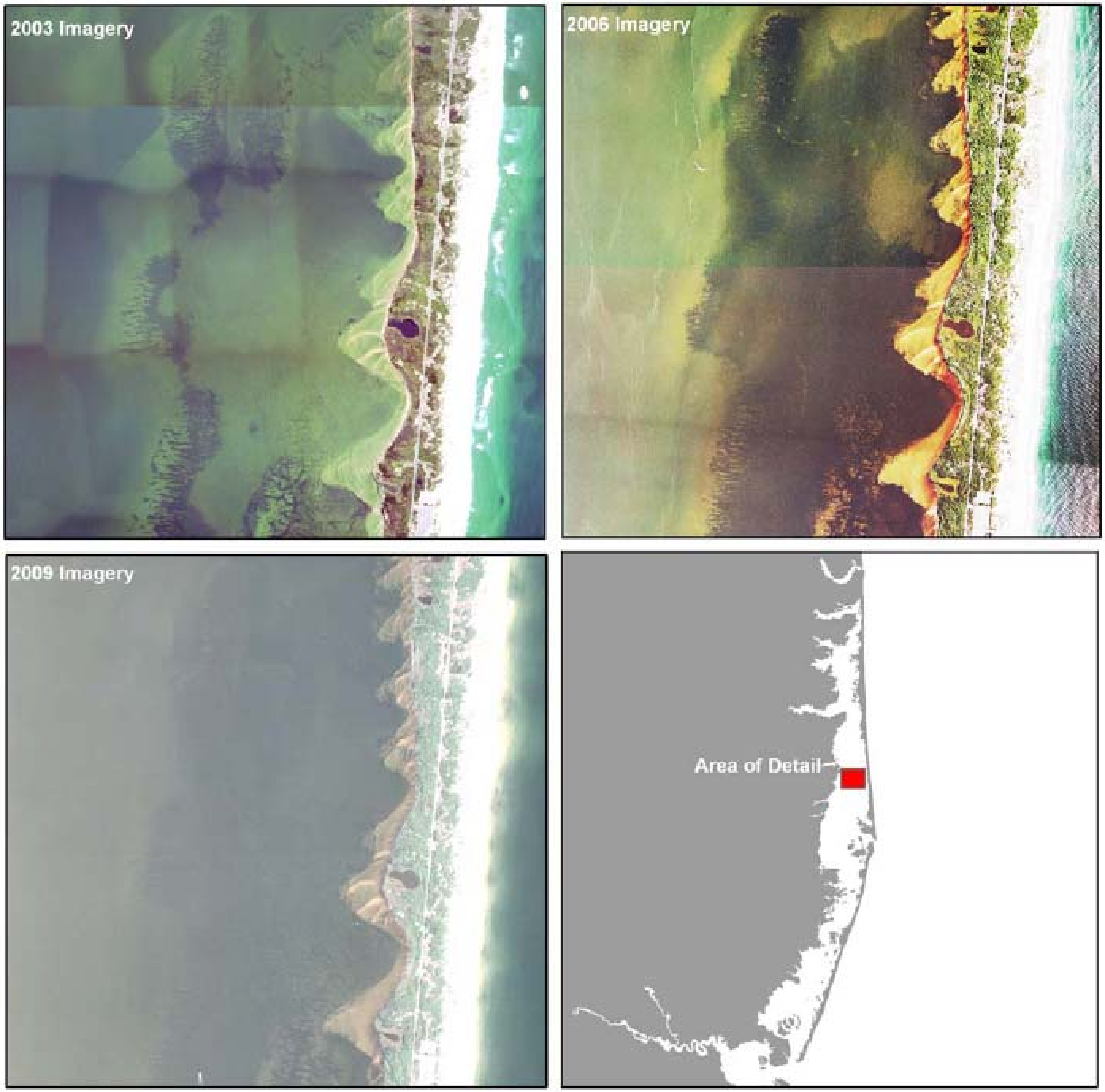
Graphic provided by S. Haag 2010

Seasonal differences in imagery affect seagrass mapping

Quickbird Satellite Imagery (Fall 2004)

Aerial Photography (Spring 2003)

Inter-annual differences: 2003 vs. 2006 vs. 2009



Graphic provided by S. Haag 2010

Conclusions:

- At over 1/3 of the bay watershed in human altered land use, the BB-LEH system is heavily impacted by watershed inputs and adjacent land use
- Next steps: Defining critical thresholds of BBW land use change in relation to the downstream impact to the Bay.
  - How much impervious and lawn surface can be added before the bay reaches a critical tipping point? Are we already there?
  - Can improved stormwater management and lawn care practices make a substantive difference?
- Seagrass, as an ecological indicator, shows great year-to-year variability as well as spatial variability in the health of the Bay(s).

USGS Hydrologic Monitoring and Research in the Barnegat Bay Watershed

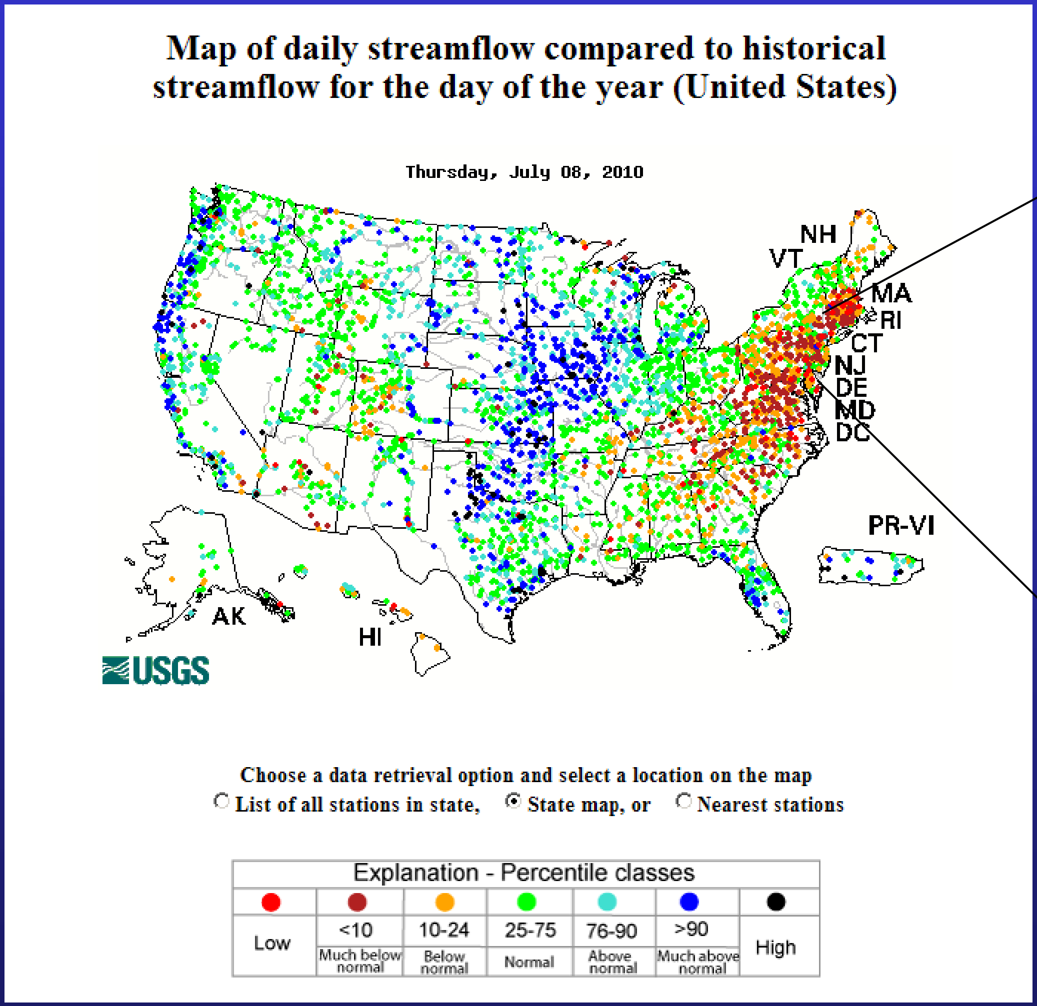
New Jersey Department of Environmental Protection
Technical Seminar for In-House Staff: The Science of Barnegat Bay

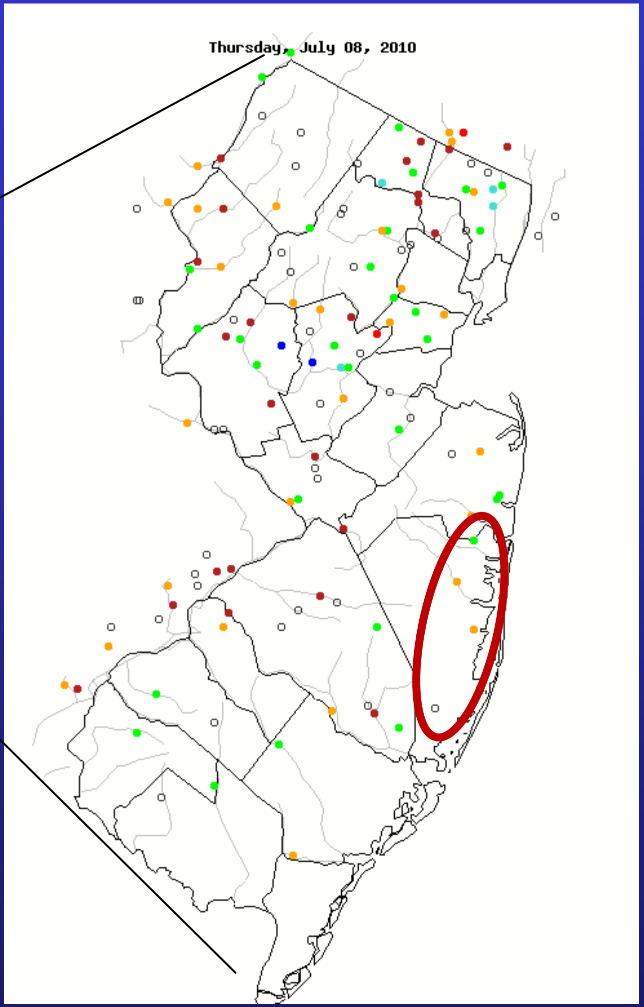
July14, 2010

Robert Nicholson
U.S. Geological Survey
New Jersey Water Science Center
West Trenton, NJ
609-771-3925
rnichol@usgs.gov

USGS

USGS STREAMFLOW MONITORING NETWORK





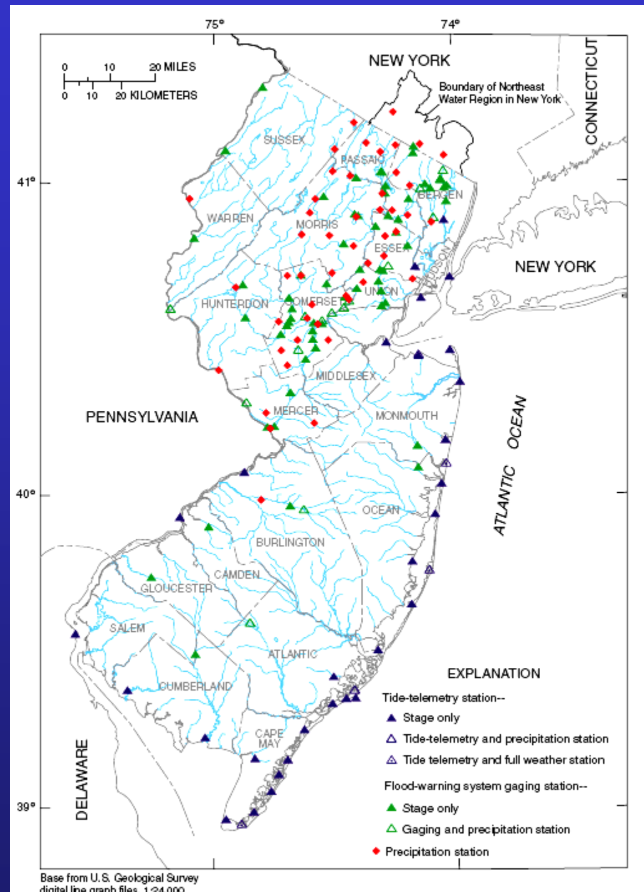
- 114 Continuous Record Discharge Gages / 4 in BBLEH
- 181 Partial Record discharge sites / 15 in BBLEH
- 99 Crest Stage Gages / 5 in BBLEH

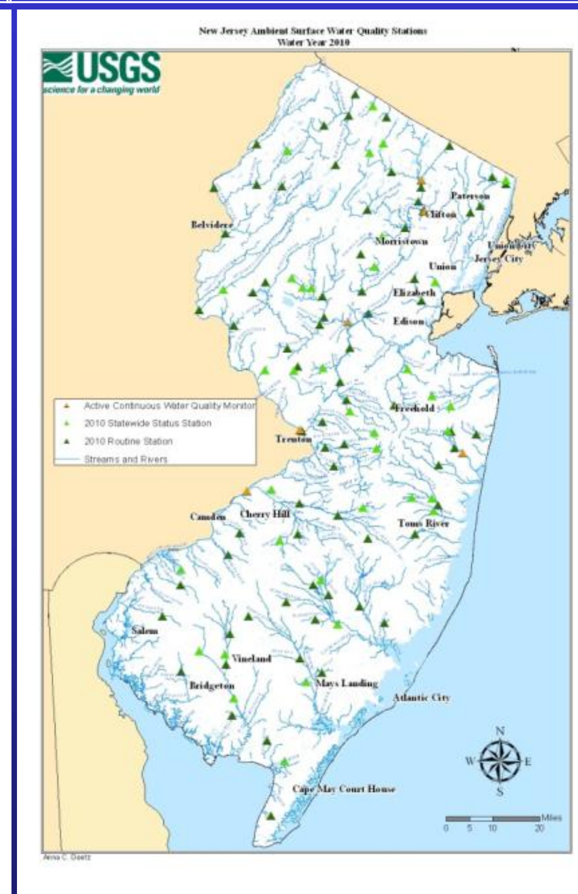
USGS

Surface-Water Monitoring Networks

Funded cooperatively with various agencies

Flood/Tide Warning	Water Quality Monitoring





NJ Coastal Tide gages w/ NJOHSP
- 25 Continuous tide gages / 5 in BBLEH
- 33 crest stage gages/ 3 in BBLEH
- 5 weather stations / 1 in BBLEH

Flood Warning Networks with 5 Counties & USACE
- 45 stage-only gages /1 in BBLEH
- 36 precipitation gages
- 13 continuous-discharge gages

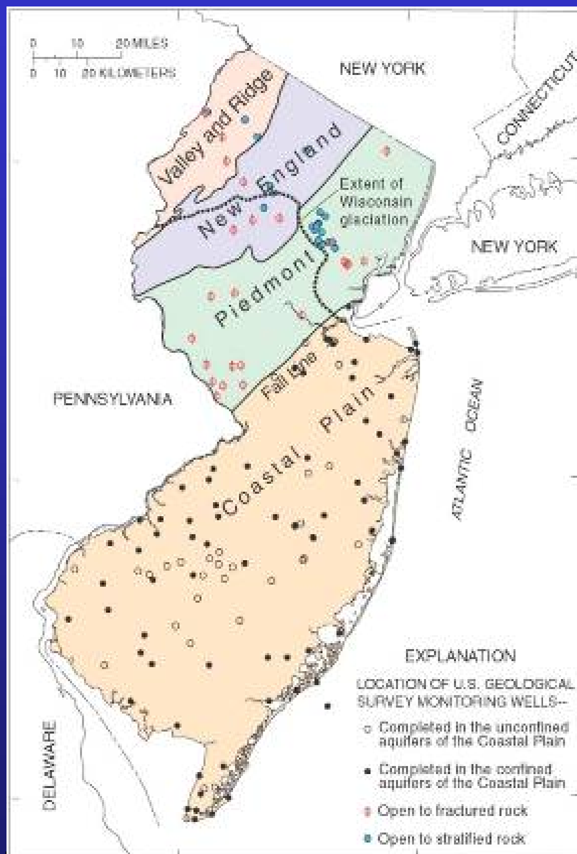
115 Water-quality sites w/ NJDEP
- 7 Background
- 42 Statewide status sites /3 in BBLEH
- 23 Watershed integrator sites / 1 in BBLEH
- 43 Land use indicator sites / 1 in BBLEH
- Sampled seasonally (4 per year)

USGS

Ground-Water Network

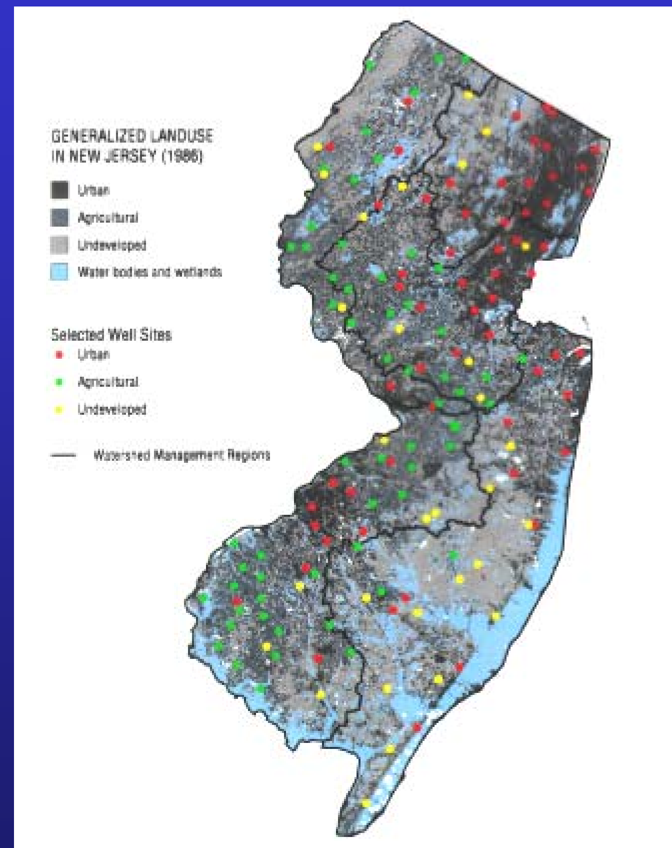
Funded cooperatively with NJDEP

Ground-Water Levels



189 Sites total / 24 in BBLEH

Ground-Water Quality



- 150 random shallow wells / 11 in BBLEH
- Land-use stratification (Urban, Ag, Undevel).
- 30 wells sampled annually (USGS & NJGS)

USGS

FRESHWATER INPUTS

590 million gallons per day (average)

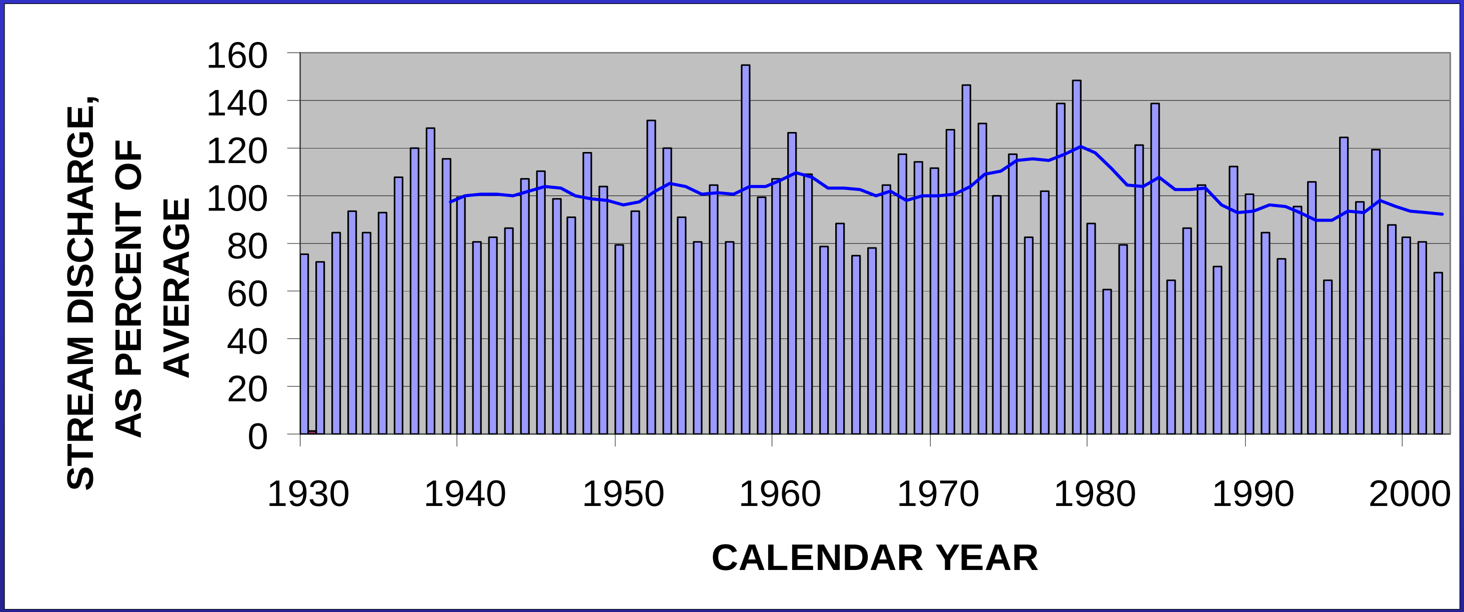
USGS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

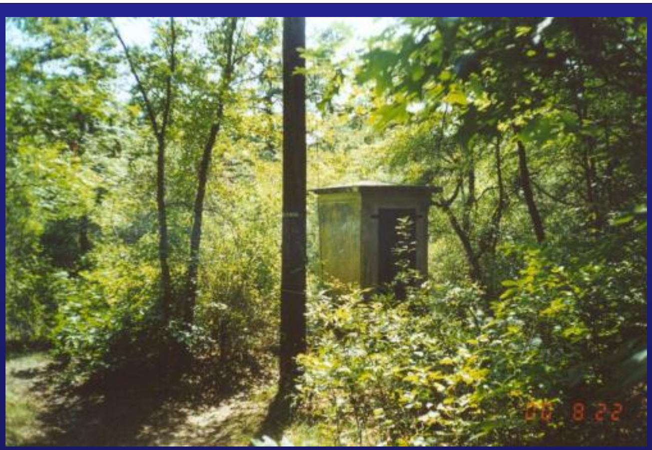
BARNEGAT BAY PARTNERSHIP
RESEARCH · EDUCATE · RESTORE

FRESHWATER INPUTS

Toms River Streamflow 1929-2002



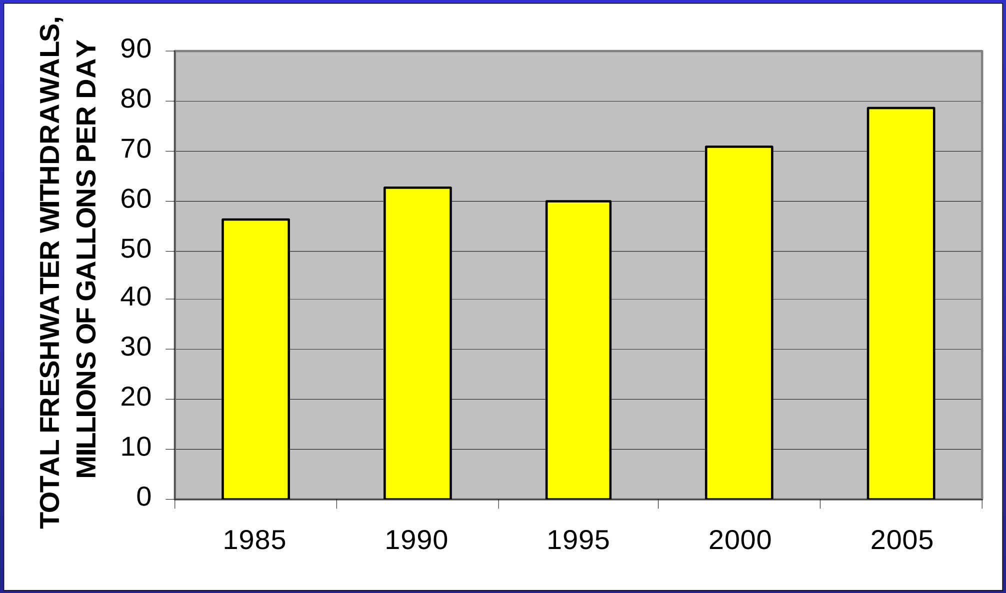
1929

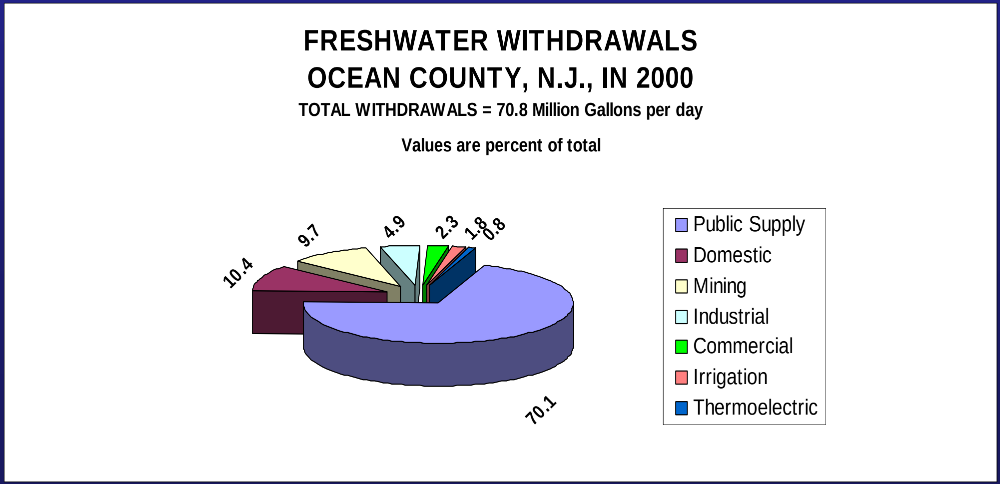


2000

USGS

FRESHWATER INPUTS





FRESHWATER WITHDRAWALS

Ocean County

1985 - 2005

USGS

Nitrogen

Importance -- Biological productivity in coastal waters is normally limited by the availability of nitrogen, with secondary P limitation (demonstrated in Barnegat Bay by Seitzinger, et al, 2001)

Common forms

- Organic nitrogen
- Inorganic forms: NO_3^-, NO_2^-, NH_3, NH_4^+

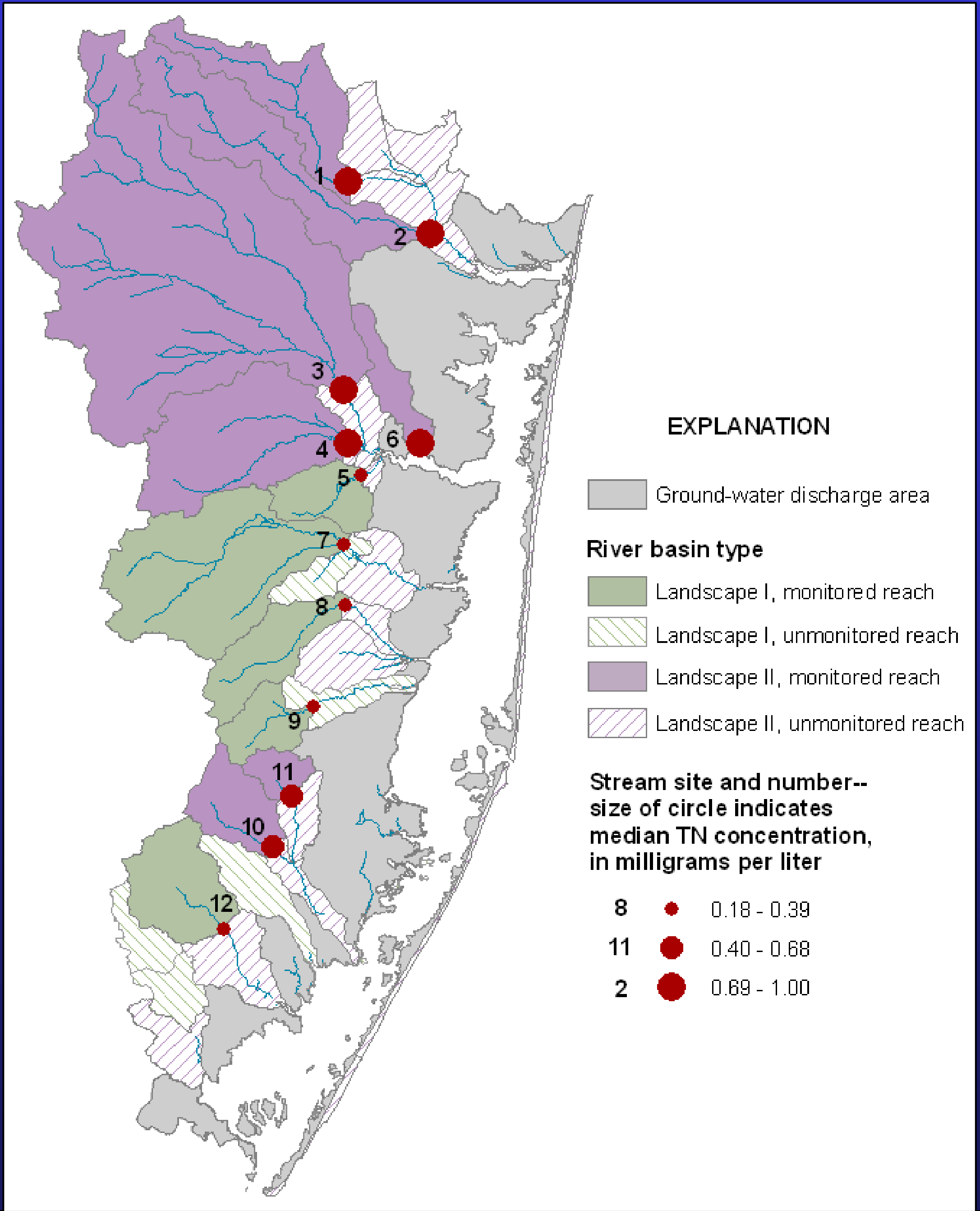
Common sources

- Residential and commercial areas
  - Lawn fertilizer, septic system waste, leaky sewer pipes, industrial discharge
- Agricultural areas
  - Crop fertilizer, animal manure, septic system waste
- Atmosphere
  - Automobile emissions, industrial emissions, natural N-fixation processes, emissions from agricultural sources

NITROGEN LOADING

Total Nitrogen Concentrations in Streams

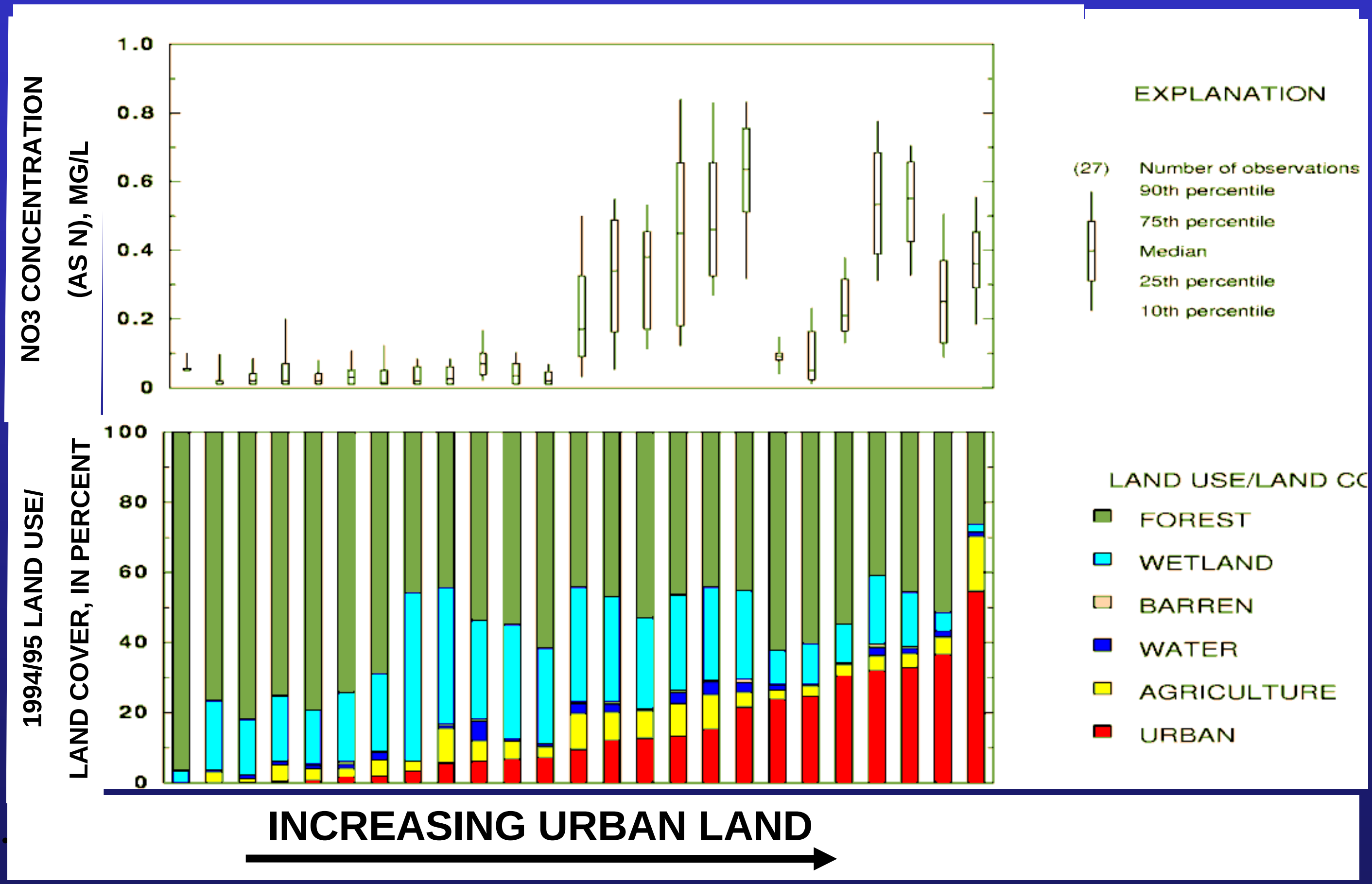
Median concentrations of total nitrogen (TN) at 12 stream sites in the Barnegat Bay Little Egg Harbor watershed, 1987 2008



USGS

NITROGEN LOADING

RELATION BETWEEN WATER QUALITY AND LAND USE/LAND COVER

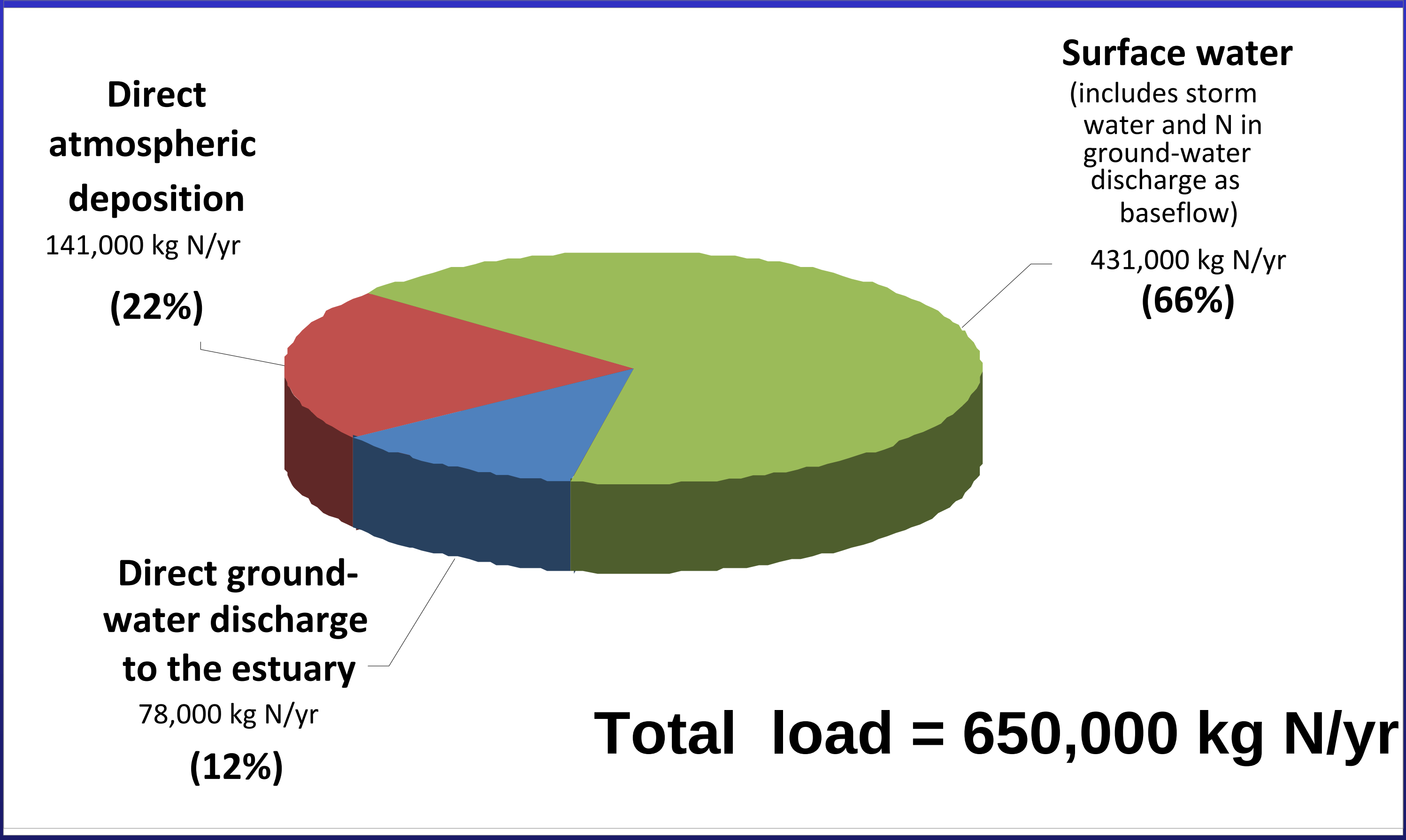


Source: Hunchak-Kariouk and Nicholson, 2001

USGS

NITROGEN LOADING

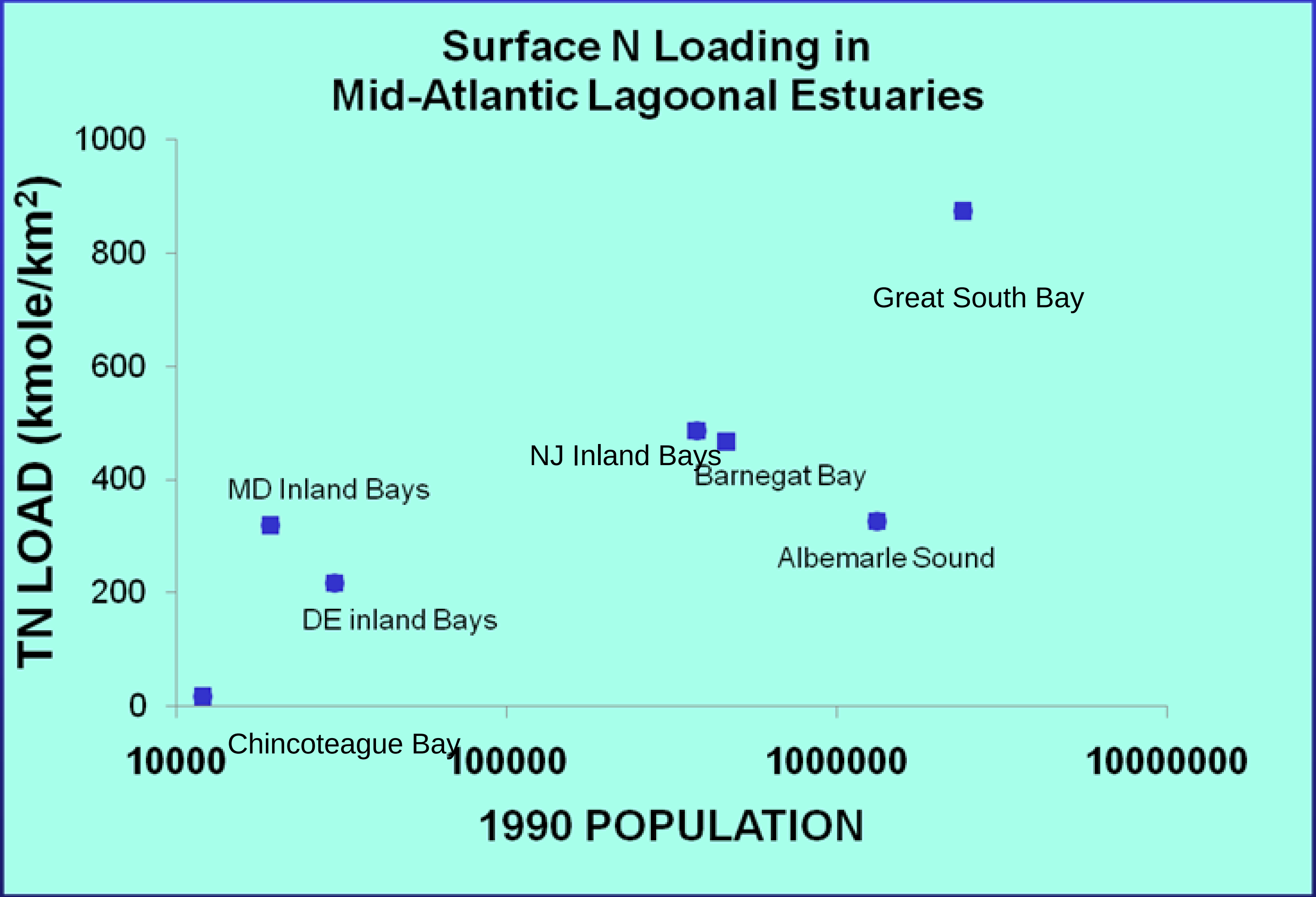
Updated (2009) Estimate of Delivered Load



Wieben and Baker (2009)

USGS

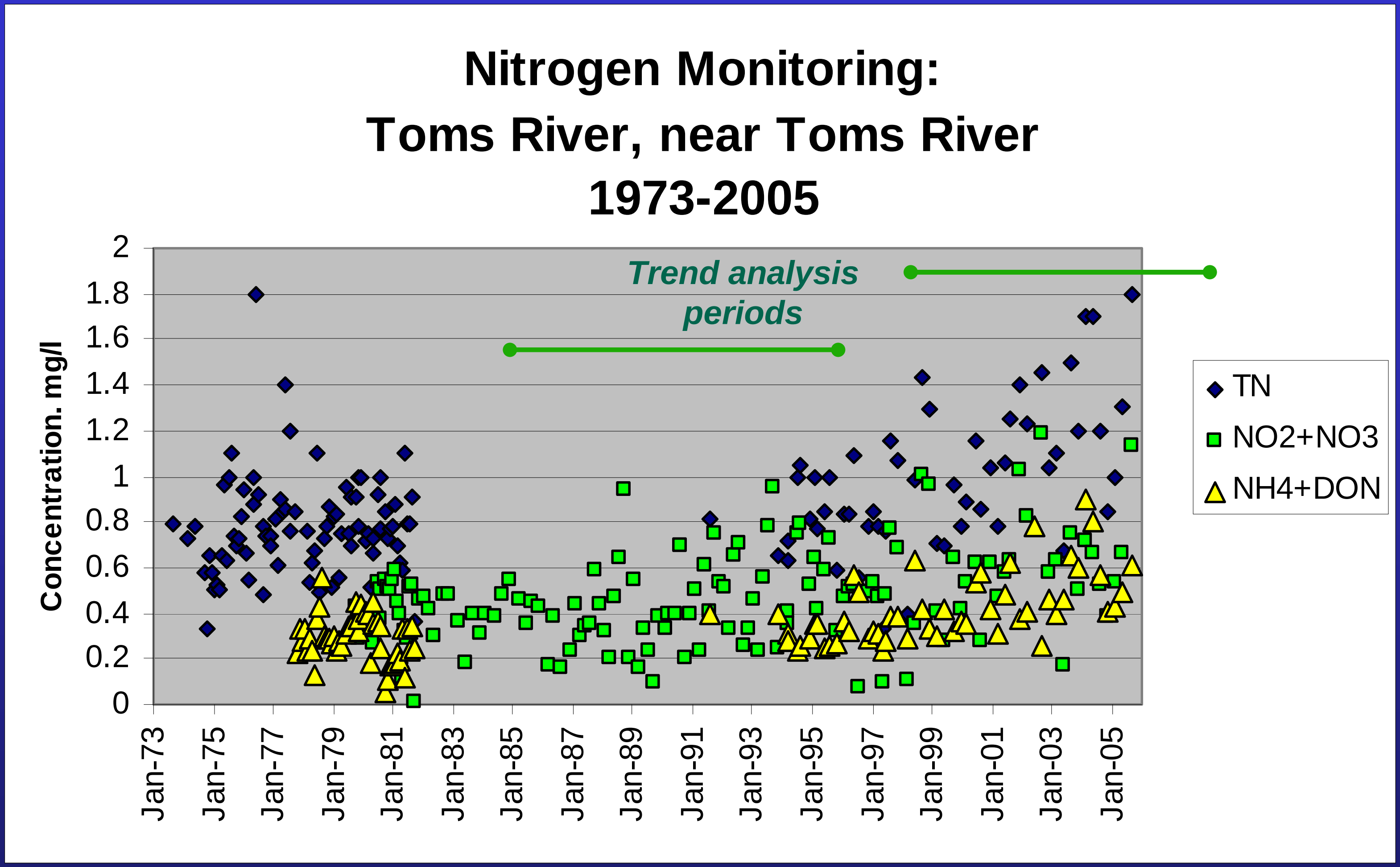
NITROGEN LOADING



Source: NOAA Estuarine Typology Database (Smith and others, 2003)

USGS

NITROGEN LOADING



Source: USGS/NJDEP Cooperative Ambient Stream Monitoring Network

Increasing trend in NO2+NO3 during 1985-95 and 1998-2007 is statistically significant (p = 0.10, 0.05) (Hickman and Barringer, 1999; Hickman, in press)

USGS

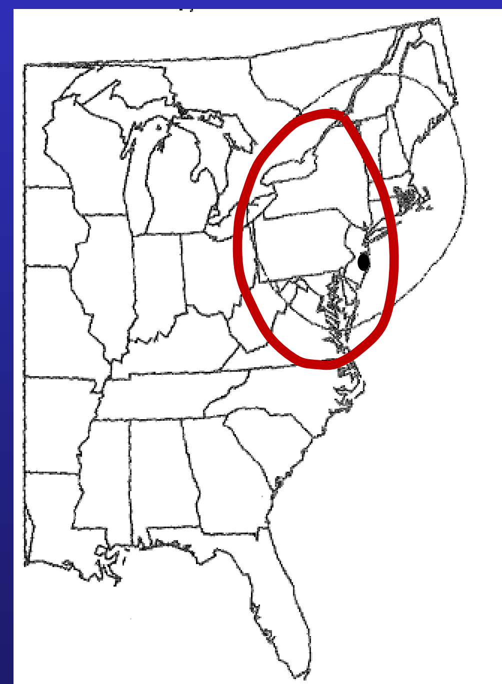
Atmospheric Deposition

NADP Monitoring Station at E.B. Forsythe National Wildlife Refuge

SOURCES

Sources of N in atmospheric deposition:
Primarily local and regional combustion of fossil fuels

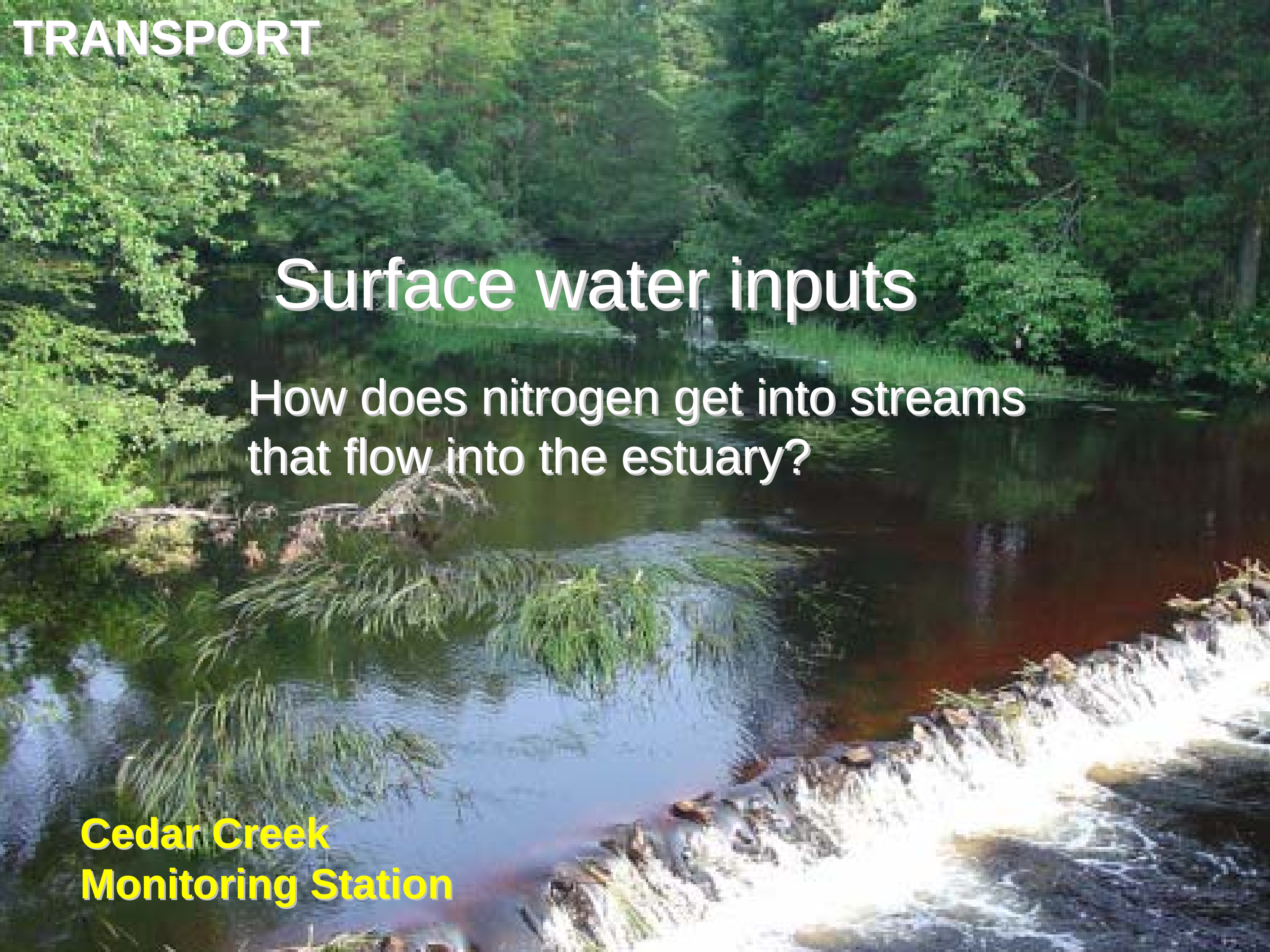
Local NOx emissions



Barnegat Bay NOx Airshed
(NOAA-ARL and USEPA-NERL, 2001)

Regional sources:
N may be transported over long distances before deposition

USGS



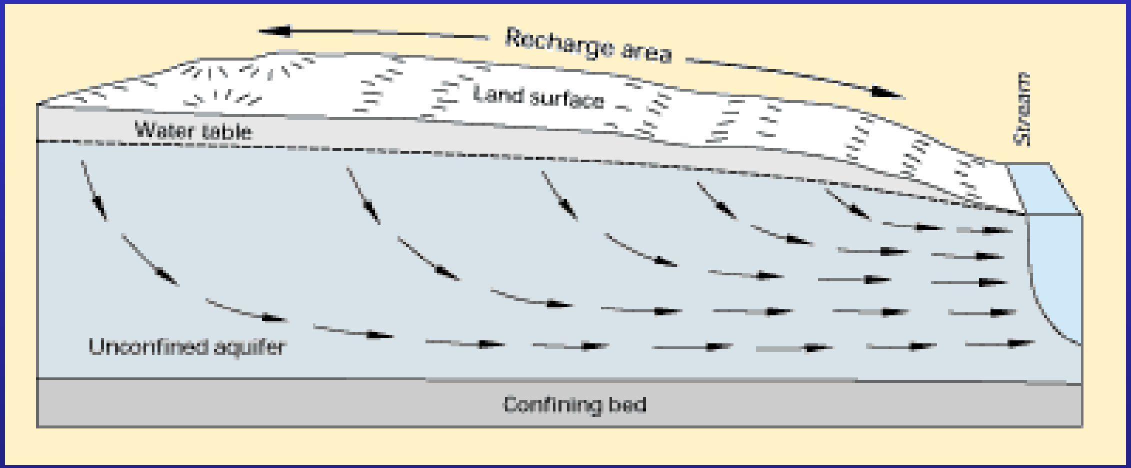
Surface water inputs

How does nitrogen get into streams that flow into the estuary?

Cedar Creek Monitoring Station

TRANSPORT

GROUNDWATER FLOW TO STREAMS



How much of the nitrogen load in streams comes from groundwater?

Baseflow sustains flow during dry periods

In southern New Jersey, 80% of streamflow is baseflow (comes from groundwater discharge)

Nearly all baseflow originates as aquifer recharge

USGS

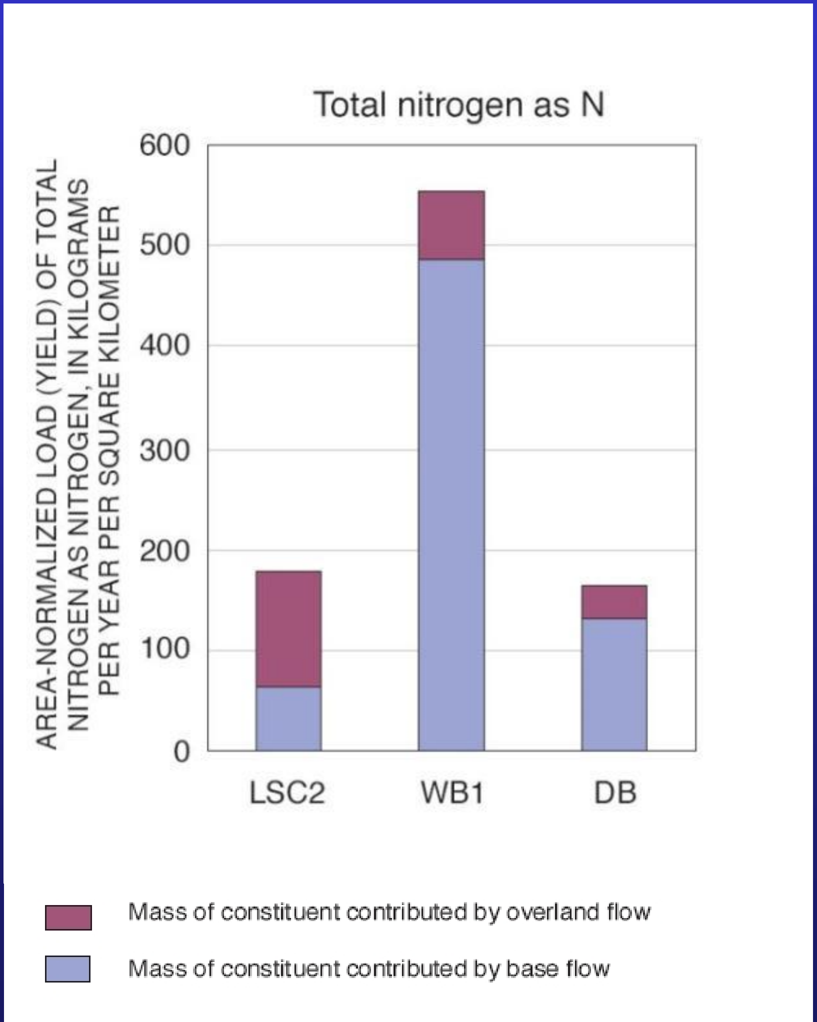
Relative Loads from Stormwater and Baseflow

USGS/NJDEP Toms River study (2006)

R. Baker and K. Hunchak-Kariouk (2006, USGS)

Connell and Schuster (NJDEP, 1999)

- Base flow contributed more of the N load than overland flow in 2 of 3 tributaries
- Groundwater is an important nitrogen transport pathway



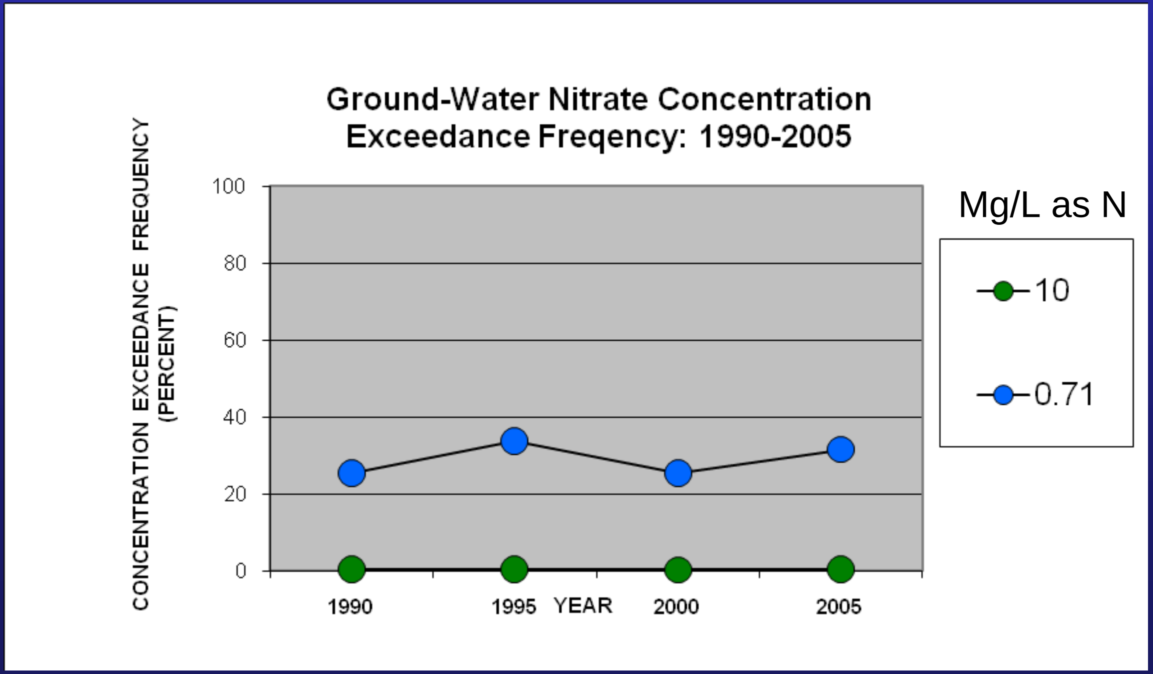
Source: Baker and Hunchak-Kariouk, 2006

Using N in Groundwater as an Indicator of Potential Load

C. Wieben, USGS (2007)

1,700+ Ocean County ground-water sample results for 1990-2005

26-34% of ground-water sample concentrations were above proposed 0.71 mg/l N criteria for rivers and streams in Nutrient Ecoregion XIV (Atlantic Coast).



Data Source: Wieben, 2007

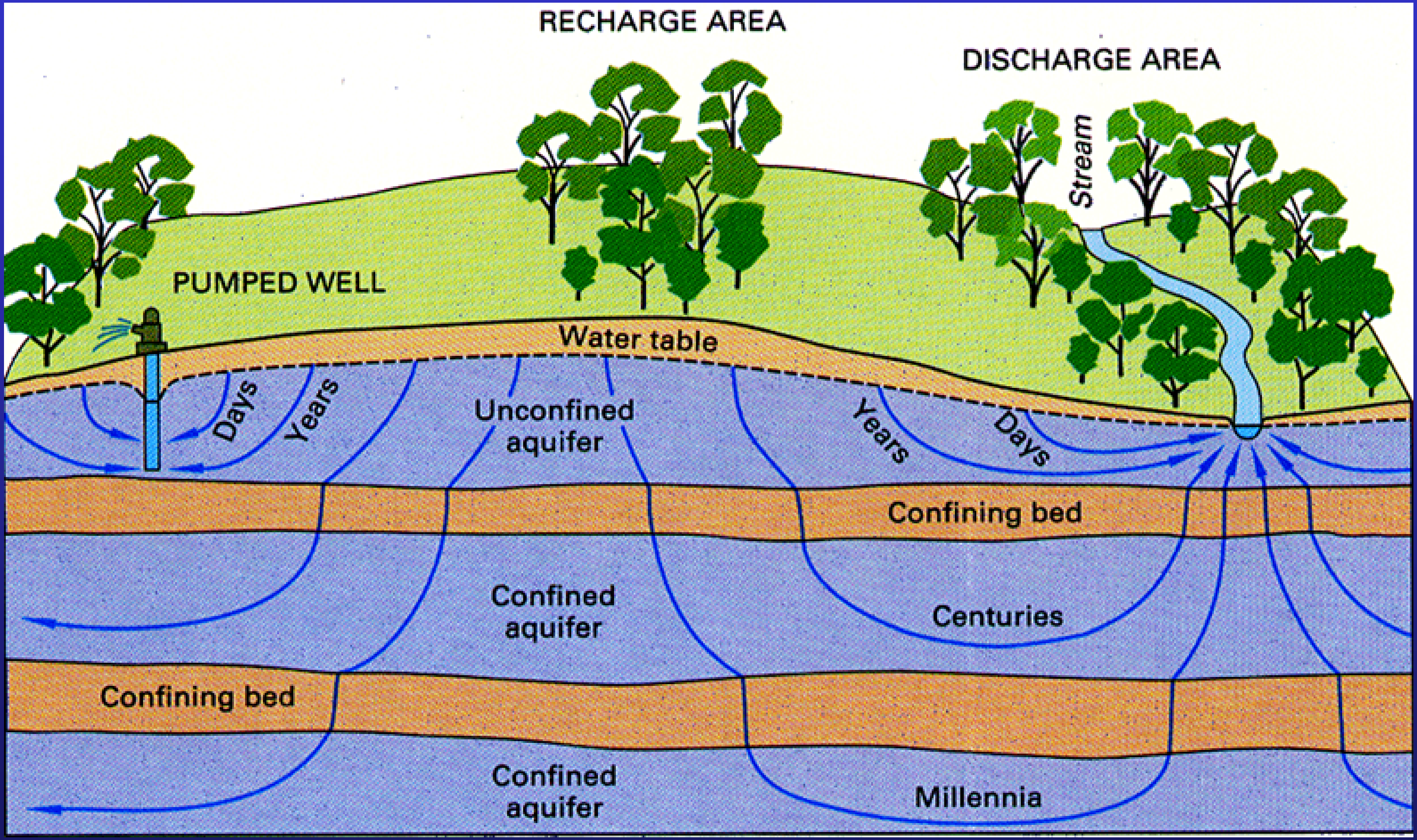
Ongoing USGS Research

- Simulation of nitrogen transport in groundwater
- Quantifying sources of nitrogen
- Exploring linkage between nutrient loads and biotic responses (with Rutgers)

USGS

Transport

GROUNDWATER INPUTS



USGS

Transport

Groundwater Flowpath Analysis

S. Cauller and L. Voronin, USGS (ongoing)

- Exploring the link between historical land use and nutrient loads
- Utilizing existing groundwater-flow model developed for water-supply analysis

- Objectives:

  - Determine if observed trends in base flow nutrient loads can be predicted from historical land use

  - Predict loads under alternative management strategies

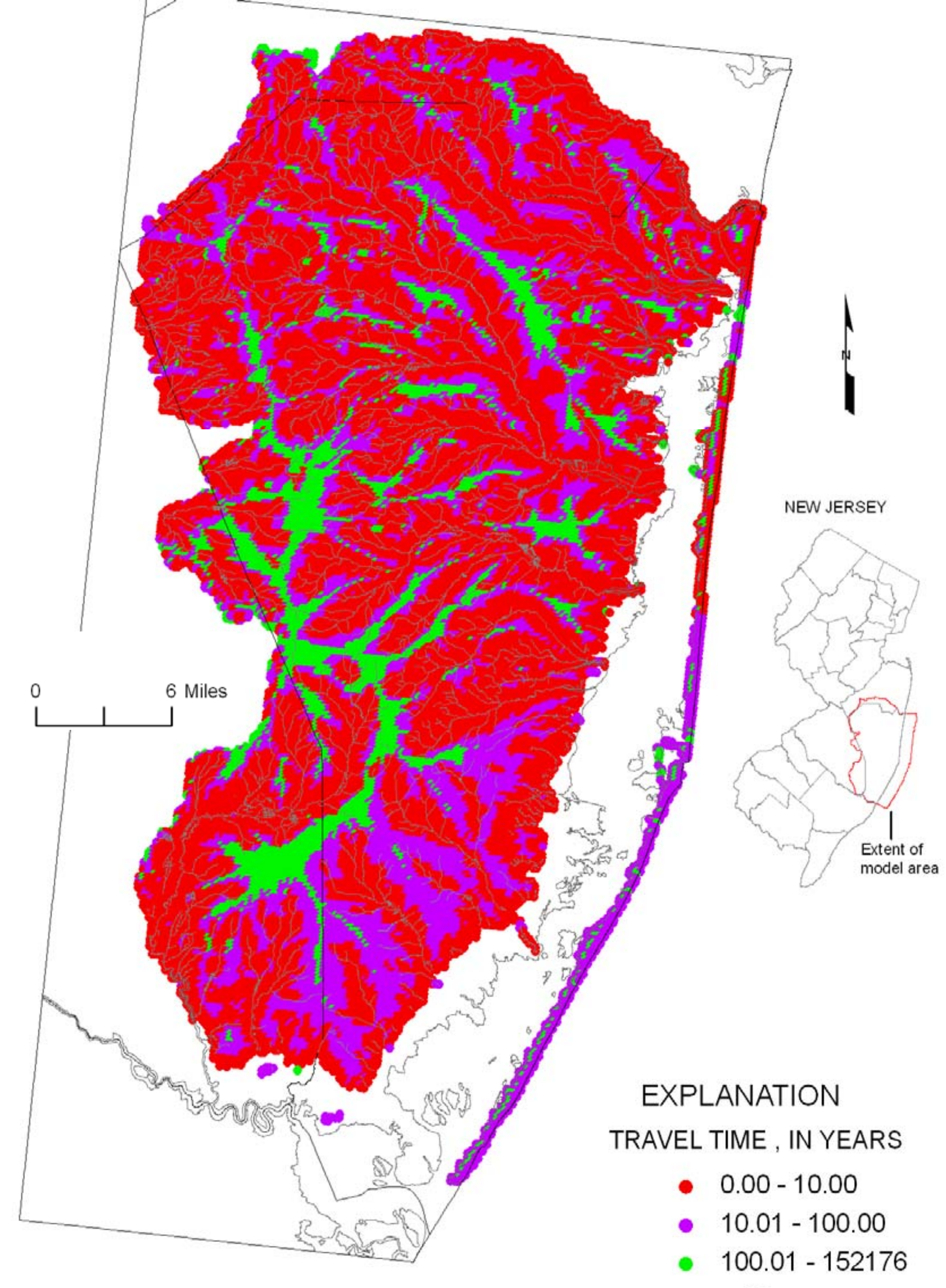
BARNEGAT BAY PARTNERSHIP
RESEARCH · EDUCATE · RESTORE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

USGS

TRANSPORT

Preliminary simulated groundwater travel time from recharge to discharge area



USGS

SOURCES

QUANTIFYING SOURCES OF NUTRIENT INPUTS TO THE BARNEGAT BAY-LITTLE EGG HARBOR ESTUARY

R. Baker and C. Wieben, USGS (ongoing)

Objectives:

- Improve current understanding of nutrient (N + P) sources

  (Using N and O isotope analysis)
- Quantify loading to previously unmonitored streams.
- Improve estimates of direct and indirect ground-water nutrient loading.

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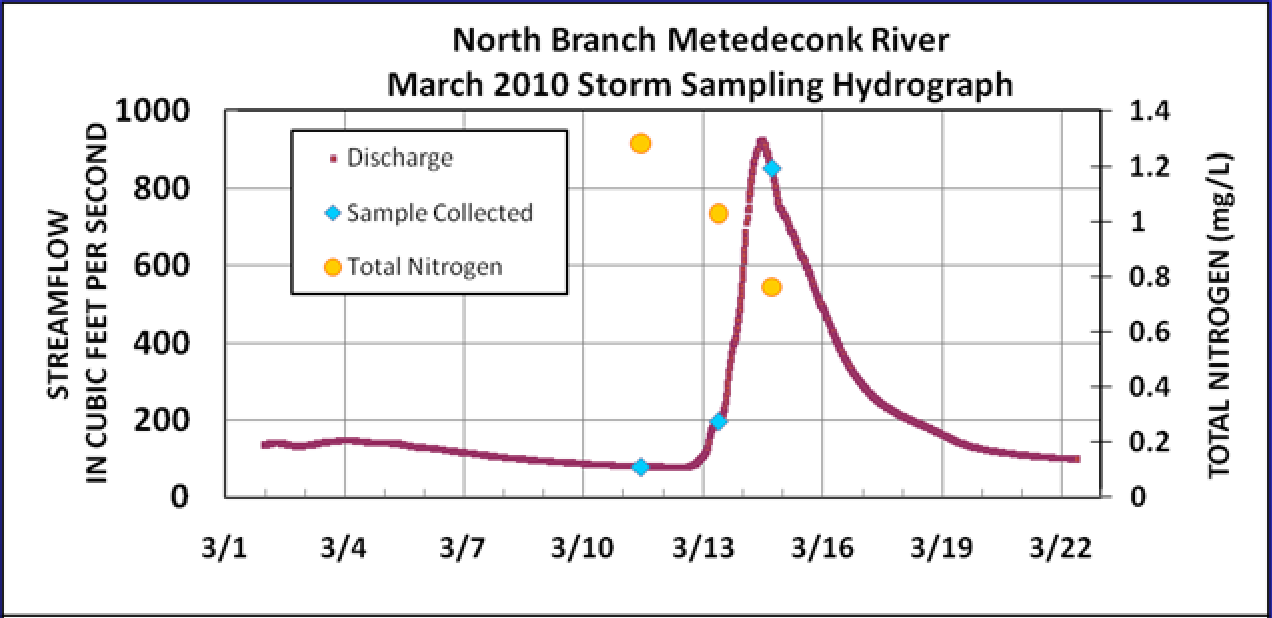
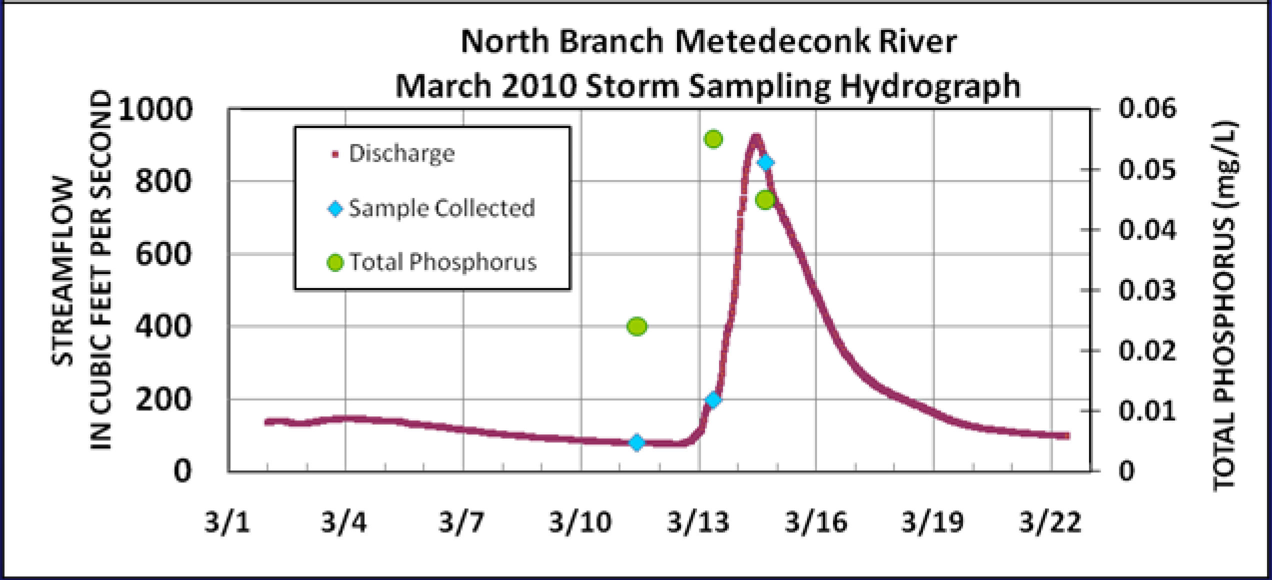
SOURCES

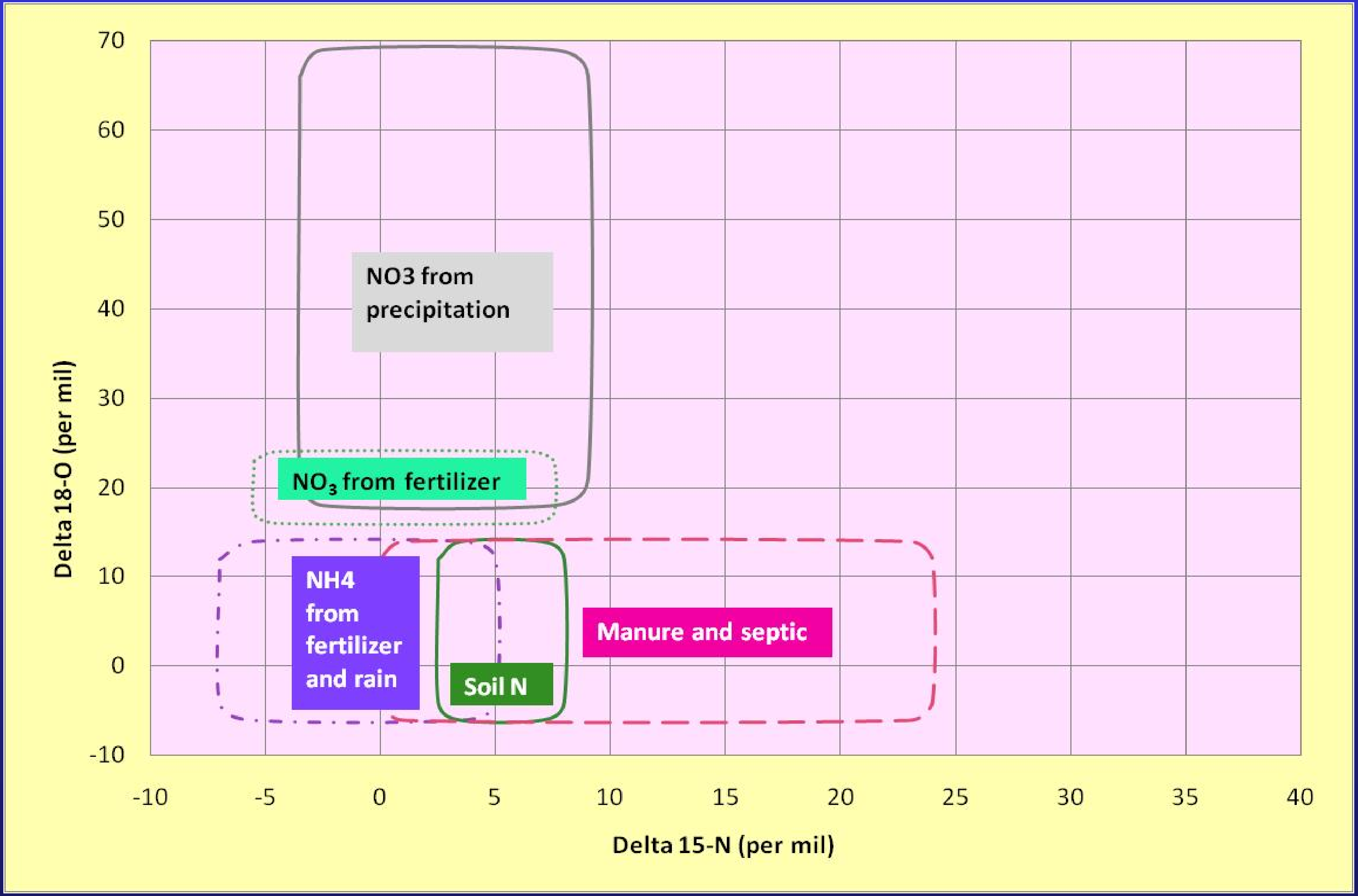


2010 STREAM SAMPLING BEFORE AND DURING STORM EVENTS



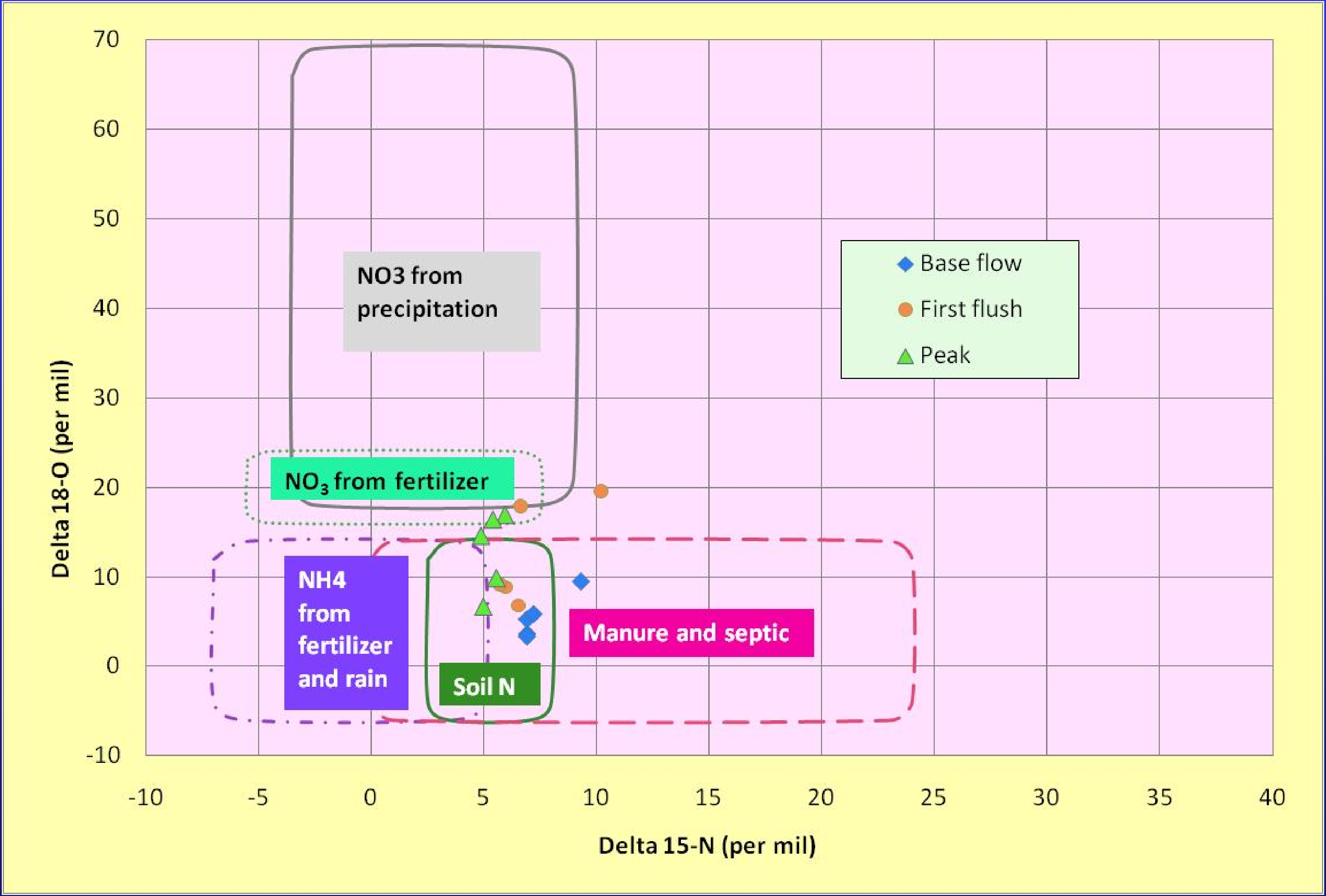
USGS

Plot of Stable Isotope Analysis: ^{18}O vs. ^{15}N



From OHTE and others, 2008

Isotope Data Stratified by Stream Stage



ECOLOGICAL CONSEQUENCES

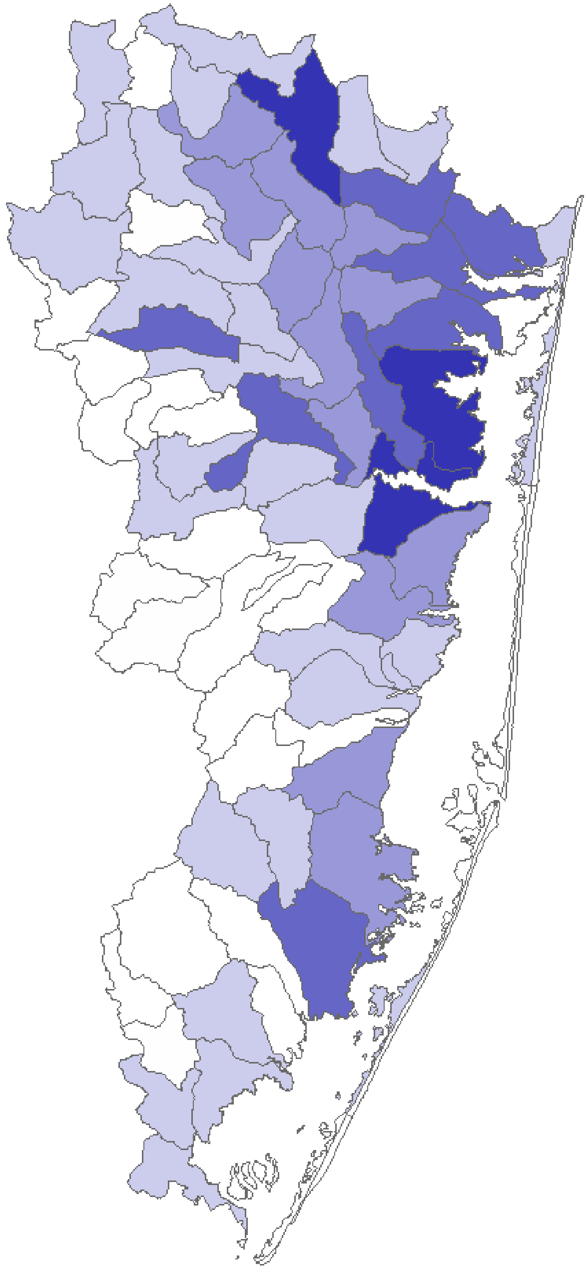
ASSESSMENT OF NUTRIENT LOADING AND BIOTIC RESPONSE IN SUPPORT OF NUTRIENT MANAGEMENT PLANNING

M. Kennish, R. Lathrop, S. Haag (Rutgers University/CRSSA/JCNERR)
R. Baker, C. Wieben (USGS) -- Ongoing: 2009-2012

- Joint project -- Rutgers University and USGS
- EPA funding through NEIWPCC
- One Objective: Determine spatial and temporal relations between nutrient loadings and biotic conditions in Barnegat Bay

PLOAD output: Yield of total N as N, HUC-14 scale, whole year.

Darker colors indicate higher nitrogen loading



USGS

NITROGEN LOAD SUMMARY

What we have learned:

- Primary nutrient delivery pathway is probably surface water
- Nutrient loads from surface water are related to land use
- Groundwater contribution to surface water N load is substantial; large reservoir of N in shallow GW
- Potentially long lag time from release to GW to delivery
- Atmospheric N input is substantial

USGS

NITROGEN LOADING SUMMARY

What we don't know:

- Interannual N load variability *
- Relations between N load and ecological responses *
- Specific, dominant N sources *
- Role of historical land use on present N load *
- Loads/freshwater flows from all streams
- Ocean/estuary nitrogen exchange
- N circulation patterns, fate
- Effect/timing of multiple management actions on N loading

* Ongoing work

USGS

USGS Contributors

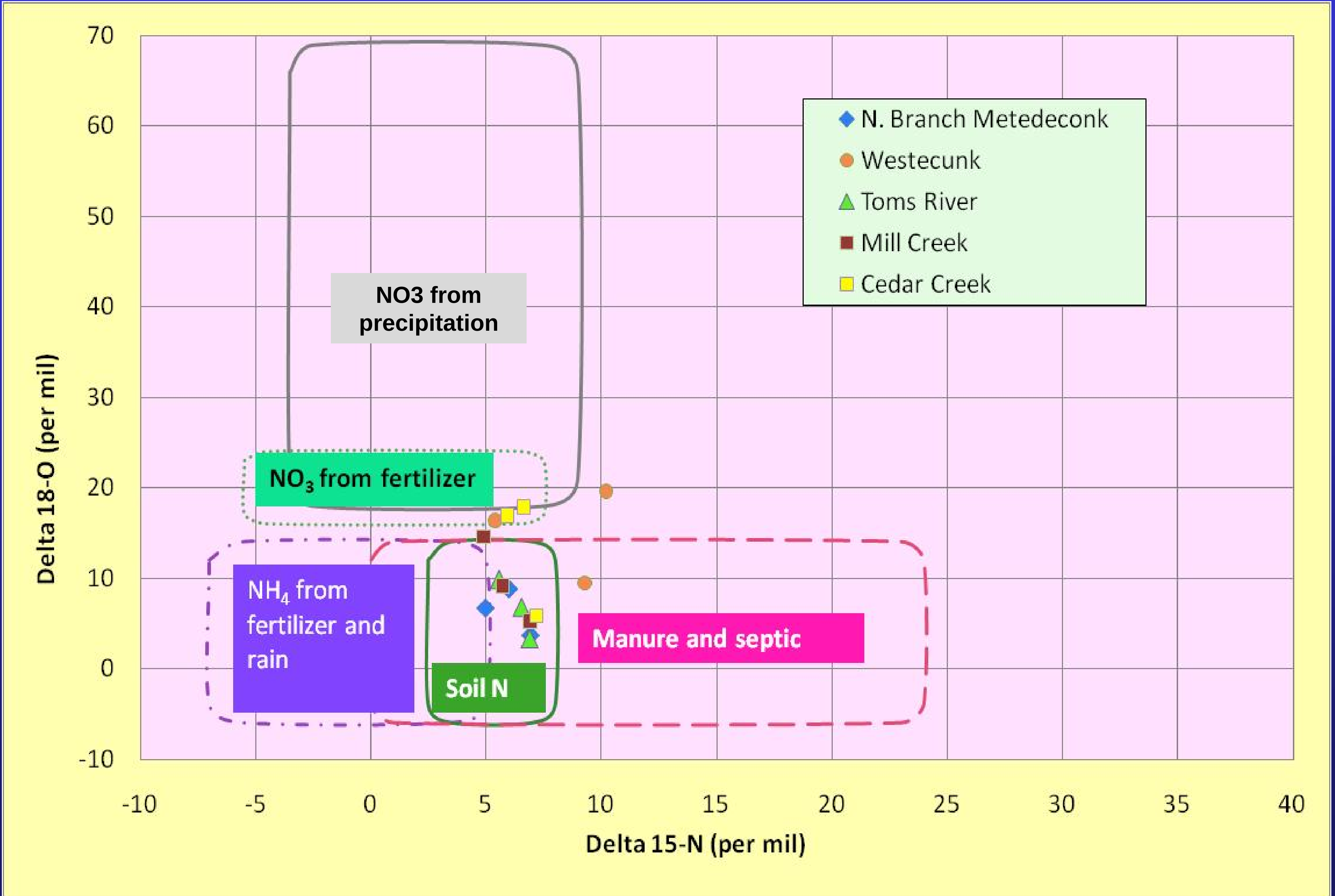
Ron Baker
Stephen Cauller
Robert Nicholson
Lois Voronin
Christine Wieben

Selected References

1. Baker, R.J. and Hunchak-Kariouk, K, 2006. Relations of water quality to streamflow, season, and land use for four tributaries to the Toms River, Ocean County, New Jersey, 1994-99: U.S. Geological Survey Scientific Investigations Report 2005-5274, 72 p.
2. Bowen, J.L., Ramstack, J.M., Mazzilli, S., and Valiela, I., 2007. NLOAD: An interactive, web-based modeling tool for nitrogen management in estuaries, in: Ecological Applications, 17(5) Supplement, pp. S17-S30.
3. Carter, G., P., Eight Characterizing Indicators in the Barnegat Bay watershed, Ocean County, New Jersey: Journal of Coastal Research, Special Issue 32, pp. 82-101.
4. Guo Q., and Psuty, N.P., 2000. The nitrogen flux through Barnegat Inlet: The ocean as source as well as sink: *The Jersey ShoreLine*, New Jersey Sea Grant College Program, 19(4), August, 2000.
5. Hickman, R.E. and Barringer, T.H., 1999, Trends in waterquality of New Jersey streams, Water Years 1986-95: U.S. Geological Survey water Resources Investigations Report 98-4204, 174.
6. Hunchak-Kariouk, K., and Nicholson, R.S., 2001, Watershed contributions of nutrients and other nonpoint source contaminants to the Barnegat Bay-Little Egg Harbor estuary: Journal of Coastal Research, Special Issue 32, pp. 28-82.
7. Seitzinger, S.P., Styles, R.M., and Pilling, I.E., 2001. Benthic macroalgal and Phytoplankton production in Barnegat Bay, New Jersey (USA): microcosm experiments and data synthesis: Journal of Coastal Research, Special Issue 32, pp. 144-162
8. Seitzinger, S.P. and Pilling, I.E., 1992, Eutrophication and nutrient loading in Barnegat Bay: initial studies of the importance of sediment-water nutrient interactions, Report No. 92-24F, The Academy of Natural Sciences, Philadelphia, PA.
9. Smith, S., Bricker, S., P. Pacheco, P., and Buddemeier, R.W., 2003. Preliminary NOAA Estuarine Typology Database Available from: http://drysdale.kgs.ku.edu/estuary/hp_firststep.cfm .
10. Wieben, C., 2007, Assessment of a Shallow Ground-Water-Quality Indicator. Barnegat Bay Partnership, http://www.bbep.org/studies.html
11. Weiben, C., and Baker, R., 2009, Contributions of Nitrogen to the Barnegat Bay-Little Egg Harbor Estuary: Updated Loading Estimates , Barnegat Bay Partnership, http://www.bbep.org/studies.html

USGS

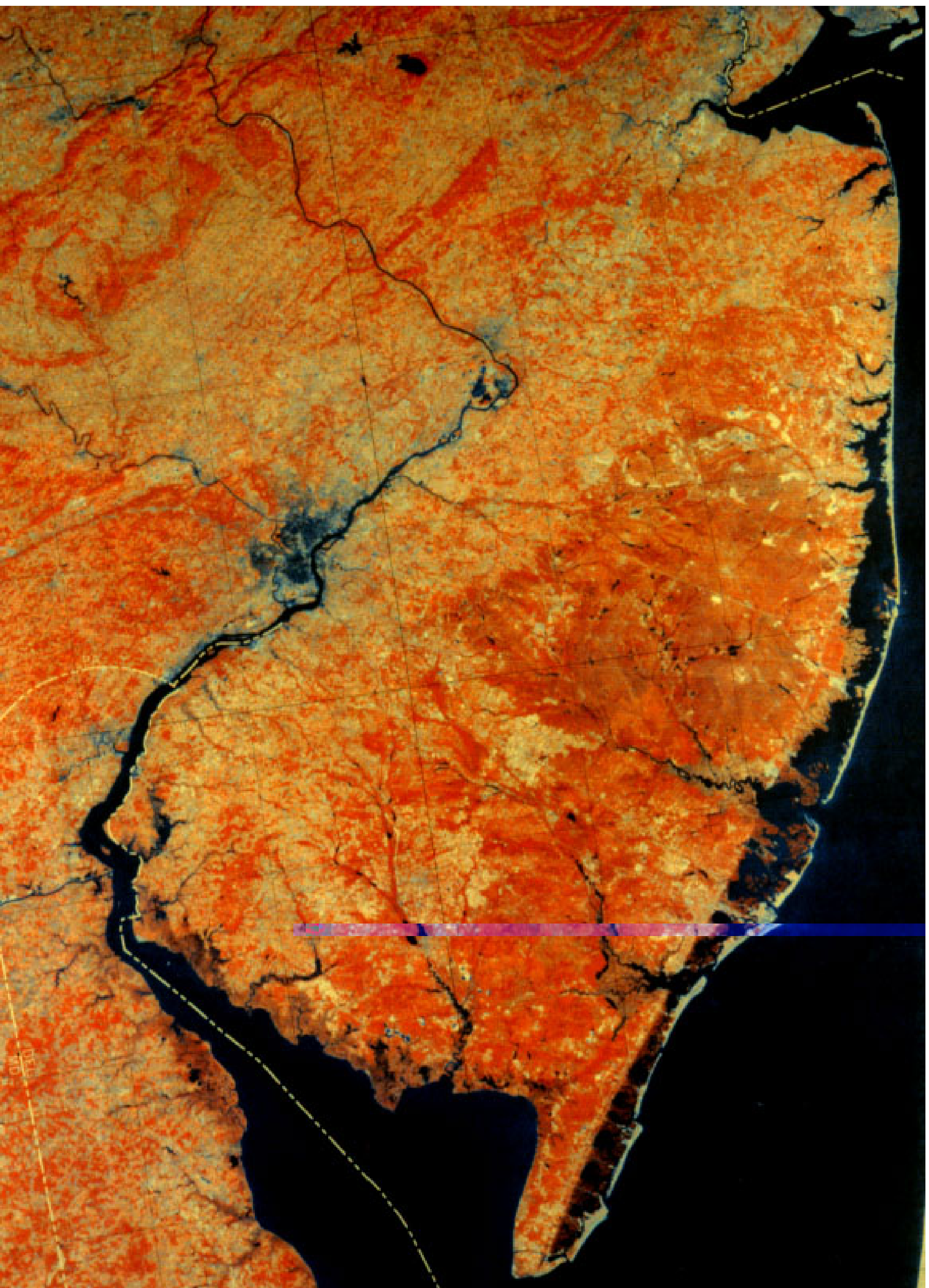
Isotope Data Stratified by Stream



Barnegat Bay-Little Egg Harbor: Ecosystem Condition

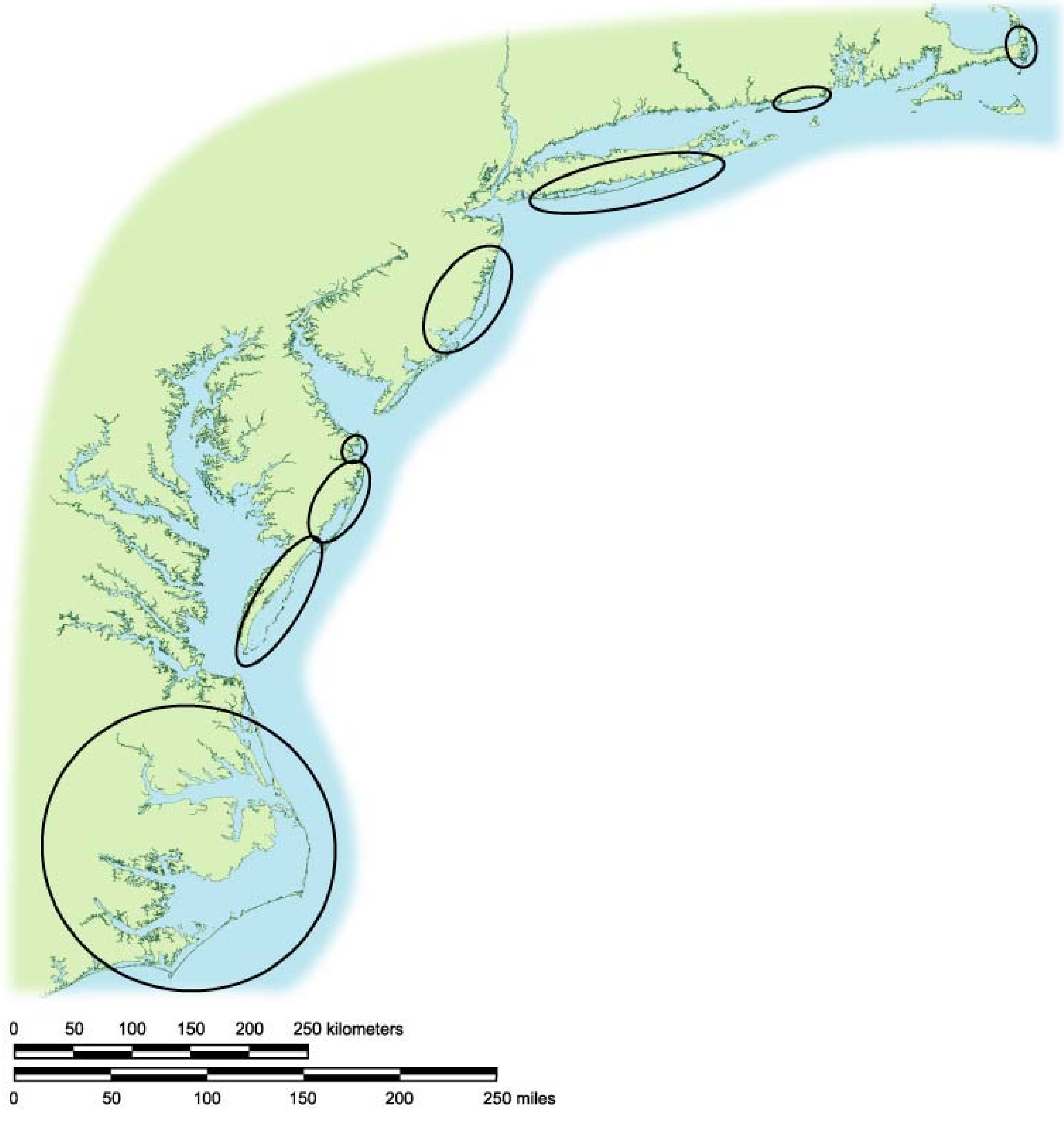
Michael J. Kennish
Institute of Marine and Coastal Sciences
Rutgers University

RUTGERS
MARINE & COASTAL
SCIENCES

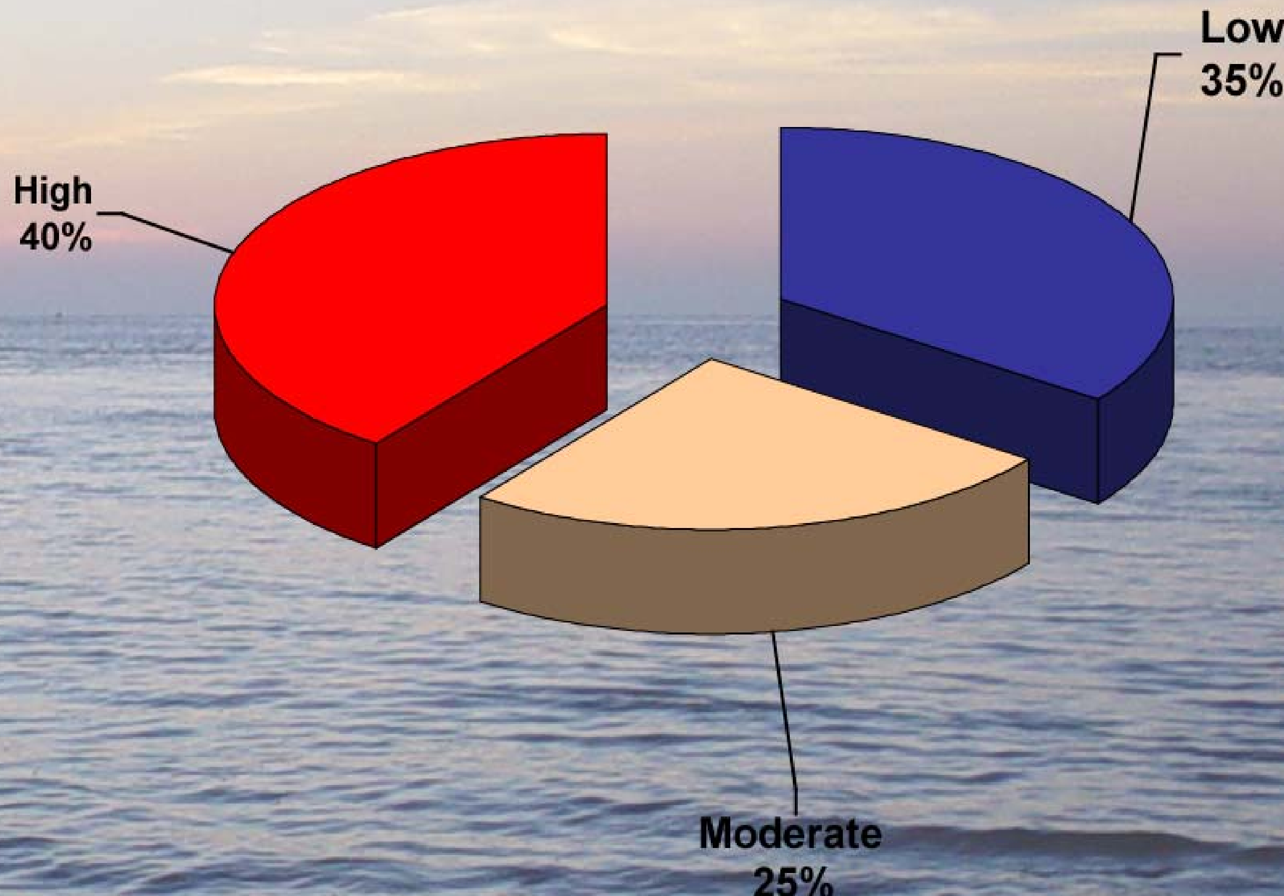


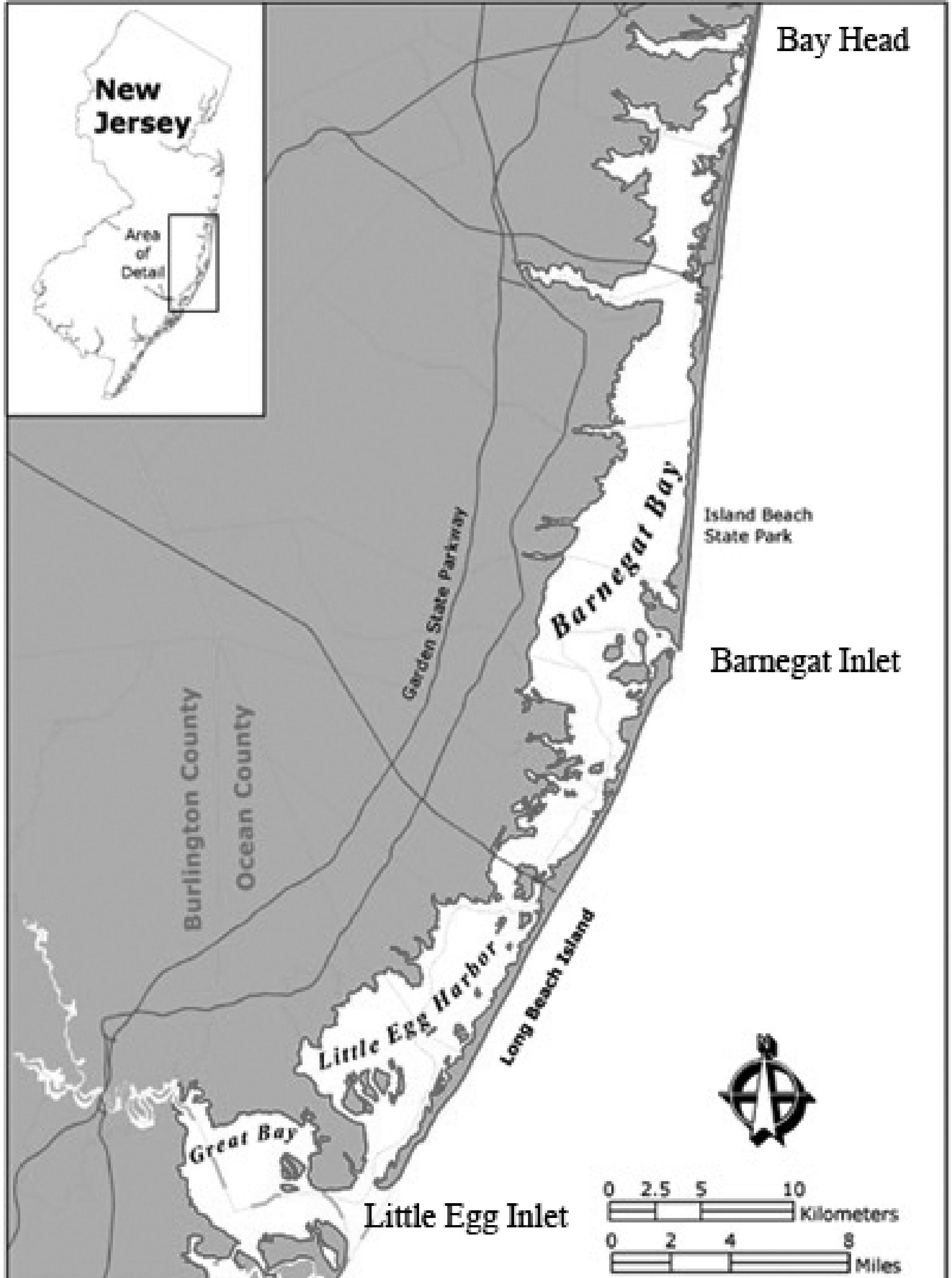
Coastal Lagoons

Barnegat Bay-
Little Egg Harbor


0 50 100 150 200 250 kilometers
0 50 100 150 200 250 miles

Eutrophication





New Jersey
Area of Detail
Bay Head
Barnegat Bay
Island Beach State Park
Barnegat Inlet
Garden State Parkway
Burlington County
Ocean County
Little Egg Harbor
Long Beach Island
Great Bay
Little Egg Inlet
0 2.5 5 10 Kilometers
0 2 4 8 Miles

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**

TIMELINE OF ECOSYSTEM EVENTS

- **1995 NEP Established for Barnegat Bay-Little Egg Harbor Estuary**
- **1995 Recurring Brown Tide Blooms Begin**
- **1997 Hard Clam Harvest Declines 10 Fold (1989-1997)**
- **1998 Recurring Macroalgal Blooms Begin**
- **1999 NOAA Reports Barnegat Bay as Highly Eutrophic**
- **2000 Sea Nettles Observed and Recurring Eruptions Documented**
- **2001 Bologna Indicates 60% SAV Decline in LEH and 30% Estuary-wide**
- **2001 USGS Reports ~790 Tons of Nitrogen Loading Per Year**
- **2001 DEP Reports 66% Decline of Hard Clam Stock in LEH (1986-2001)**
- **2006 High Epiphytic Infestation of Seagrass Documented by Rutgers**
- **2006 Seagrass Biomass Declines by 50-88%**
- **2006 No Bay Scallops Found in Seagrass Beds**
- **2007 Hard Clam Harvest Declines by >99% (1977-2007)**
- **2007 NOAA Reconfirms the Estuary as Highly Eutrophic**
- **2008 Low DO Recorded in the Northern Segment of the Estuary**
- **2009 Rutgers Finds Lowest Seagrass Biomass Since Surveys Began in 2004**
- **2010 USGS Reports Two-Thirds of Nitrogen Loading from Surface Runoff**

PRIMARY PRODUCERS

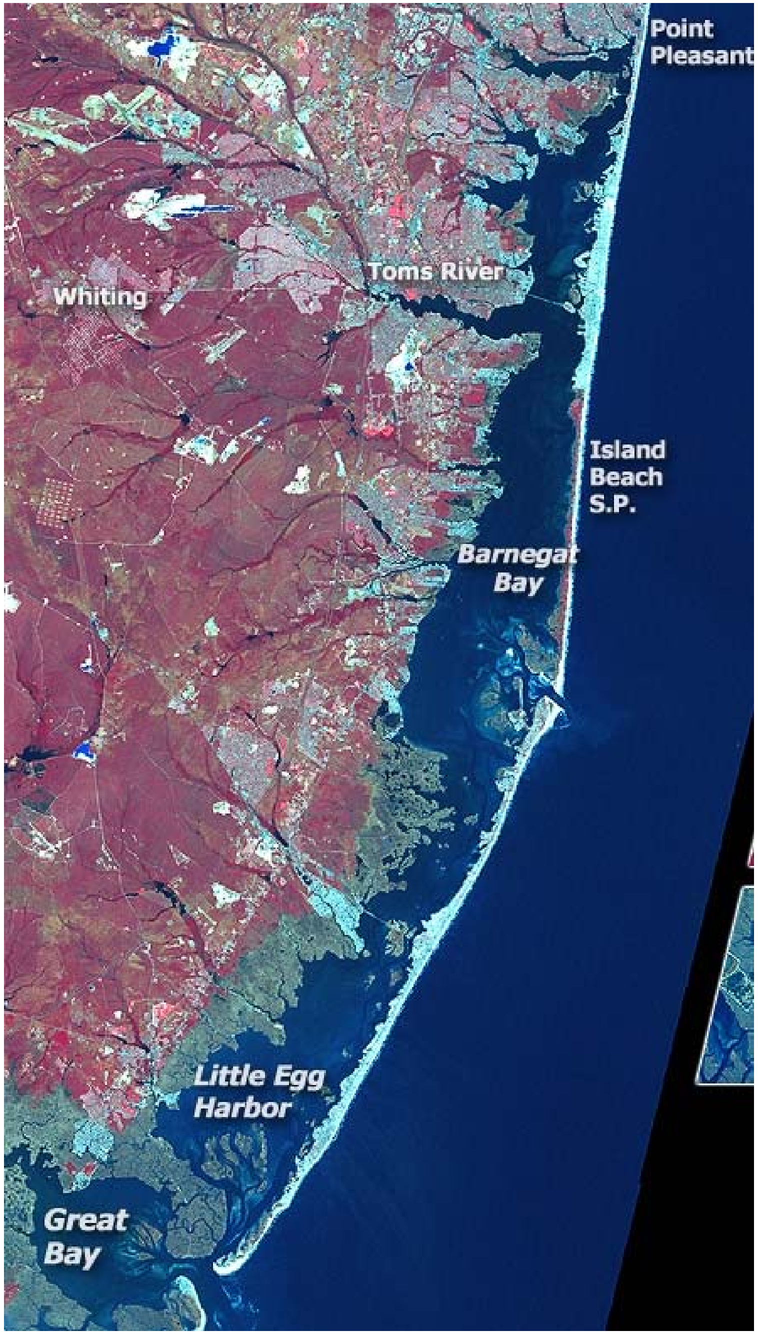
Phytoplankton
0 – 500 g C m^{-2} yr^{-1}

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
Toms River
Whiting
Island Beach S.P.
Barnegat Bay
Little Egg Harbor
Great Bay

BARNEGAT BAY WATERSHED

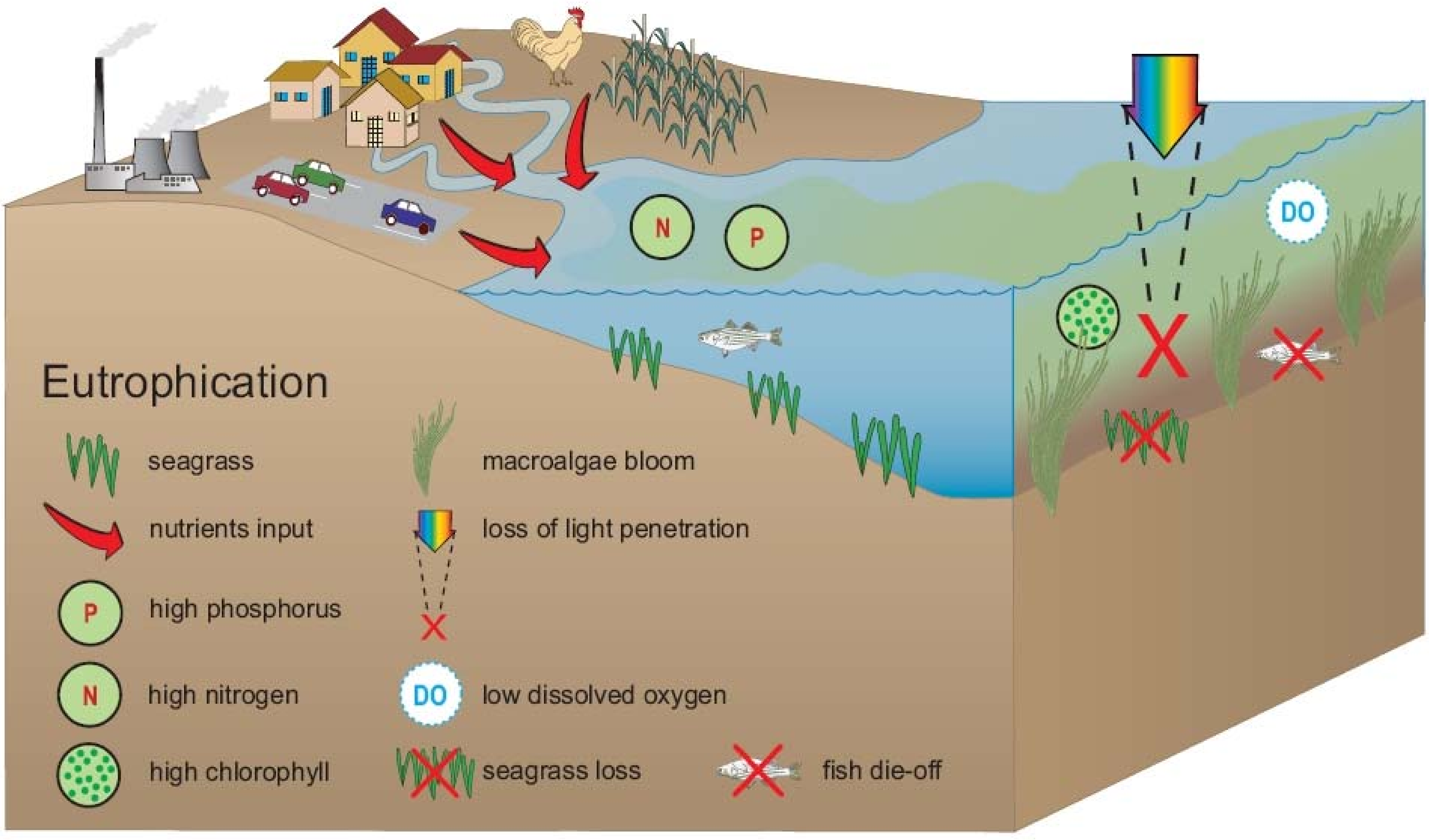
Population = 573,000 (~850,000 at buildout)

Population > 1,400,000 (Summer Season)

~35% Developed Area; >10% Impervious Cover

(LAND USE-LAND COVER CHANGE)

	1995	2006
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)

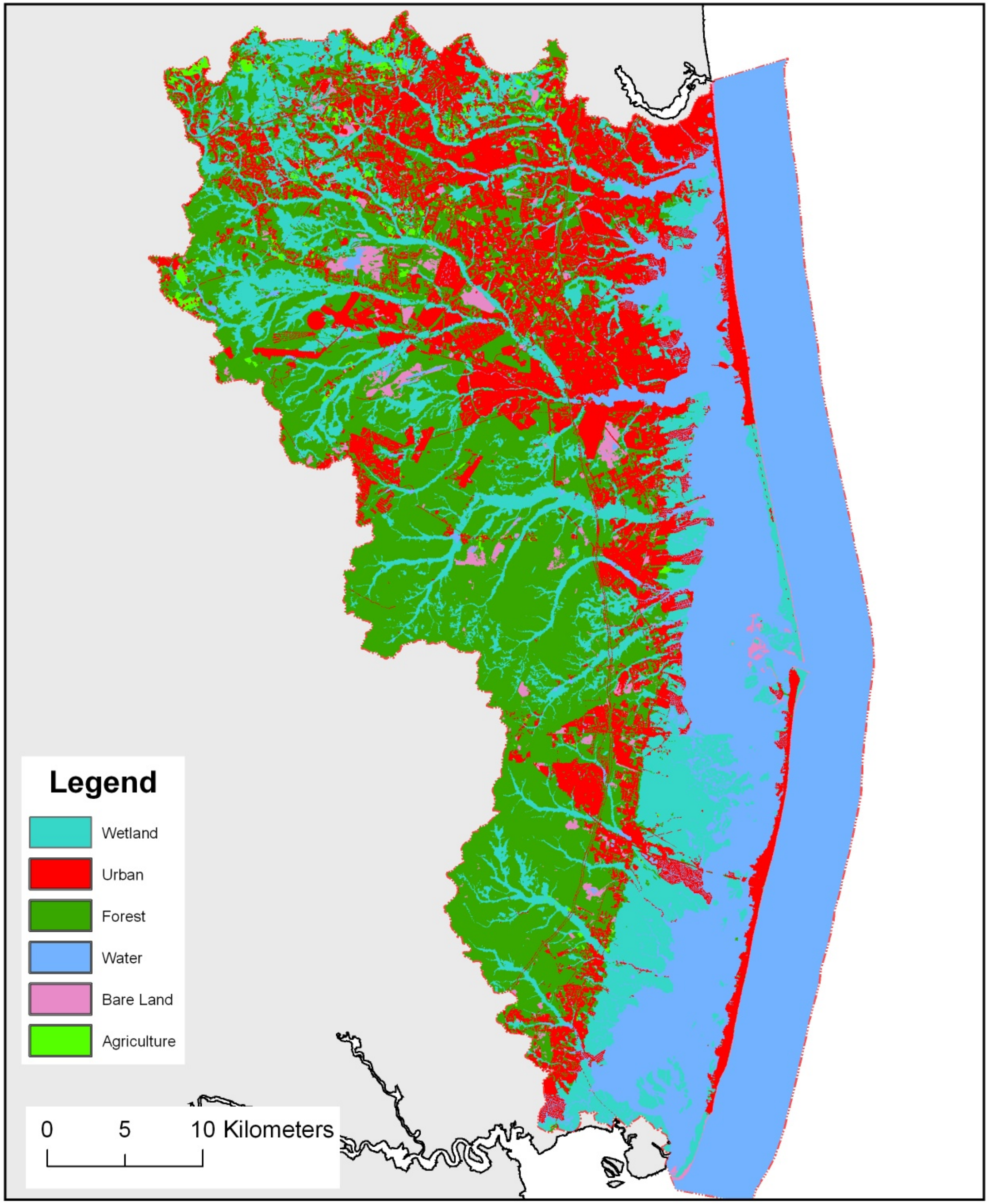


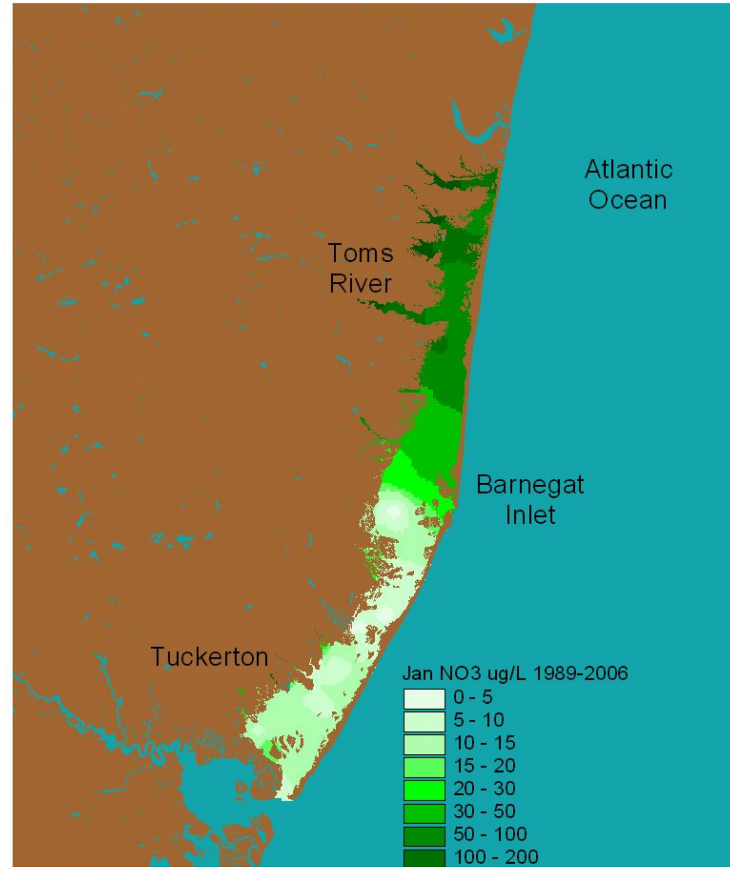
N
P
DO
Eutrophication
seagrass
nutrients input
high phosphorus
high nitrogen
high chlorophyll
macroalgae bloom
loss of light penetration
low dissolved oxygen
seagrass loss
fish die-off

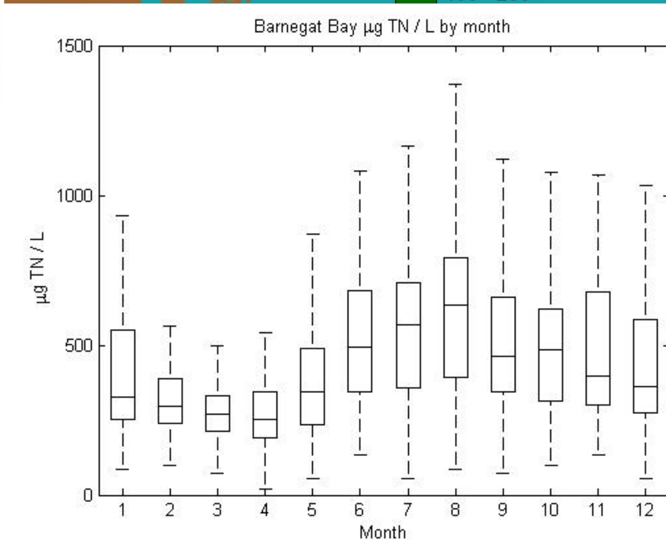
NITROGEN LOADING

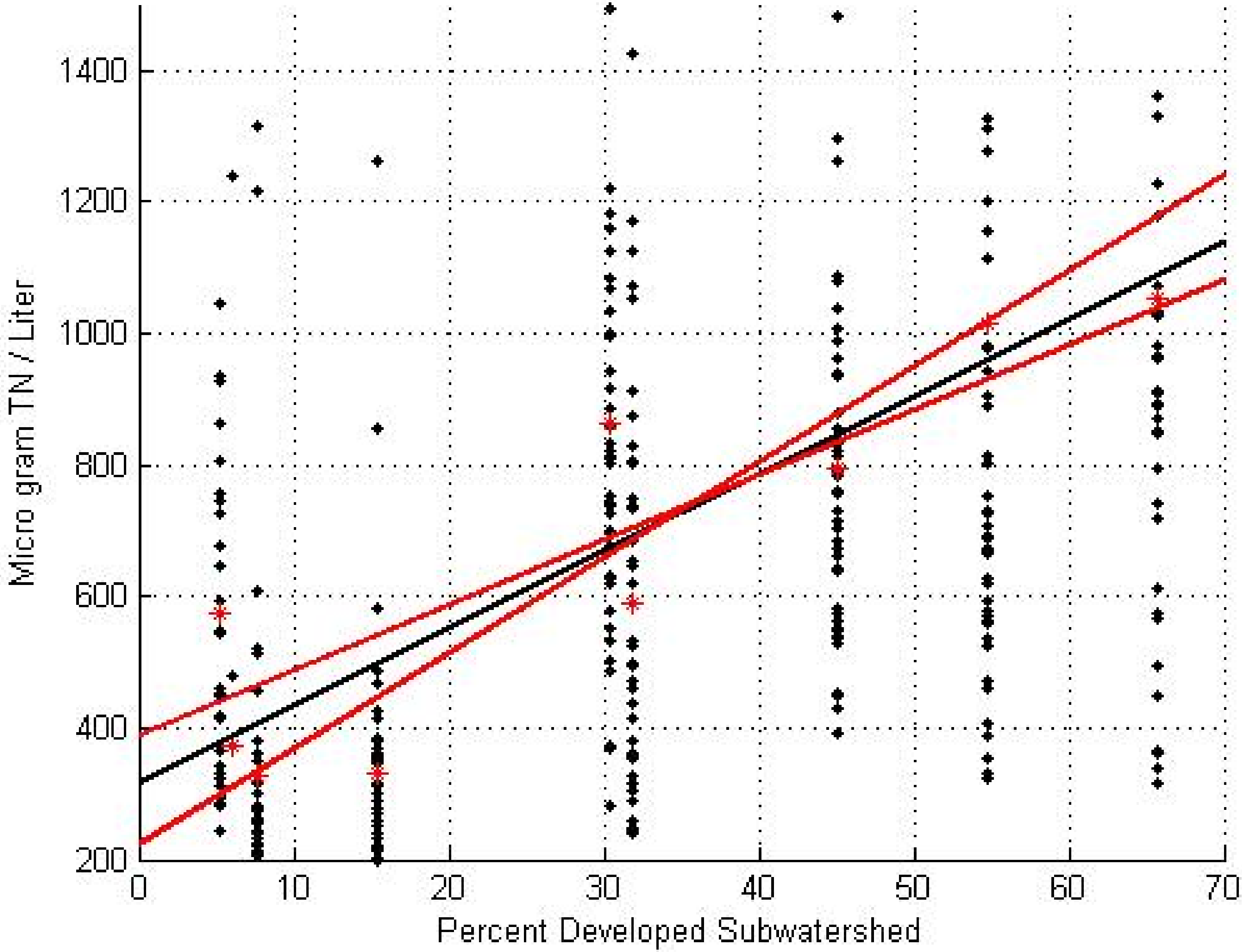
- **~650,000 kg/yr   (1,433,250 lbs/yr)**
- **~66% Surface Runoff**
- **~22% Atmospheric Deposition**
- **~12% Groundwater Discharges**

Land Cover Type 2006 for the Barnegat Bay Watershed



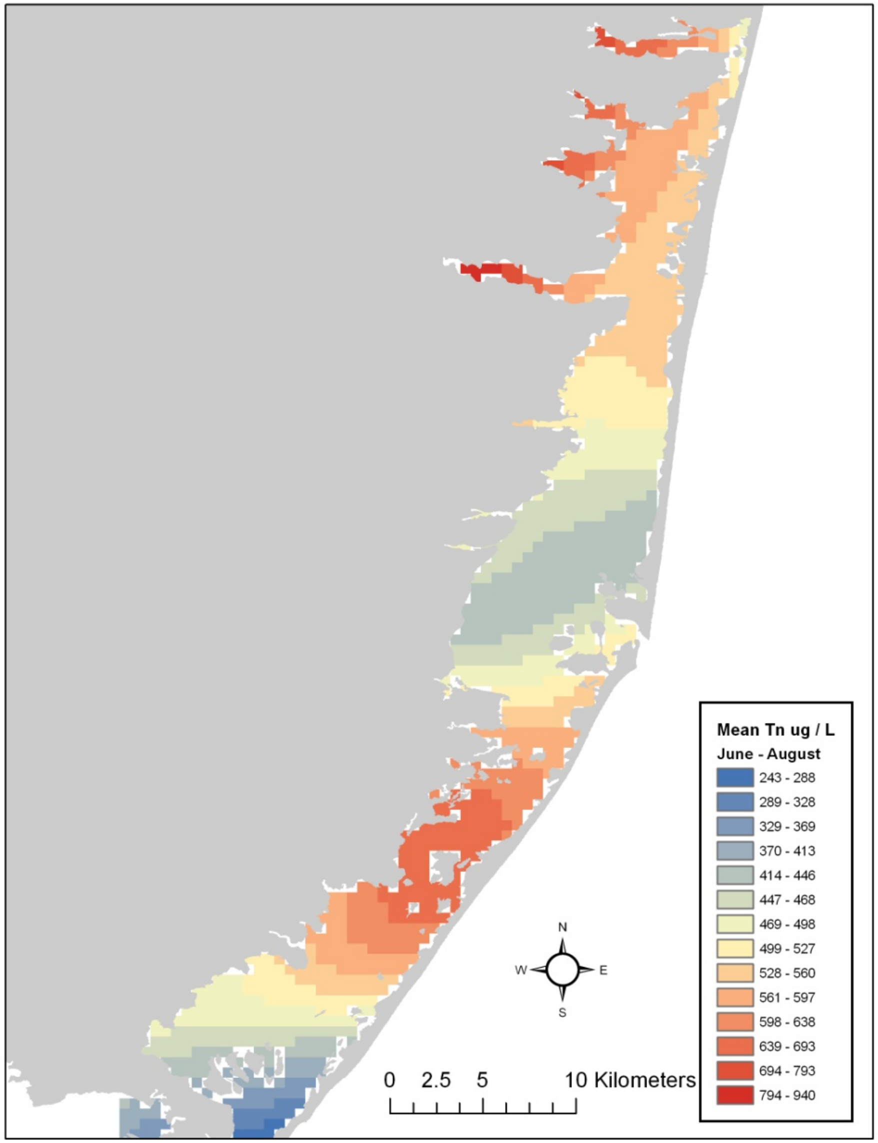




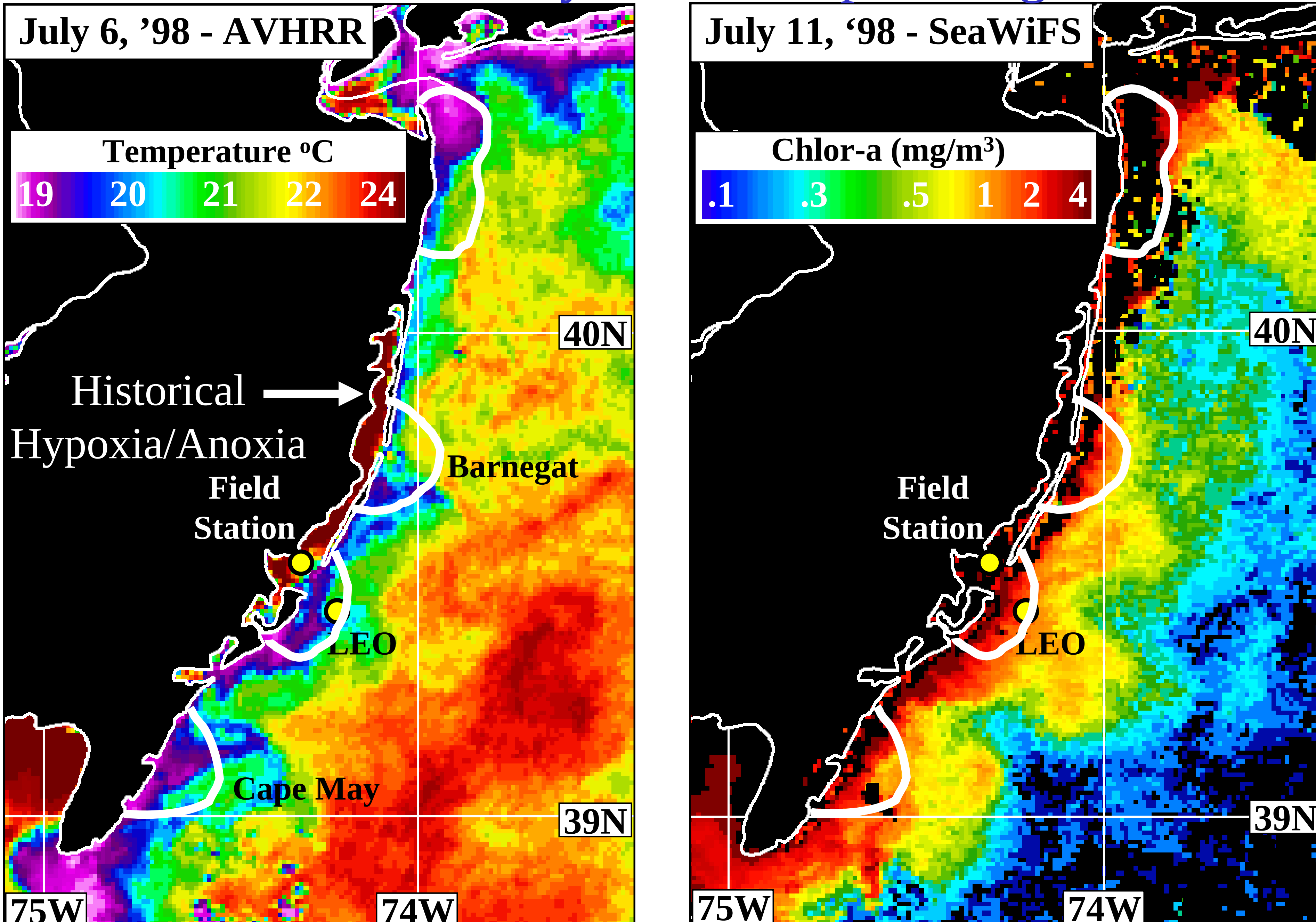


1400
1200
1000
800
600
400
200
0
10
20
30
40
50
60
70
Micro gram TN / Liter
Percent Developed Subwatershed

Mean Total Nitrogen by stations
June - August 1989 2006

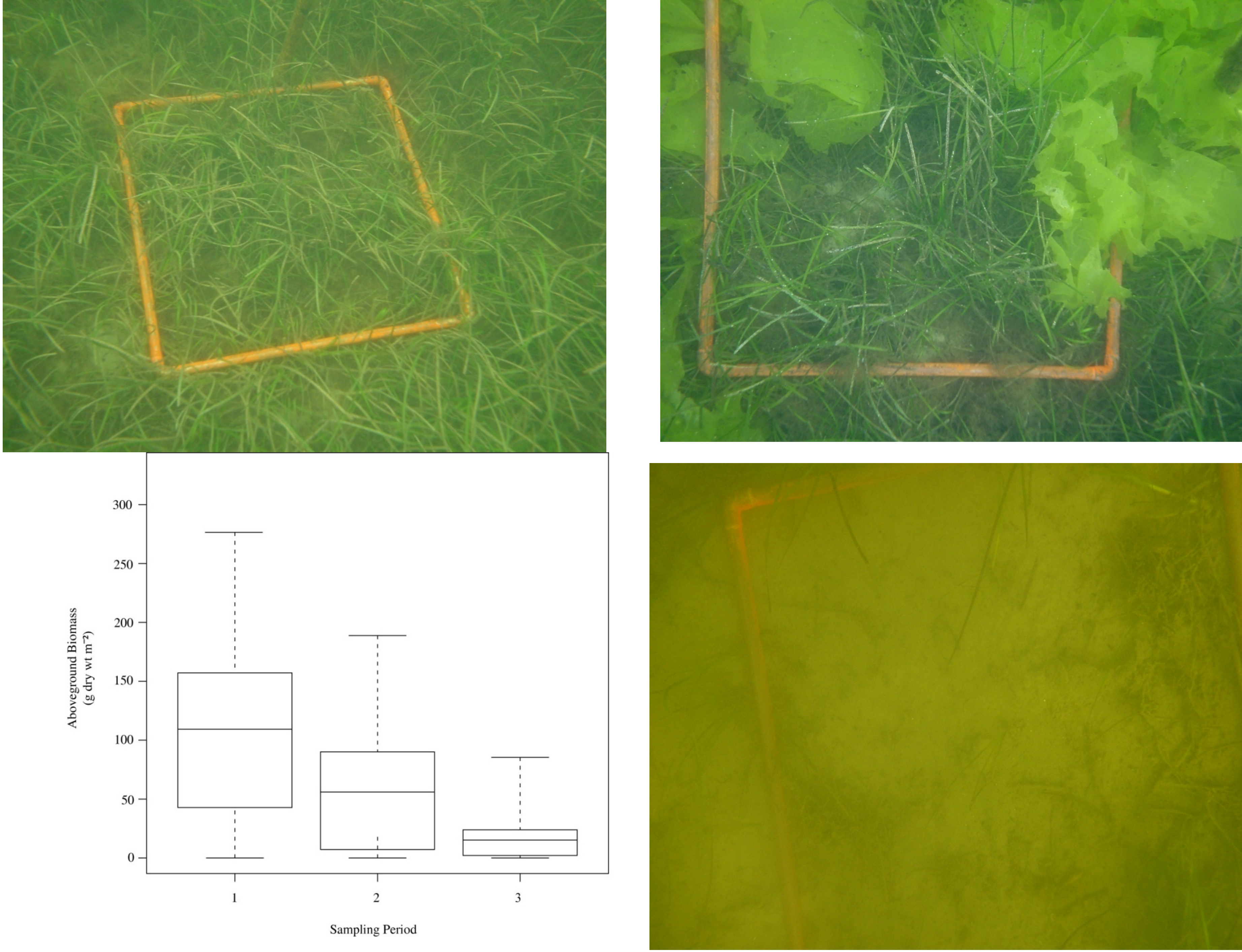


New Jersey Coastal Upwelling



Algal Blooms

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


Aboveground Biomass
(g dry wt m^{-2})
300
250
200
150
100
50
0
1
2
3
Sampling Period

Sea Lettuce

Phytoplankton Production

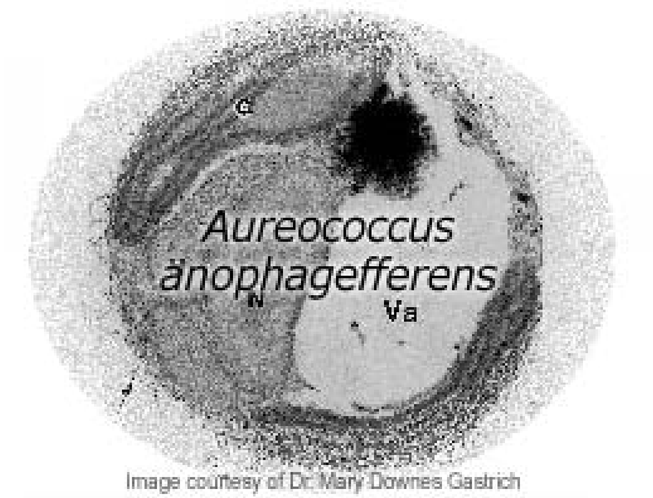
(Up to ~500 g C m^{-2} yr^{-1})

Nixon Trophic Classification

Brown Tide Blooms

1-2 million cells ml^{-1}

(1995, 1997, 1999-2002)



Phytoplankton Species Shift

Diatoms to Microflagellates

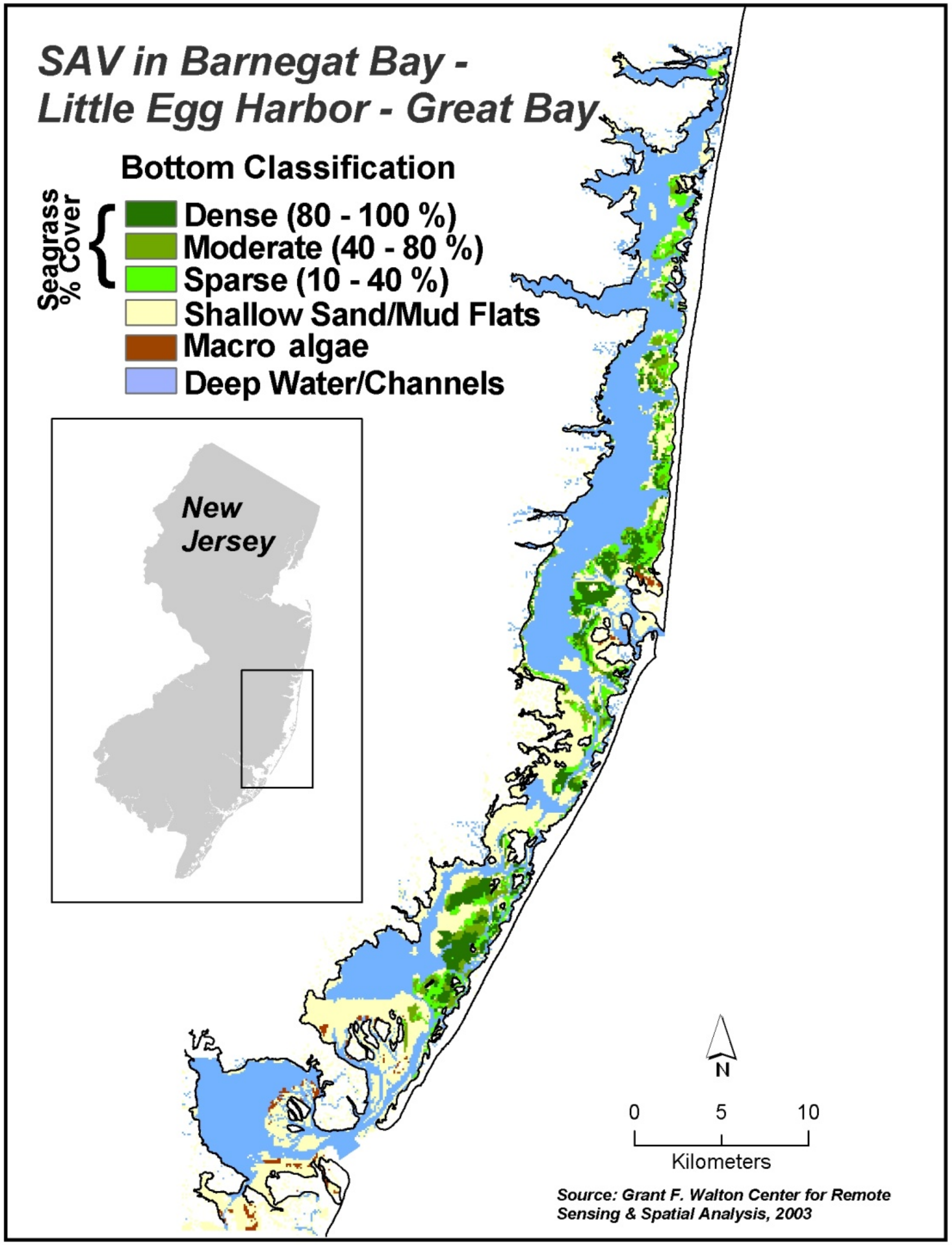
Raphidophytes, Pelagophytes

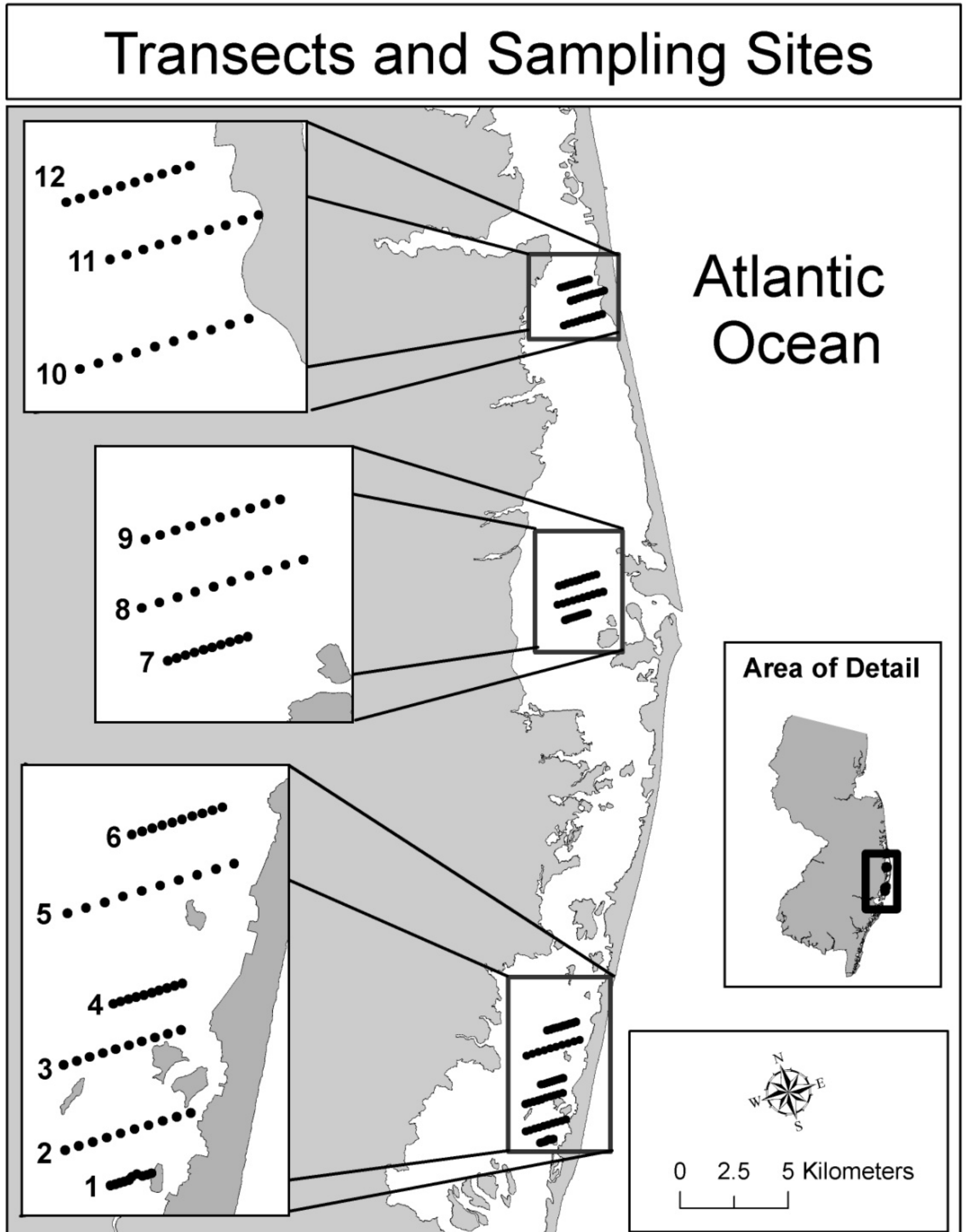
Eelgrass Decline

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

>30% in Entire Estuary

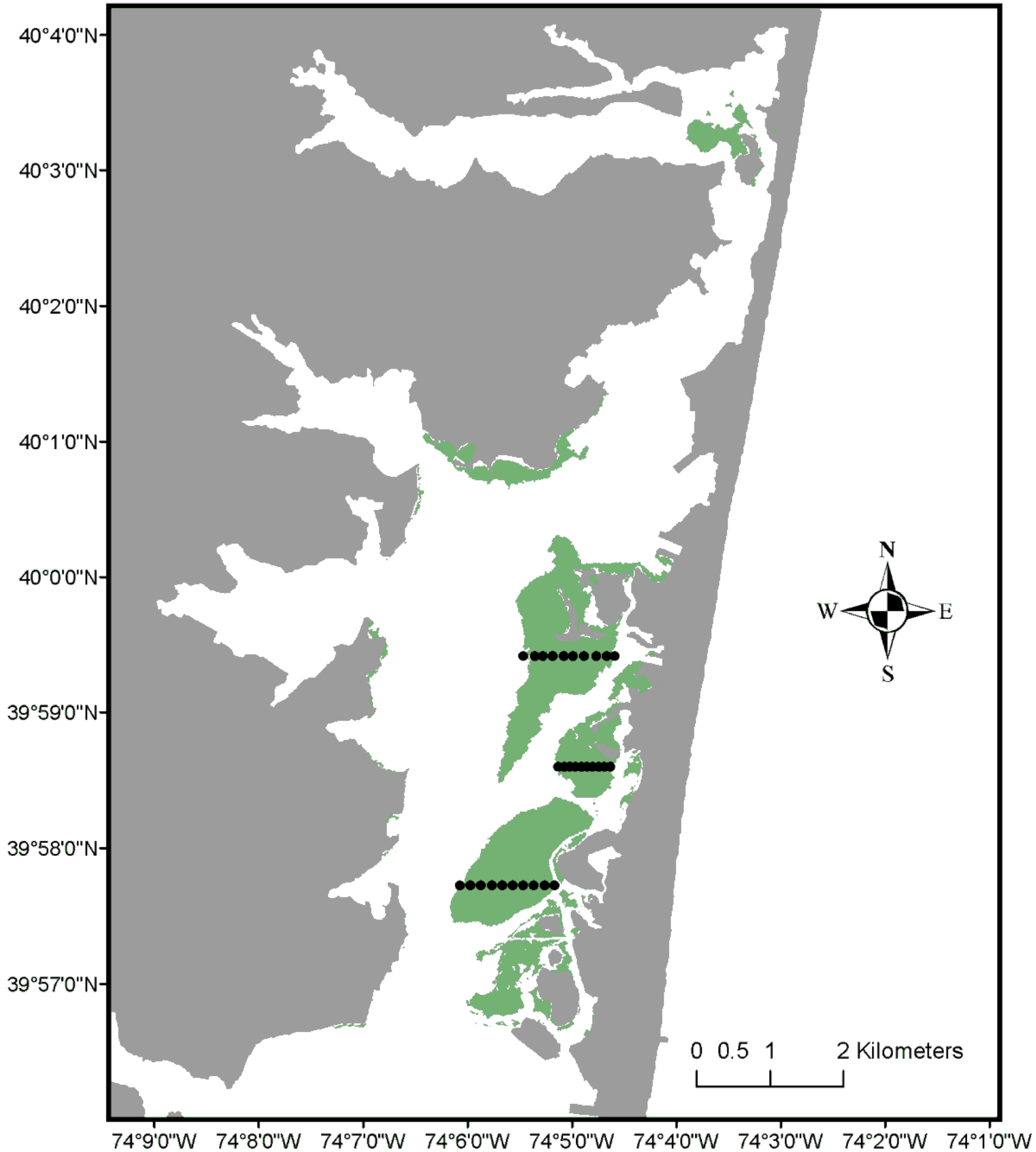
(Data Source: Paul Bologna)

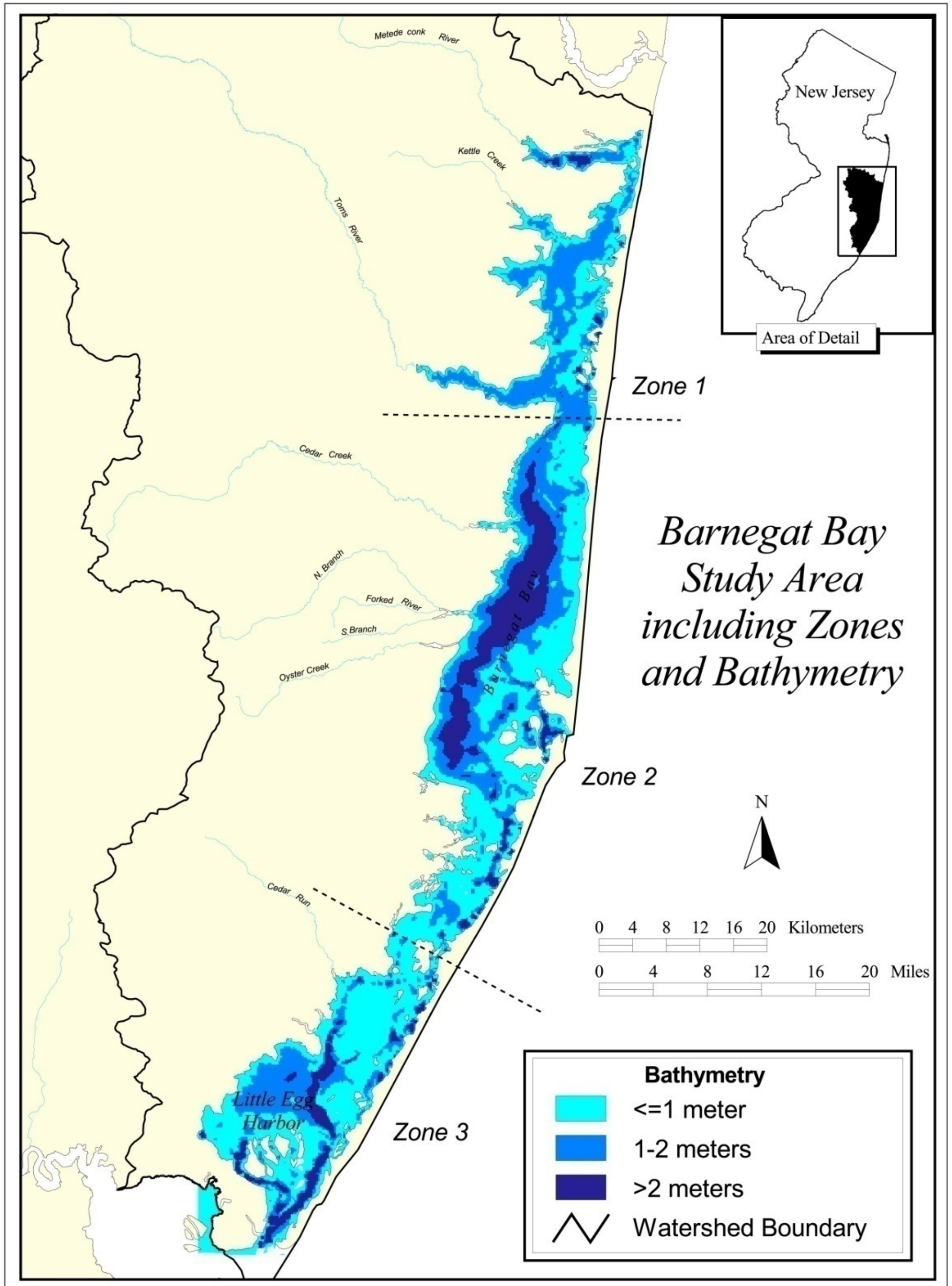




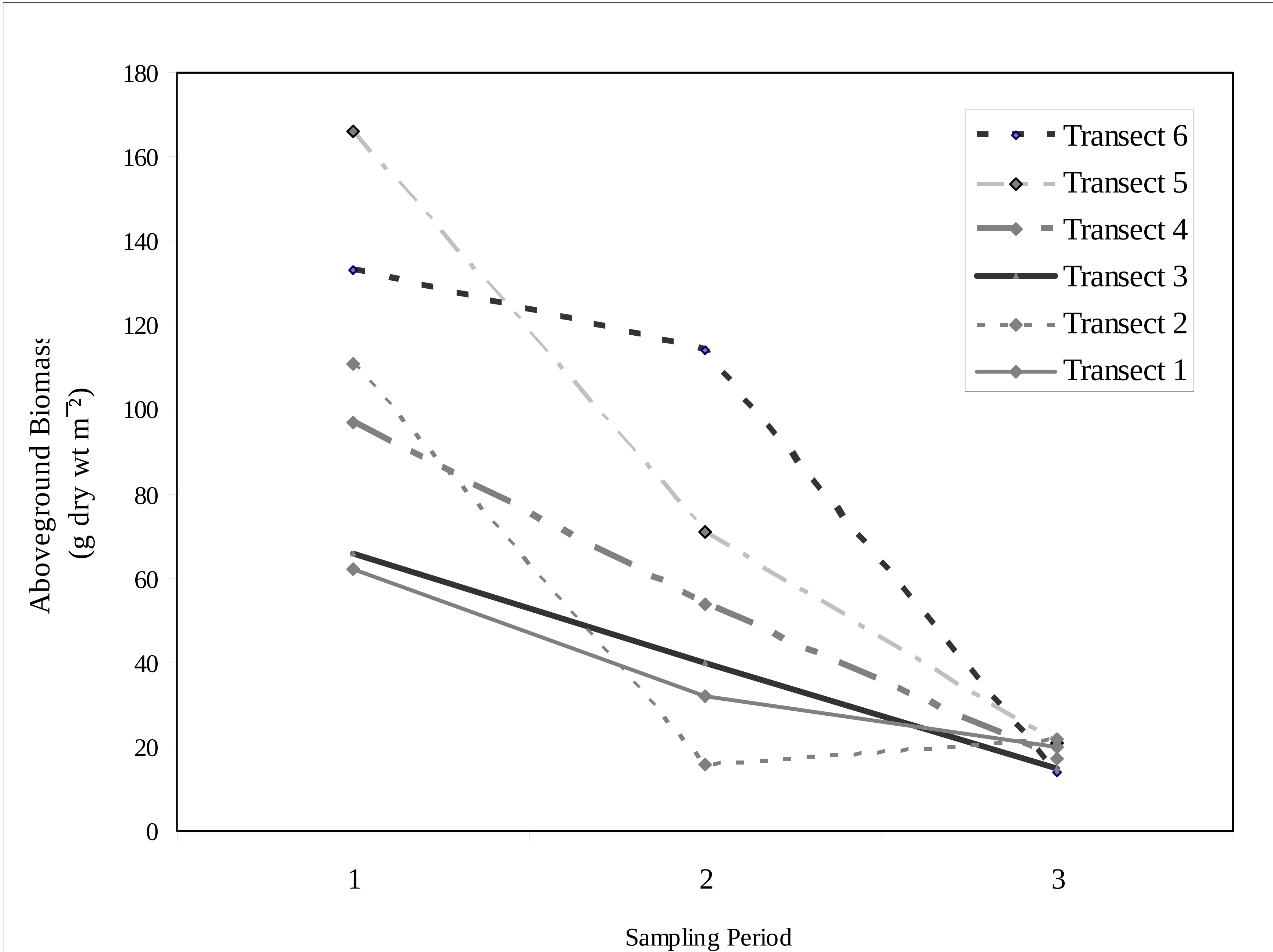
Transects and Sampling Sites
Atlantic Ocean
Area of Detail
12
11
10
9
8
7
6
5
4
3
2
1
N
E
S
W
0 2.5 5 Kilometers

Seagrass Sampling Locations in Northern Barnegat Bay

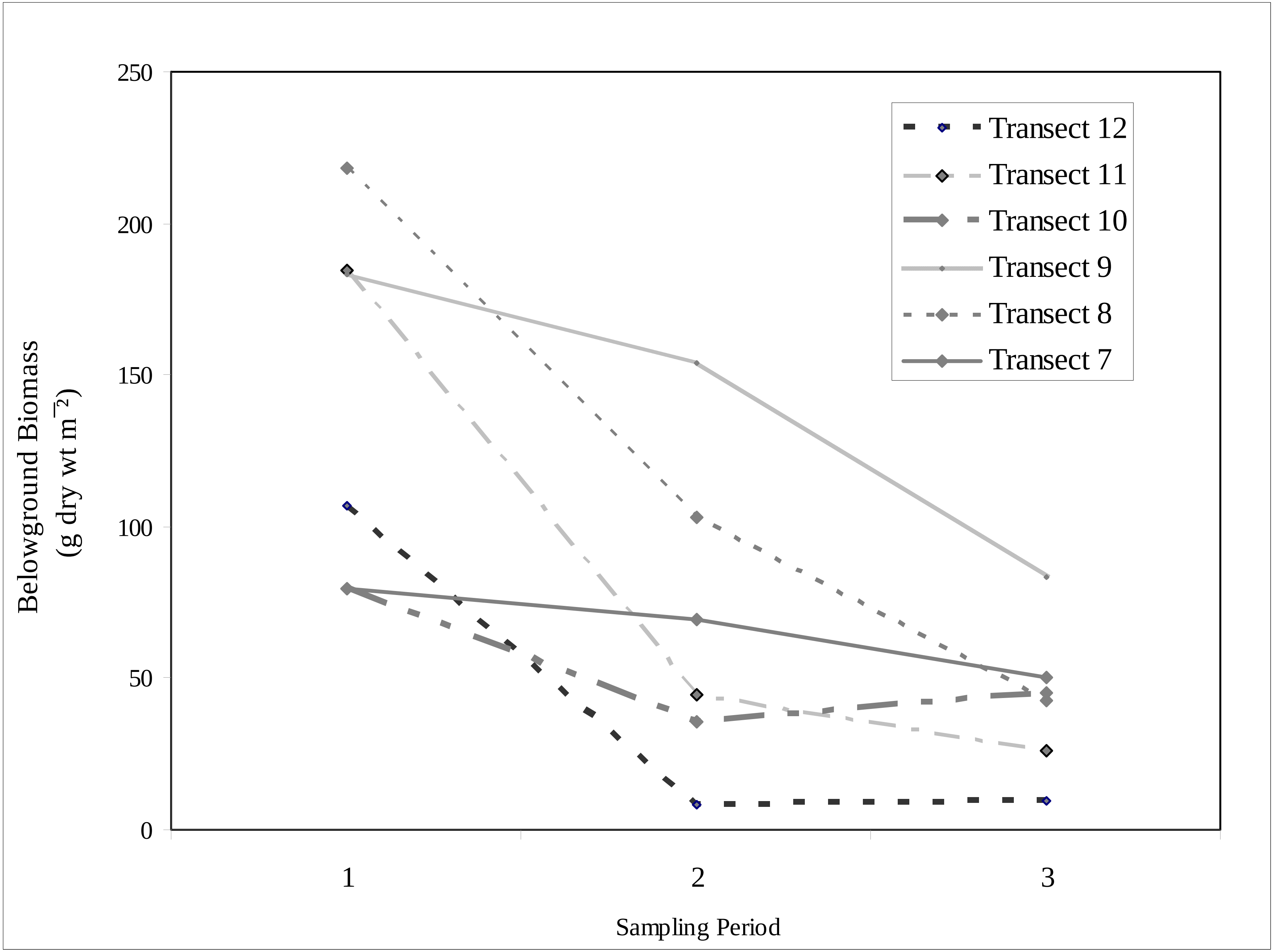




Barnegat Bay Study Area including Zones and Bathymetry
Zone 1
Zone 2
Zone 3
Metede conk River
Kettle Creek
Toms River
Cedar Creek
N. Branch
Forked River
S.Branch
Oyster Creek
Cedar Run
Barnegat Bay
Little Egg Harbor
New Jersey
Area of Detail
N
0 4 8 12 16 20 Kilometers
0 4 8 12 16 20 Miles
Bathymetry
<=1 meter
1-2 meters
>2 meters
Watershed Boundary



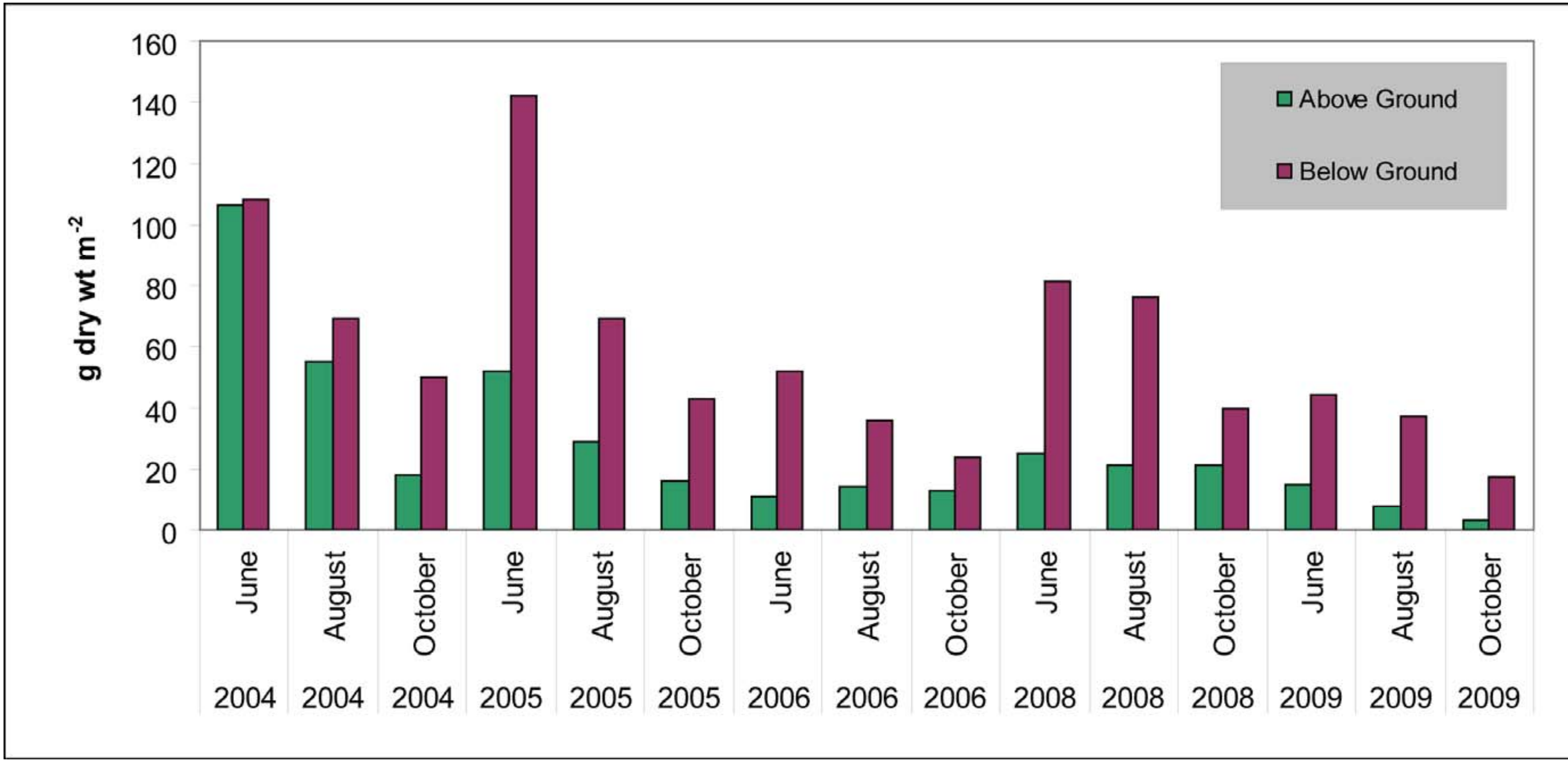
Aboveground Biomass (g dry wt m⁻²)
180
160
140
120
100
80
60
40
20
0
1
2
3
Sampling Period
Transect 6
Transect 5
Transect 4
Transect 3
Transect 2
Transect 1



Transect 12
Transect 11
Transect 10
Transect 9
Transect 8
Transect 7
Belowground Biomass
(g dry wt m^{-2})
250
200
150
100
50
0
1
2
3
Sampling Period

SEAGRASS BIOMASS (g dry wt m^{-2})

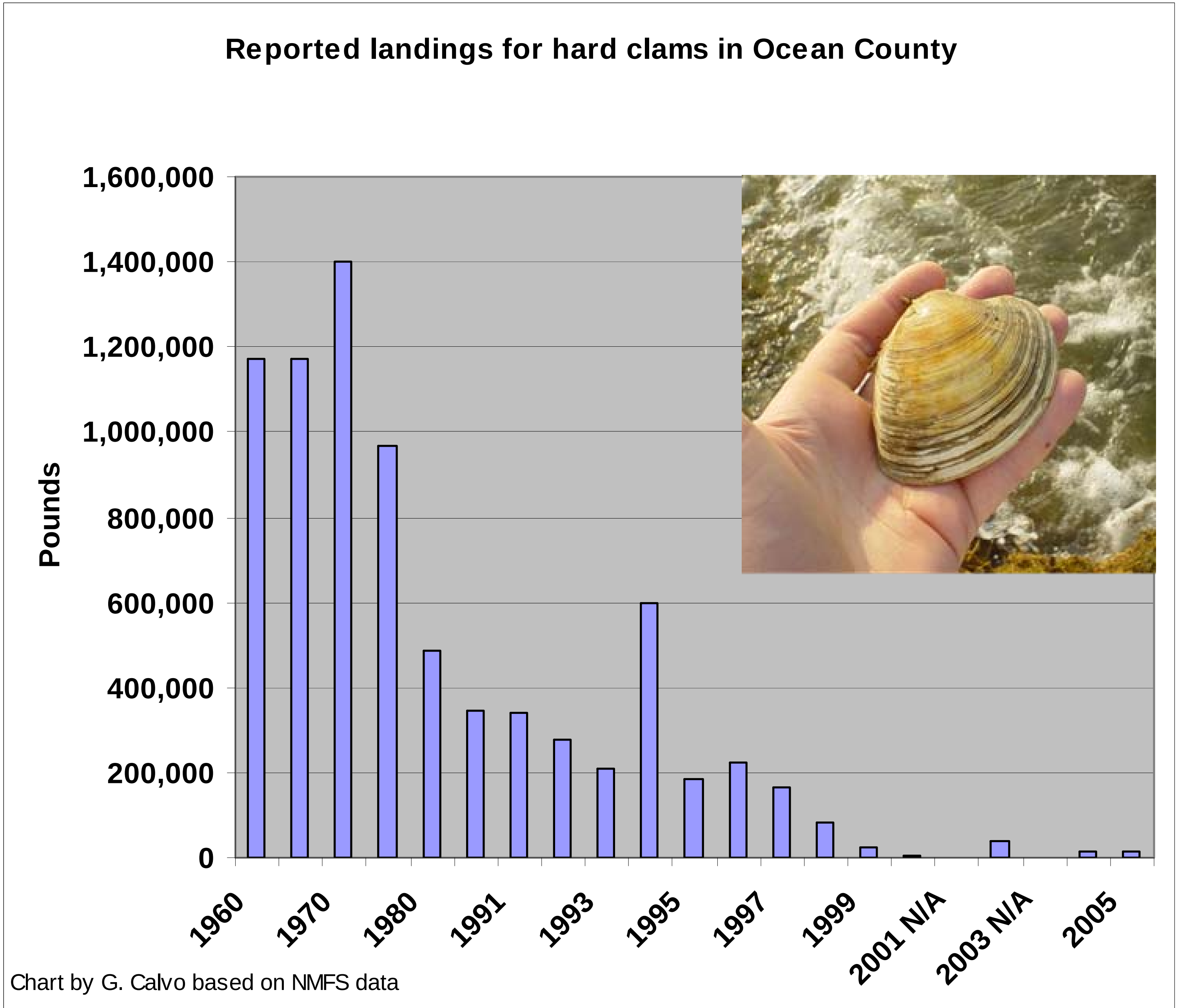
	Jun	Aug	Oct
2004	104	55	18
	110	69	50
2005	52	29	16
	142	69	43
2006	11	14	13
	54	50	33
2008	25	31	23
	81	76	40
2009	15	8	3
	44	37	17

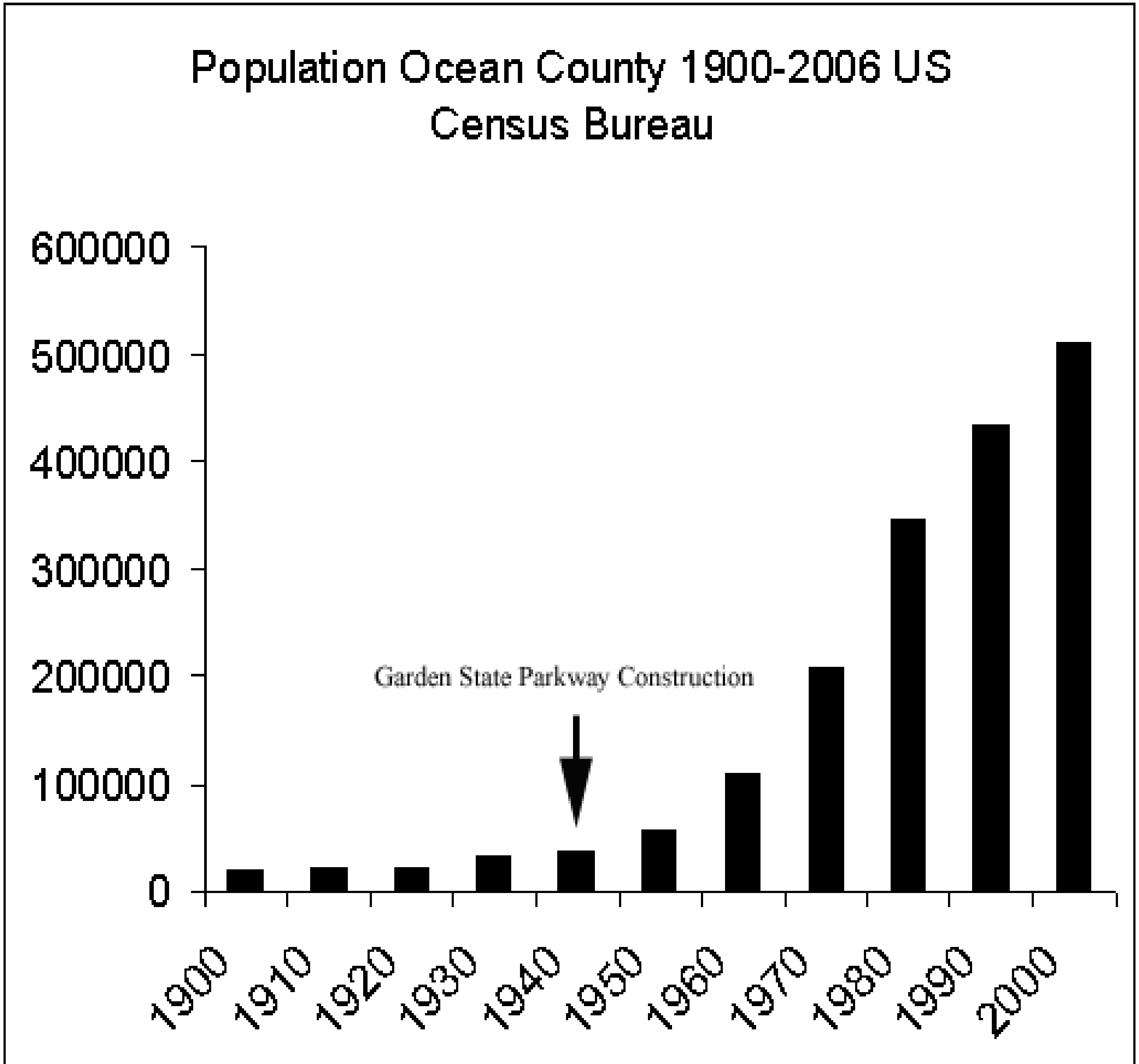


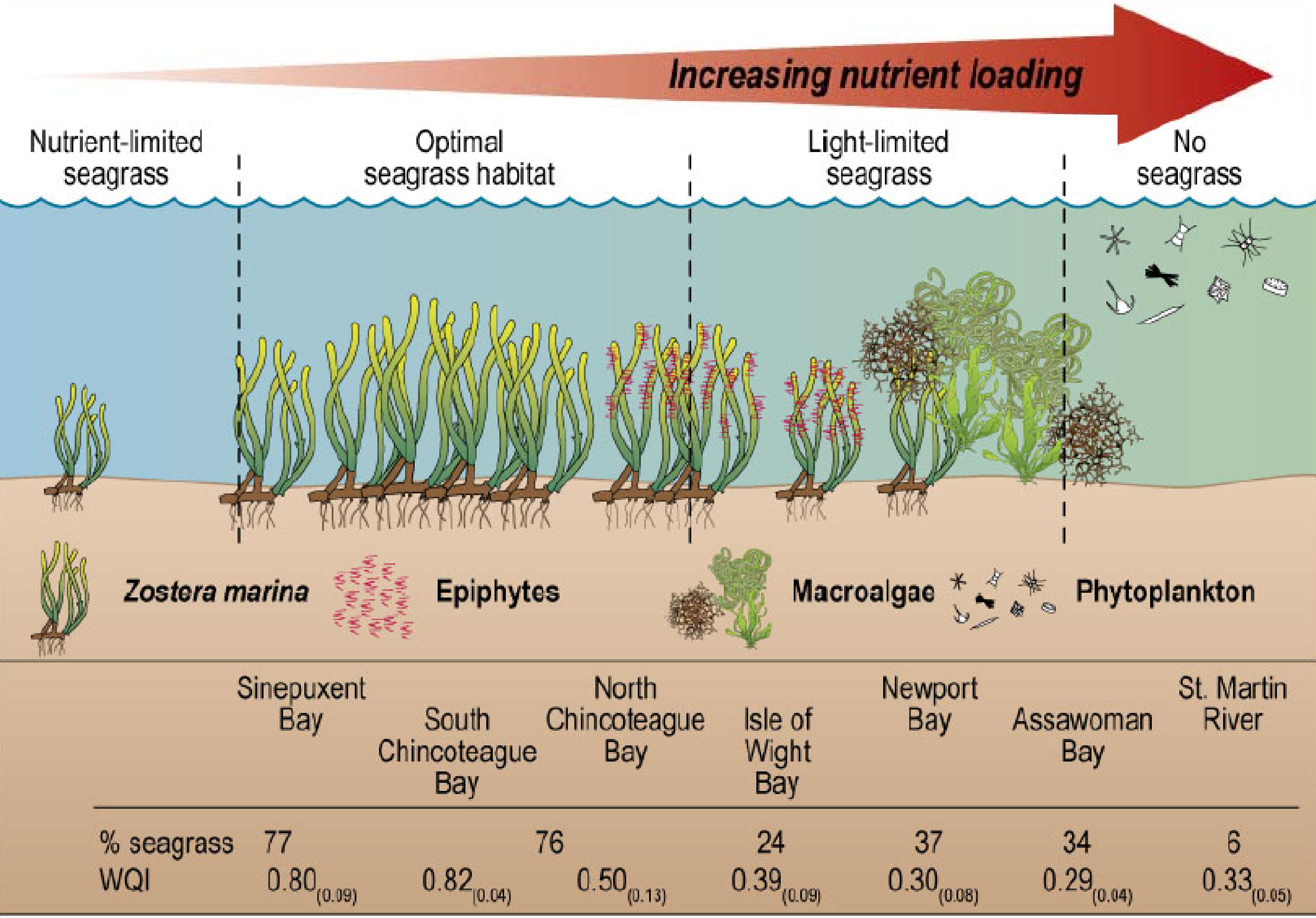
Above Ground
Below Ground
g dry wt m-2
0
20
40
60
80
100
120
140
160
June
August
October
June
August
October
June
August
October
June
August
October
June
August
October
2004
2004
2004
2005
2005
2005
2006
2006
2006
2008
2008
2008
2009
2009
2009

SEAGRASS LOSS 2004-2009

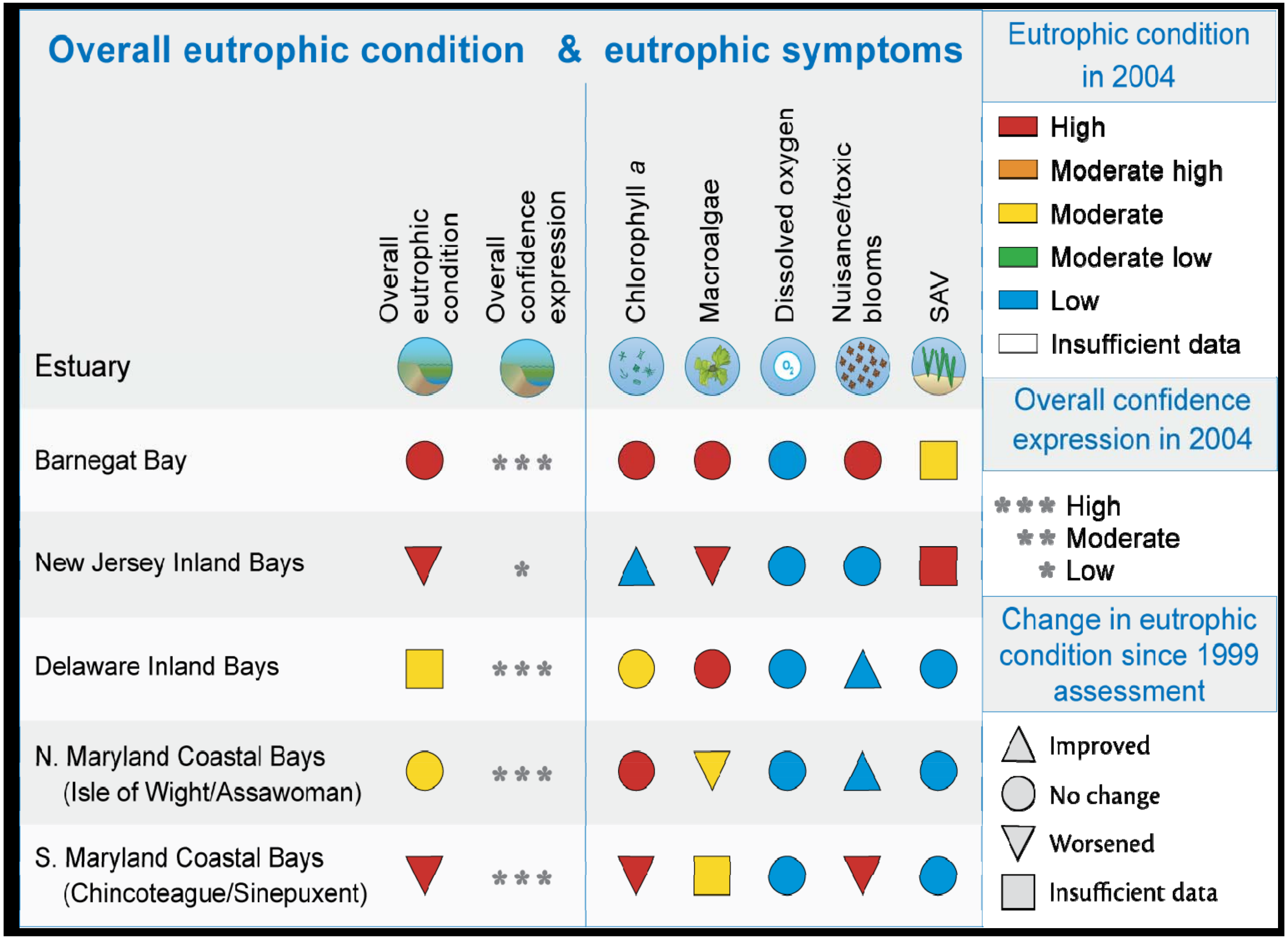
- Aboveground Biomass
  (Reduced ~50-88%)
- Belowground Biomass
  (Reduced ~50-59%)
- Percent Cover
  (Decreased 28.9%)
- Shoot Density
  (Decreased 21.1%)
- Blade Length
  (Decreased 42.2%)


Reported landings for hard clams in Ocean County
Pounds
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1960
1970
1980
1991
1993
1995
1997
1999
2001 N/A
2003 N/A
2005
Chart by G. Calvo based on NMFS data


Population Ocean County 1900-2006 US Census Bureau
600000
500000
400000
300000
200000
100000
0
Garden State Parkway Construction
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000


Increasing nutrient loading
Nutrient-limited seagrass
Optimal seagrass habitat
Light-limited seagrass
No seagrass
Zostera marina
Epiphytes
Macroalgae
Phytoplankton
Sinepuxent Bay
South Chincoteague Bay
North Chincoteague Bay
Isle of Wight Bay
Newport Bay
Assawoman Bay
St. Martin River
% seagrass 77 76 24 37 34 6
WQI 0.80 (0.09) 0.82 (0.04) 0.50 (0.13) 0.39 (0.09) 0.30 (0.08) 0.29 (0.04) 0.33 (0.05)

Mid-Atlantic Lagoon Systems



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)

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

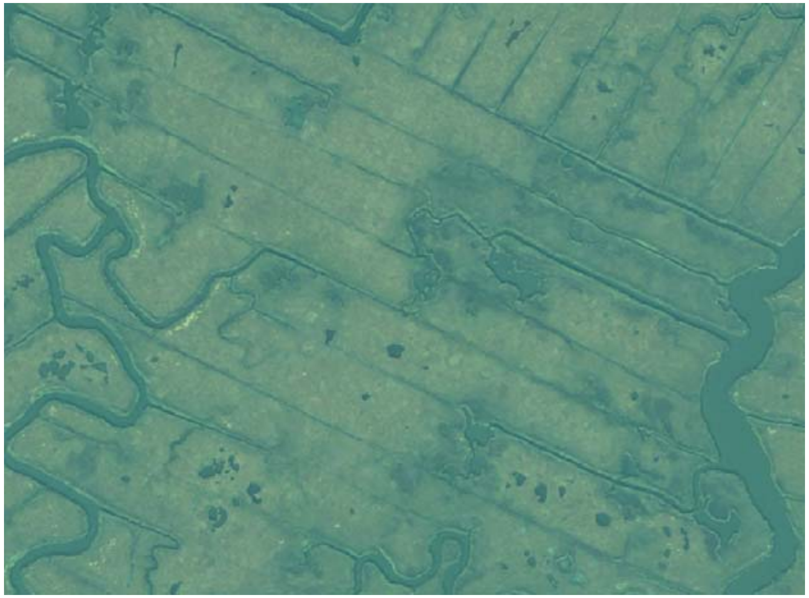
Seagrass (Biomass, Shoot Density, Areal Cover, Blade Length)

Epiphytes (Biomass and Overgrowth)

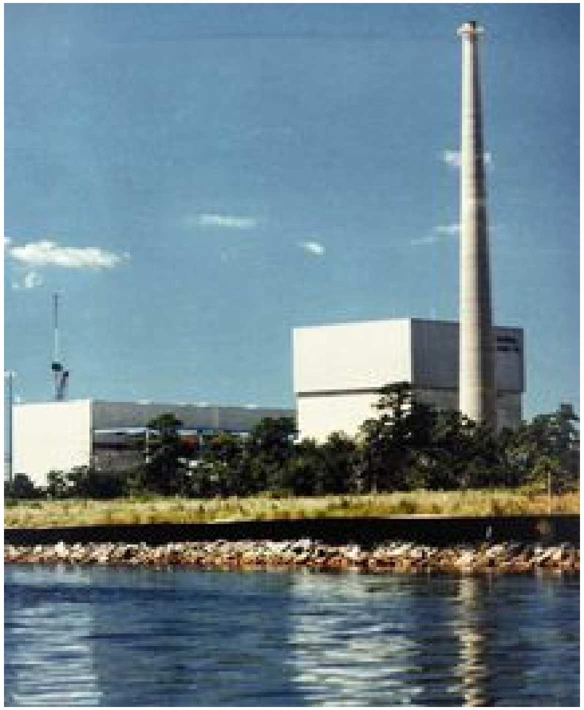
Macroalgae (Abundance, Areal Cover)

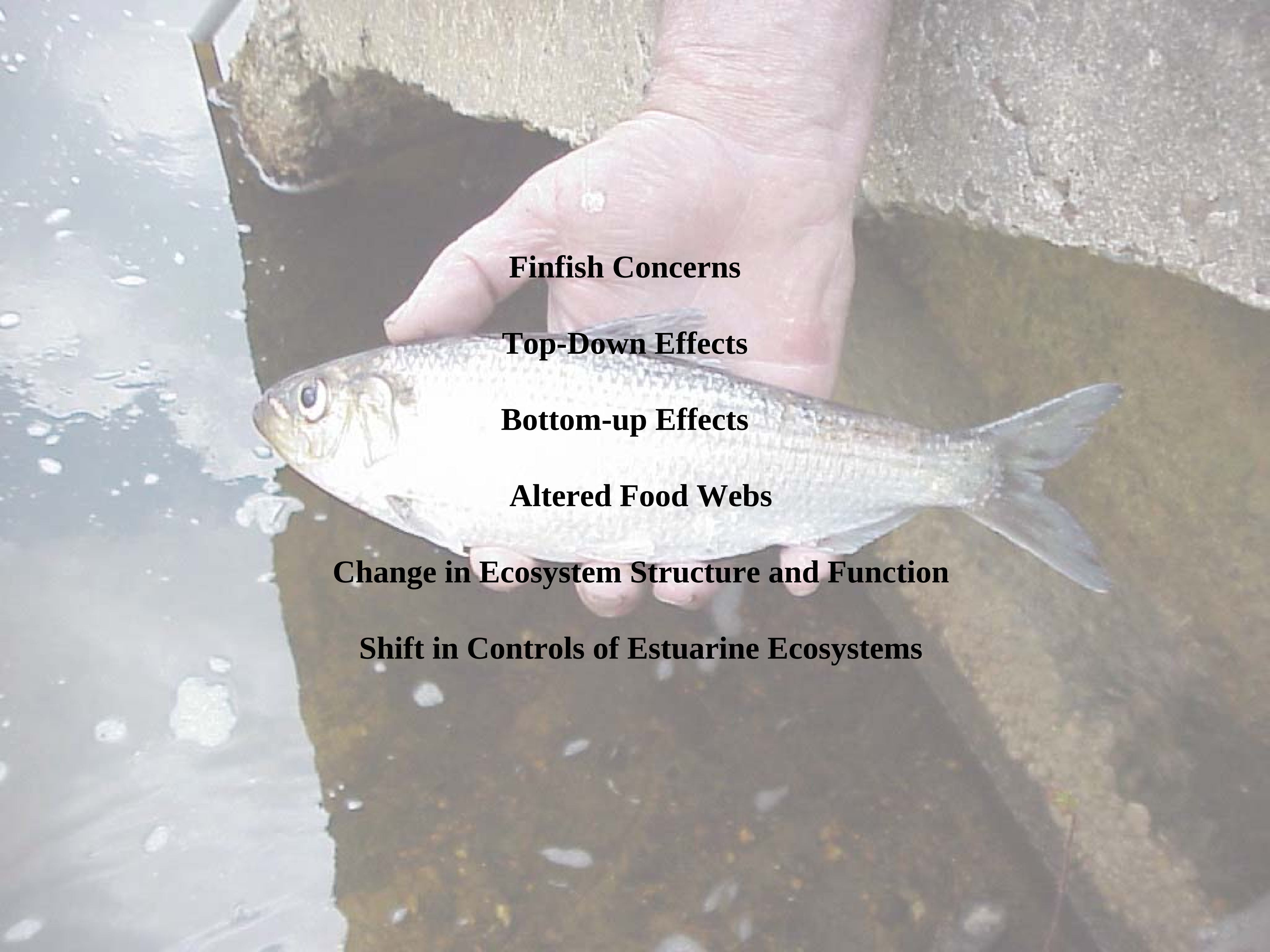
Phytoplankton Blooms (Brown Tide)

Shellfish Abundance (Scallops, Hard Clams)



IMPACTS




Finfish Concerns
Top-Down Effects
Bottom-up Effects
Altered Food Webs
Change in Ecosystem Structure and Function
Shift in Controls of Estuarine Ecosystems

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%

How Do We Remediate?

Land Conservation

Land Use Regulations (No Sprawl)

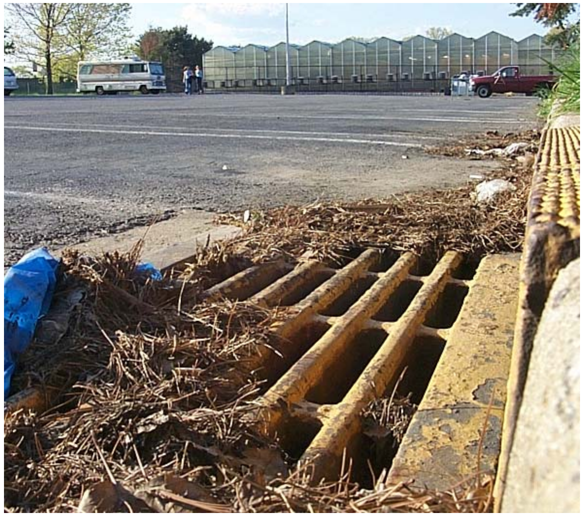
Smart Growth, Cluster Development

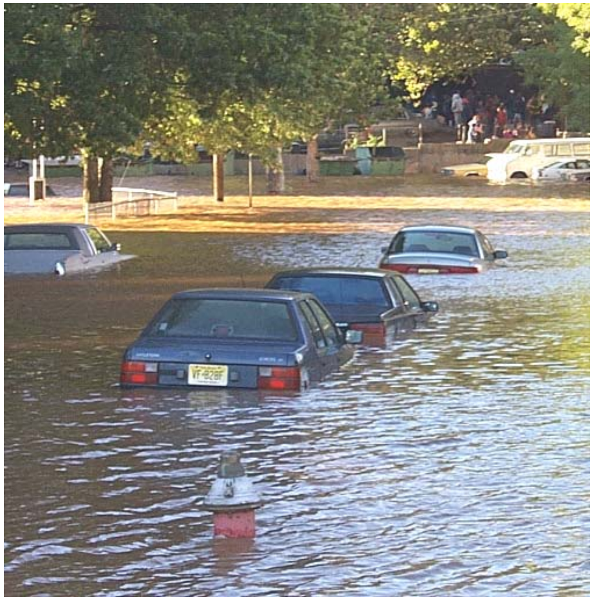
Down-zoning (Reduced Unit Density)

Maintain Buffers

MANAGEMENT ACTIONS

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






The End

NJDEP Monitoring and Research in the Barnegat Estuary Human and Ecological Health

Bob Connell
Water Monitoring & Standards
New Jersey Department of Environmental Protection

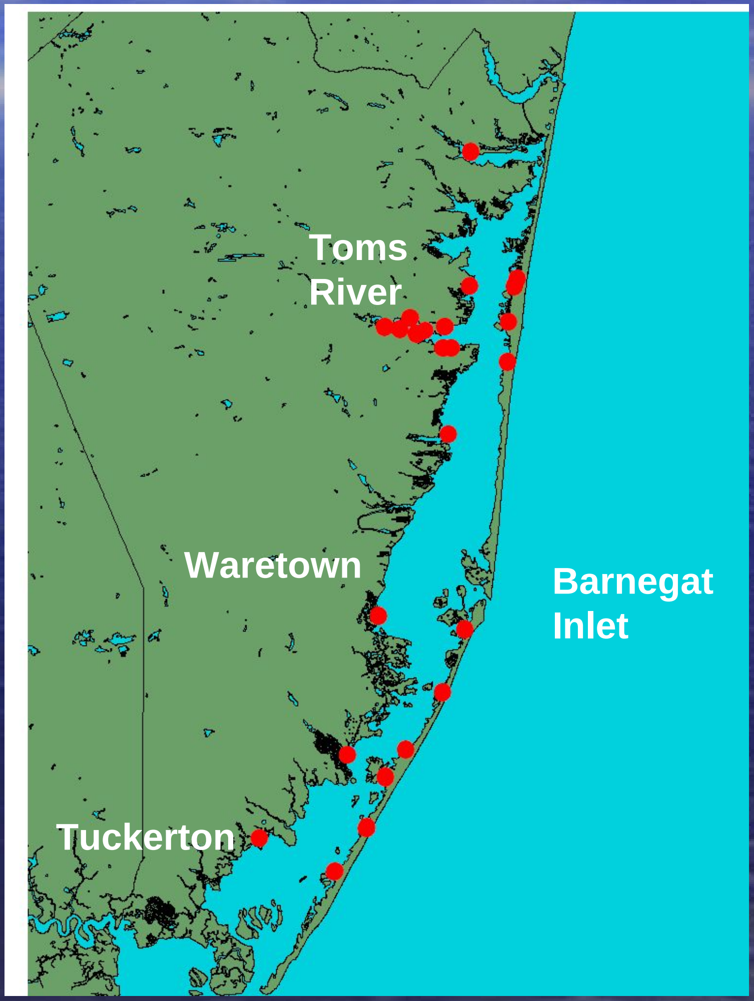
Barnegat Bay Stakeholder Meeting
May 5, 2010

Collaborators on this Presentation

- Mike Celestino, NJDEP Division of Fish and Wildlife
- Thomas Belton, NJDEP Office of Science
- Jeffrey Hoffman, NJDEP – NJ Geological Survey
- Barbara Hirst, NJDEP – TMDL/319H programs
- Leslie McGeorge, Bob Schuster, Julie Nguyen, Tracy Fay, Helaine Liwacz – NJDEP Water Monitoring & Standards

Measuring the Sanitary Quality of the Estuary for Human Use - Recreation

- 24 Recreational Bathing Beaches
  - Monitoring for indicators of human waste
    - Fecal coliform
    - Enterococcus
  - Weekly summer testing
  - Cooperative program between NJDEP, county and local health officials



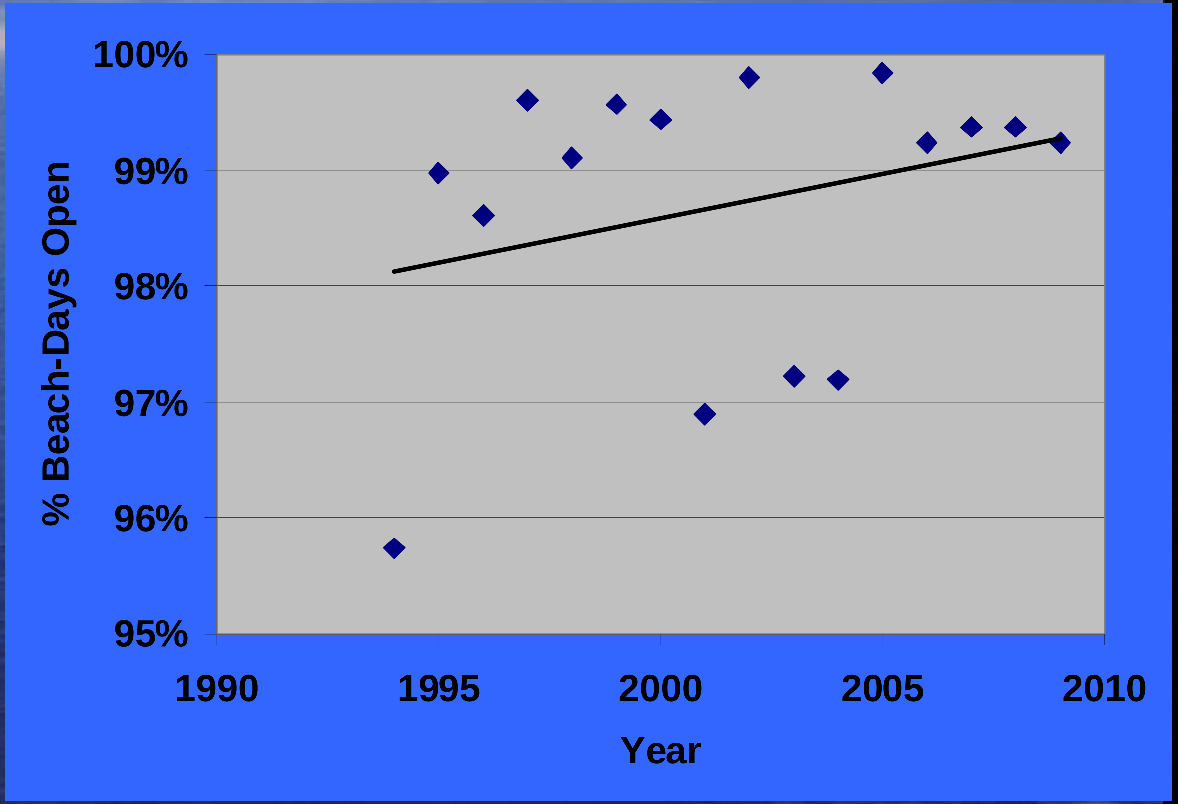
Recreational Bathing Beaches in the Barnegat Estuary

For more information:
http://www.nj.gov/dep/bmw/bathingbeach/bbindex.html

Measuring the Sanitary Quality of the Estuary for Human Use

- Can we swim at beaches in the estuary?

  Yes. In 2009 monitored beaches in the Barnegat Estuary were open of 99.2% of the time. However, our goal is 100%. On average, this trend has been improving over the past 15 years.

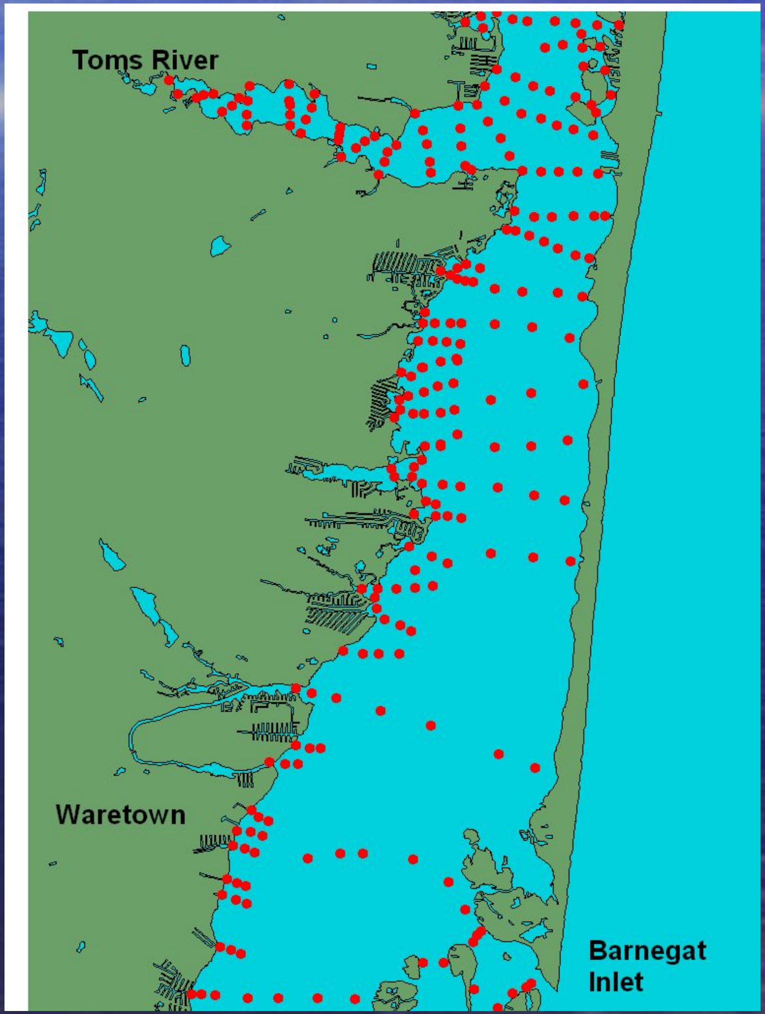


Measuring the Sanitary Quality of the Estuary for Human Use – Shellfish Consumption

- Monitoring for indicators of human waste as per the NSSP*.
  - Total coliform
- 5-12x per year
- NJDEP, Water Monitoring & Standards

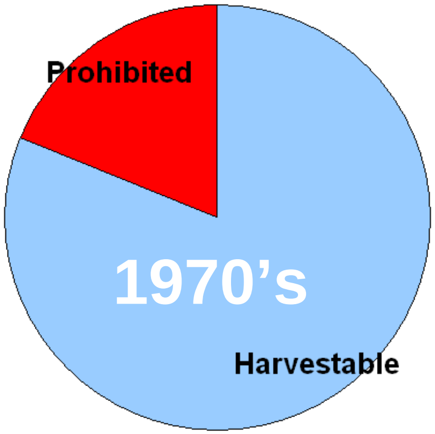
*NSSP = National Shellfish Sanitation Program

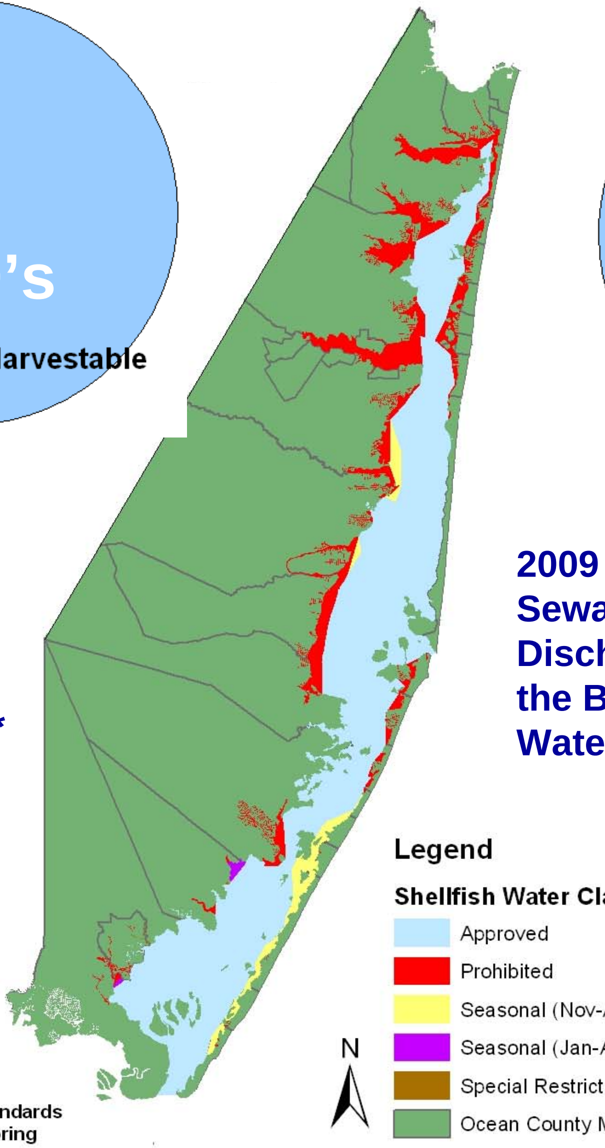
For further information:
http://www.nj.gov/dep/bmw/waterclass.htm



Shellfish Sanitation monitoring in a portion of the Barnegat Estuary

Measuring the Sanitary Quality of the Estuary for Human Use – Shellfish Consumption

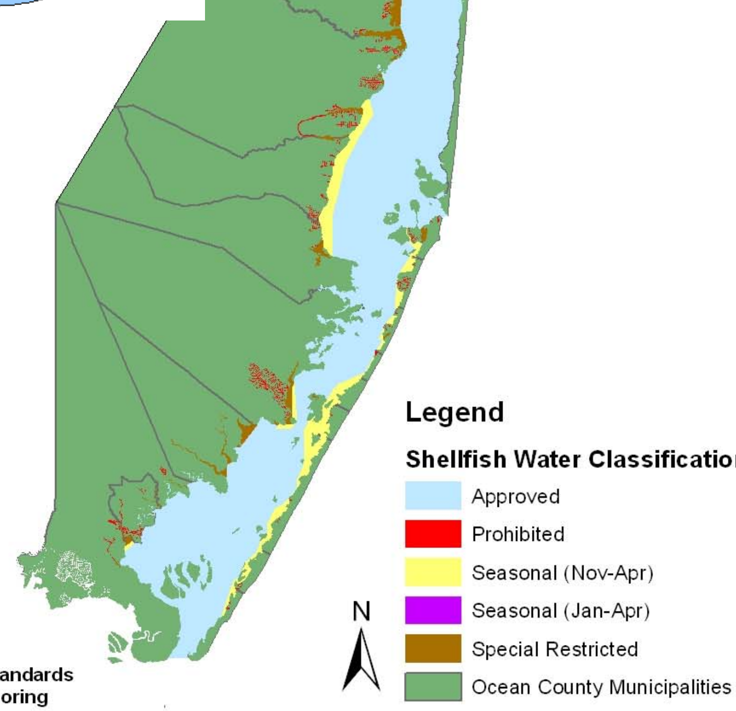




1970's
Sewage Plant Discharges into the Barnegat Watershed = 45*

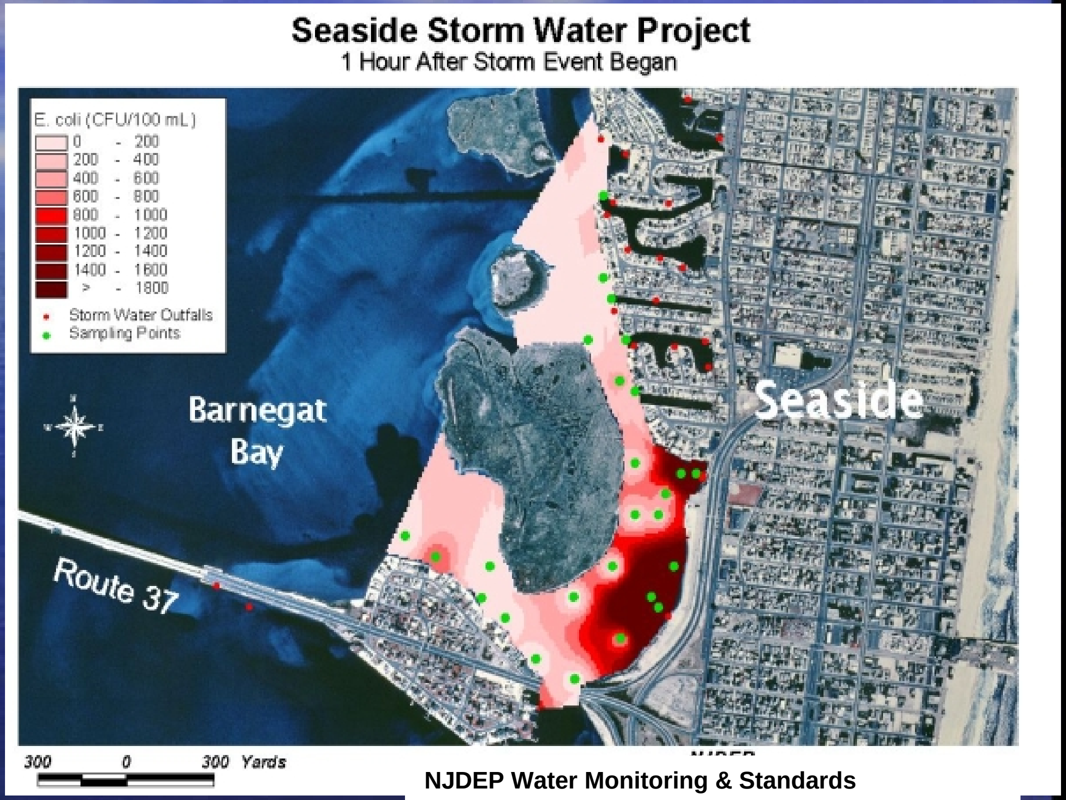
*Source: Ocean County Utilities Authority

2009
Sewage Plant Discharges into the Barnegat Watershed = 0



Targeted Monitoring to Improve Human Health Protection

- Remaining impacts to the Barnegat Estuary are primarily related to stormwater
- DEP's Microbial Source Tracking includes:
  - Monitoring through storm events
  - Application of new, more specific indicators of human waste
    - F+ RNA coliphage
    - Antibiotic resistance
    - Optical brighteners



NJDEP Water Monitoring & Standards

- Has successfully tracked down illicit wastewater handling (e.g. broken sewer lines)
- Limited municipal resources can be focused on the most significant problems.

For further information:
http://www.nj.gov/dep/bmw/info03.htm

Ecosystem Health – Sediment Quality

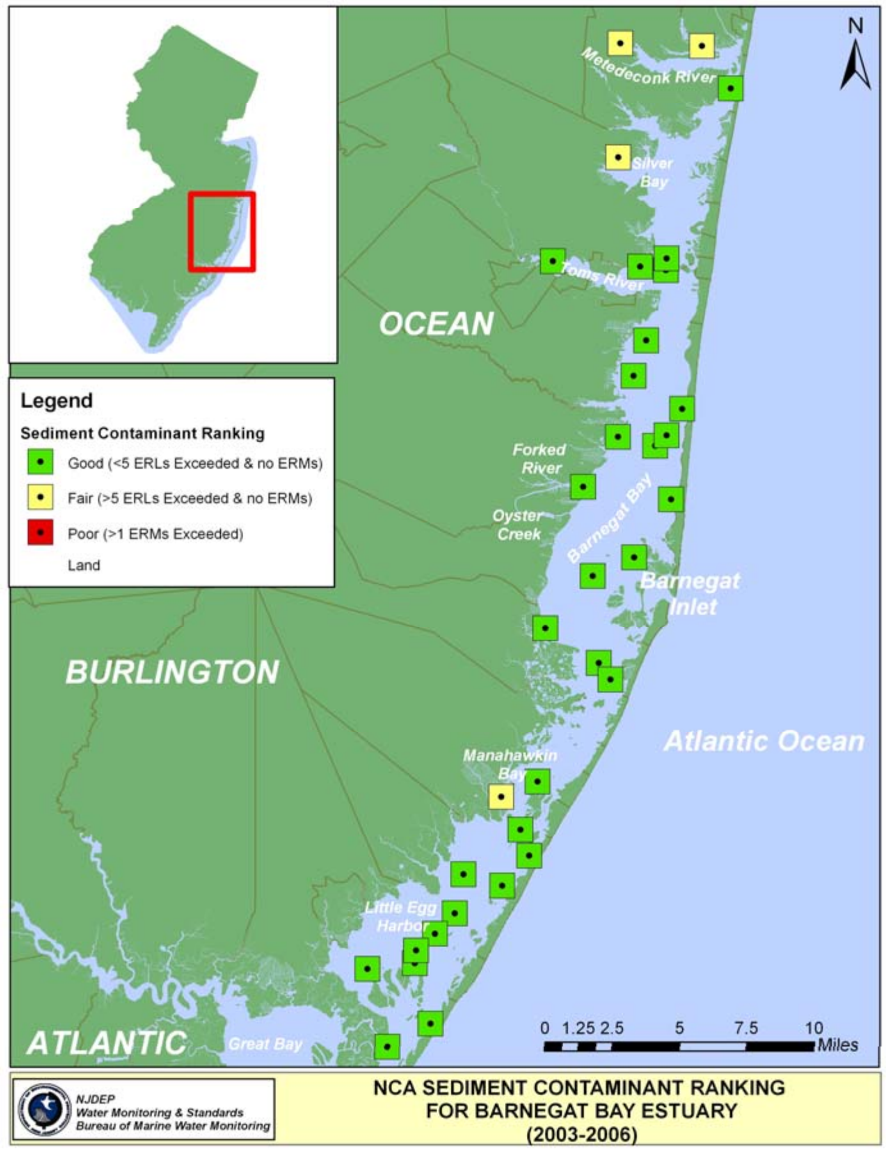
National Coastal Assessment Sediment Contaminants

National Coastal Assessment is a USEPA funded national aquatic survey to assess the health of the nation's estuaries

Sediment samples collected in the Barnegat Estuary by NJDEP as part of the National Coastal Assessment.

Results are assessed against NOAA's Effects Range Medium (ERM) and Effects Range Low (ERL) criteria.

For more information:
http://www.nj.gov/dep/bmw/NCA/NCAmain.htm



Ecosystem Health Research – Benthic Index

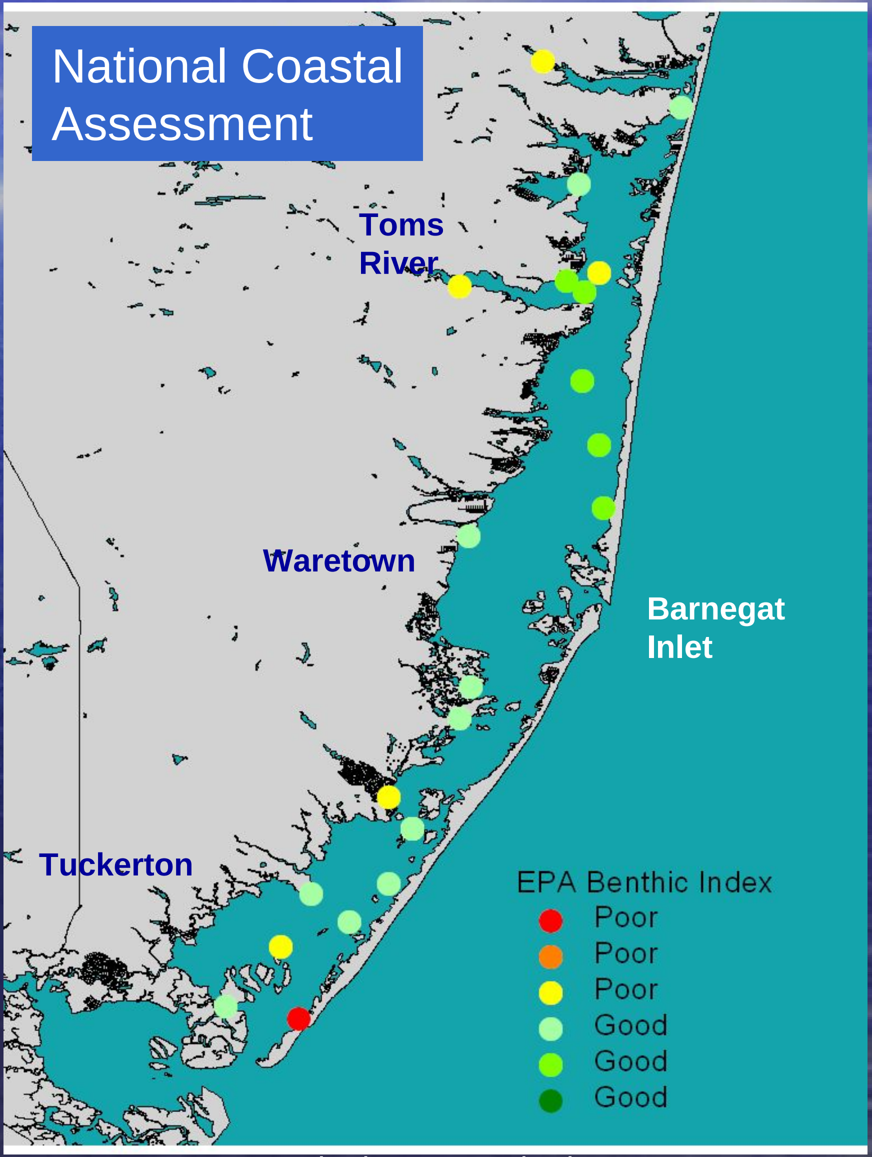
Regional Environmental Monitoring and Assessment Program (REMAP)

- **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.**

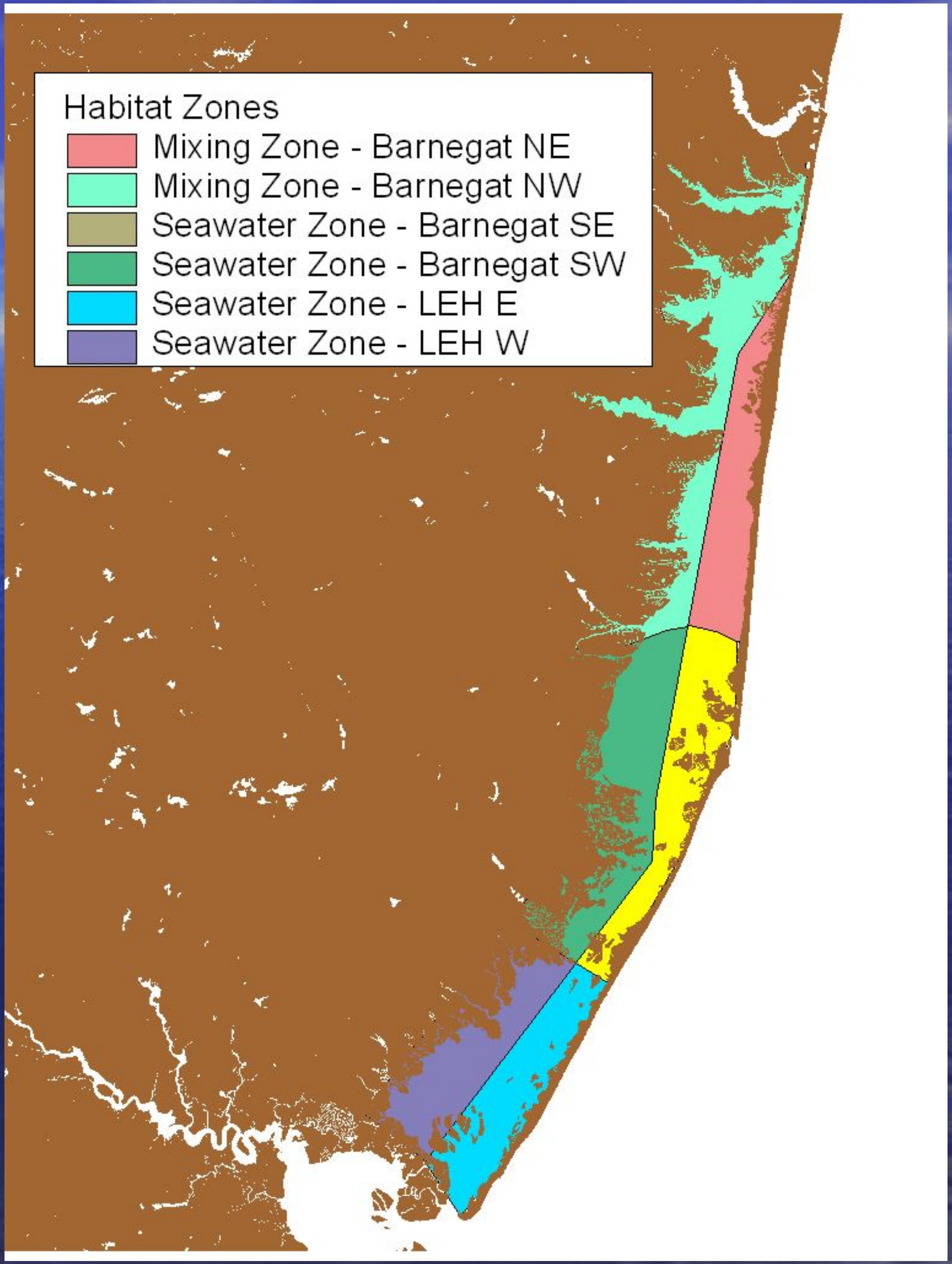
* Based on Paul, J. et al., 2001.



NJDEP, Water Monitoring & Standards

Ecosystem Health Potential New Design

- Six sampling zones based on salinity and sediment.
- Salinity zones based on NOAA Estuarine Inventory classifications
- Sediment zones in general are coarse sediment east and finer sediments west.
- Ideal design would involve 20 NCA-type samples per zone



Ecosystem Health Research

Hard Clam Population Surveys – NJDEP Division of Fish & Wildlife

Barnegat Bay: Current population trend not known.

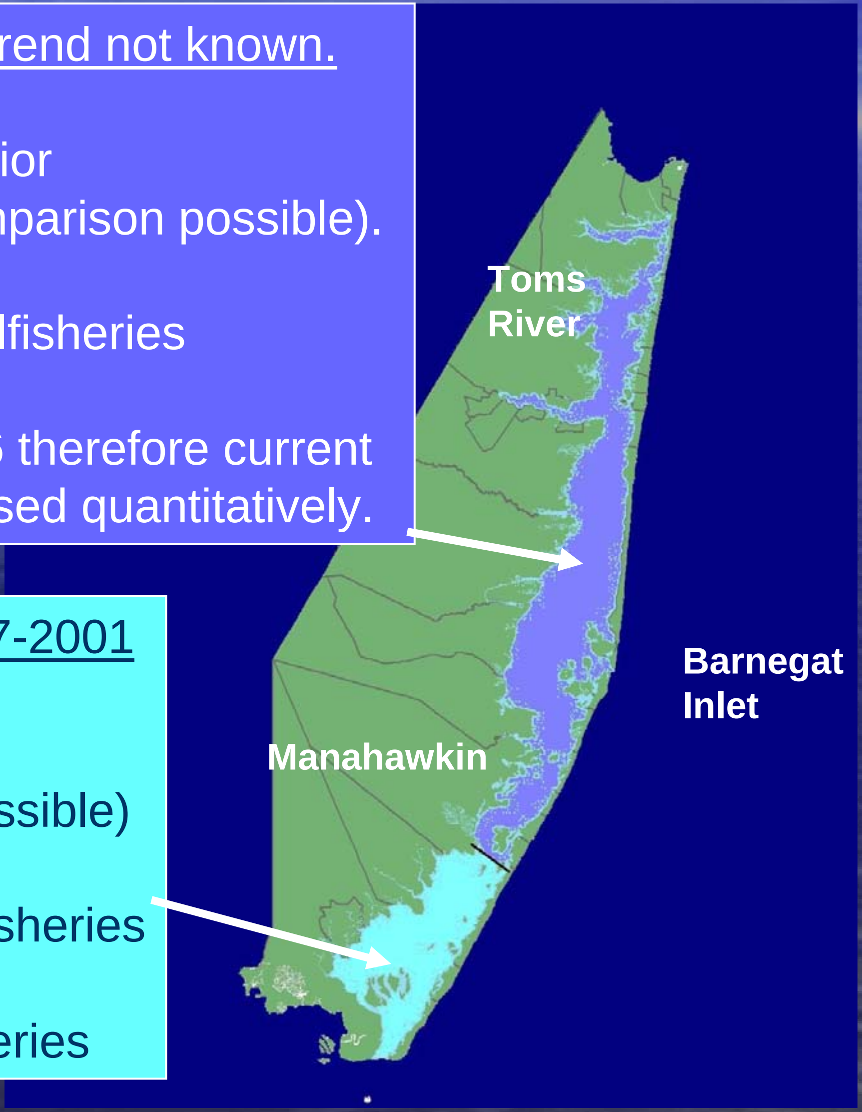
Surveys:

- 1963: US Department of Interior (not repeated ∴ no comparison possible).
- 1985-86: NJDEP Bureau of Shellfisheries
- No funding for surveys since 1986 therefore current status and trend cannot be assessed quantitatively.

Little Egg Harbor: 68% decline 1987-2001

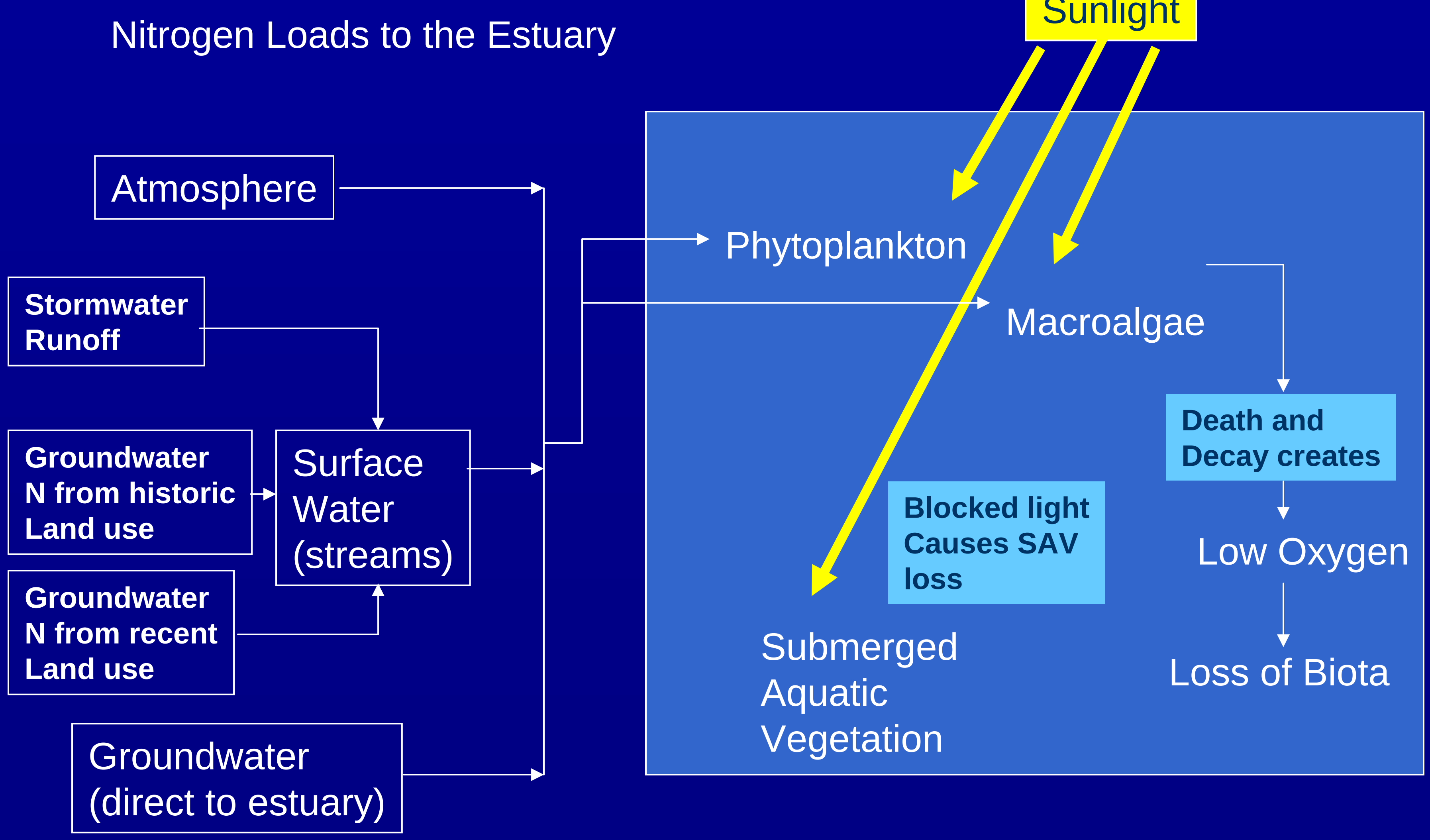
Surveys:

- 1963: US Department of Interior (not repeated ∴ no comparison possible)
- 1986-87: NJDEP Bureau of Shellfisheries
- 2001: NJDEP Bureau of Shellfisheries

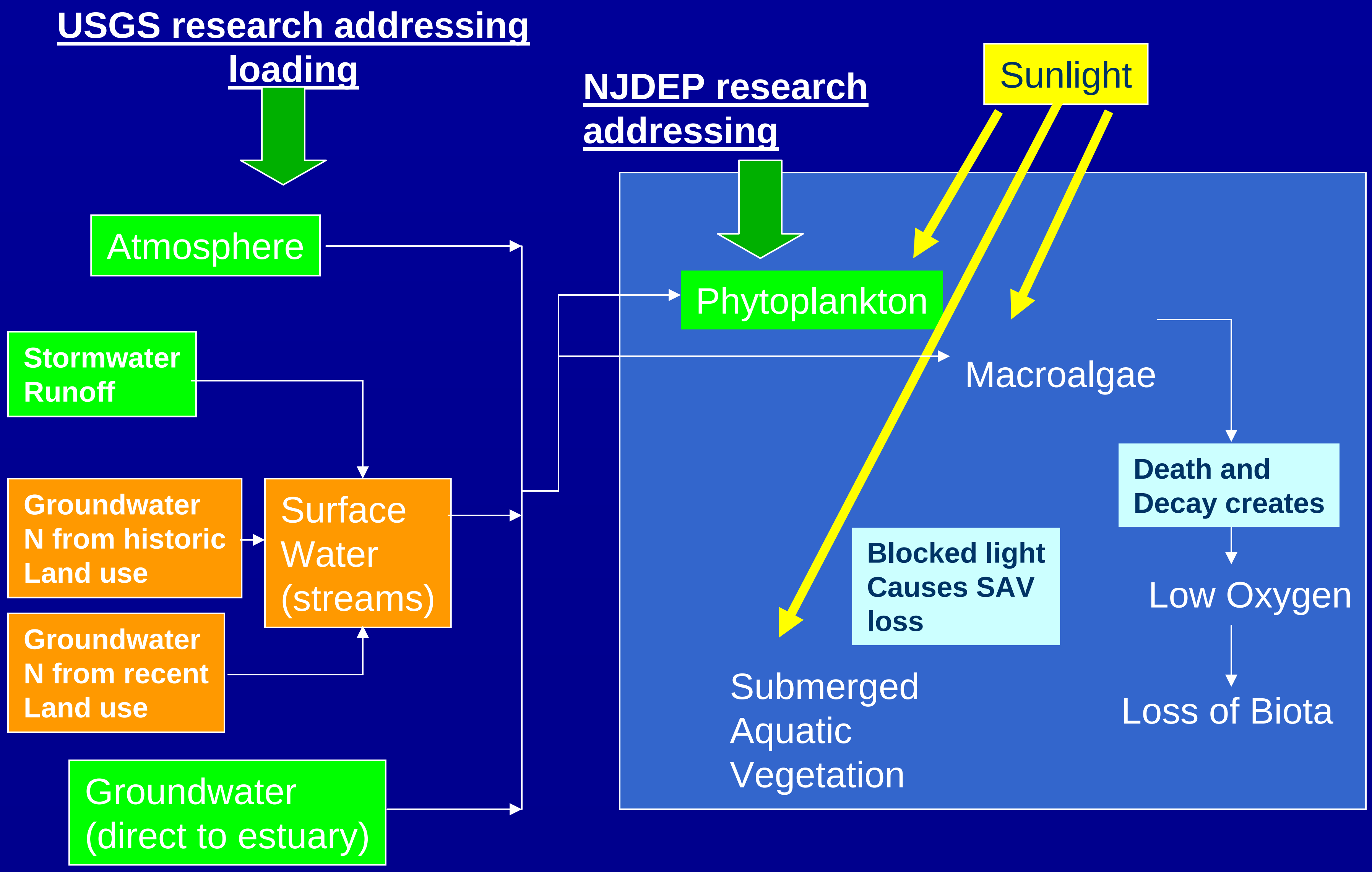


Eutrophication

NOAA Conceptual Model (modified)



Eutrophication – Barnegat Estuary



Eutrophication – Barnegat Estuary

Phytoplankton Levels

Chlorophyll measured quarterly by NJDEP Water Monitoring and Standards by traditional surface grab sampling since 1999.

Collaborative research by NJDEP, NOAA, NASA and Rutgers University lead to availability of near-daily remote sensing for chlorophyll during the summer months for bloom detection with much greater spatial coverage.

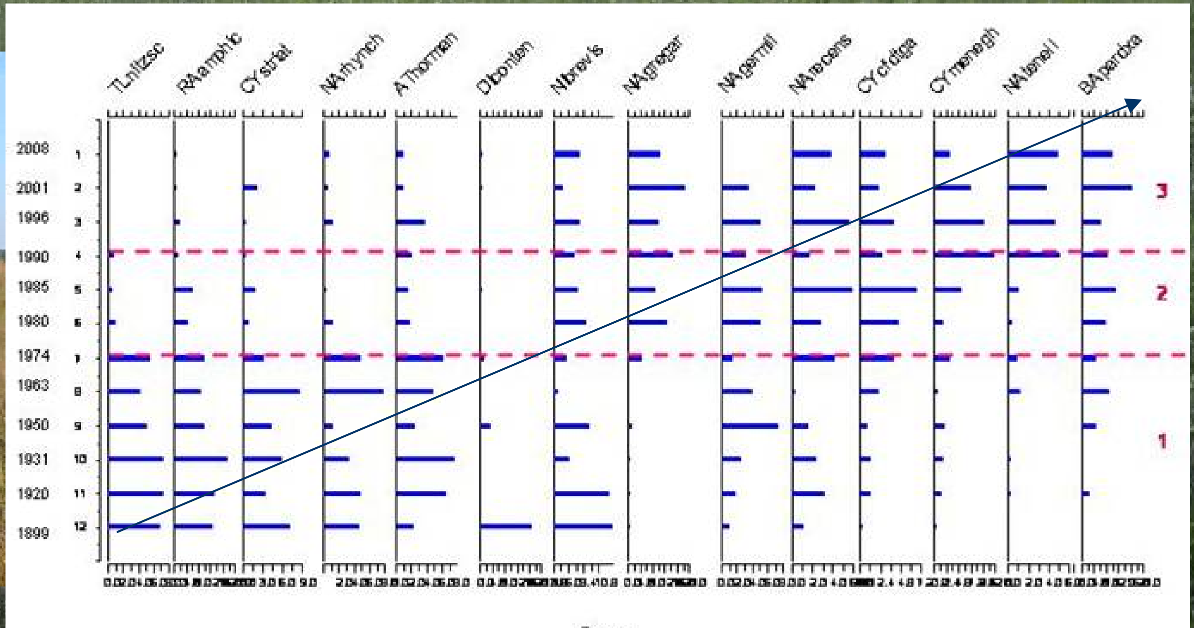
Location	# observations (Summer months 2008 & 2009)	Classification Scheme		
		EPA National Coastal Assessment	NOAA ASSETS	Maryland Inland Bays
Barnegat Bay	29,330	Low	Moderate	Low
Manahawkin Bay	2,794	Low	Low	Low
Little Egg Harbor	13,296	Low	Low	Low

For further information:
http://www.nj.gov/dep/bmw/remotesensing.htm
http://www.nj.gov/dep/bmw/phytoplankton.htm

Nutrient and Ecological Histories in Barnegat Bay, New Jersey

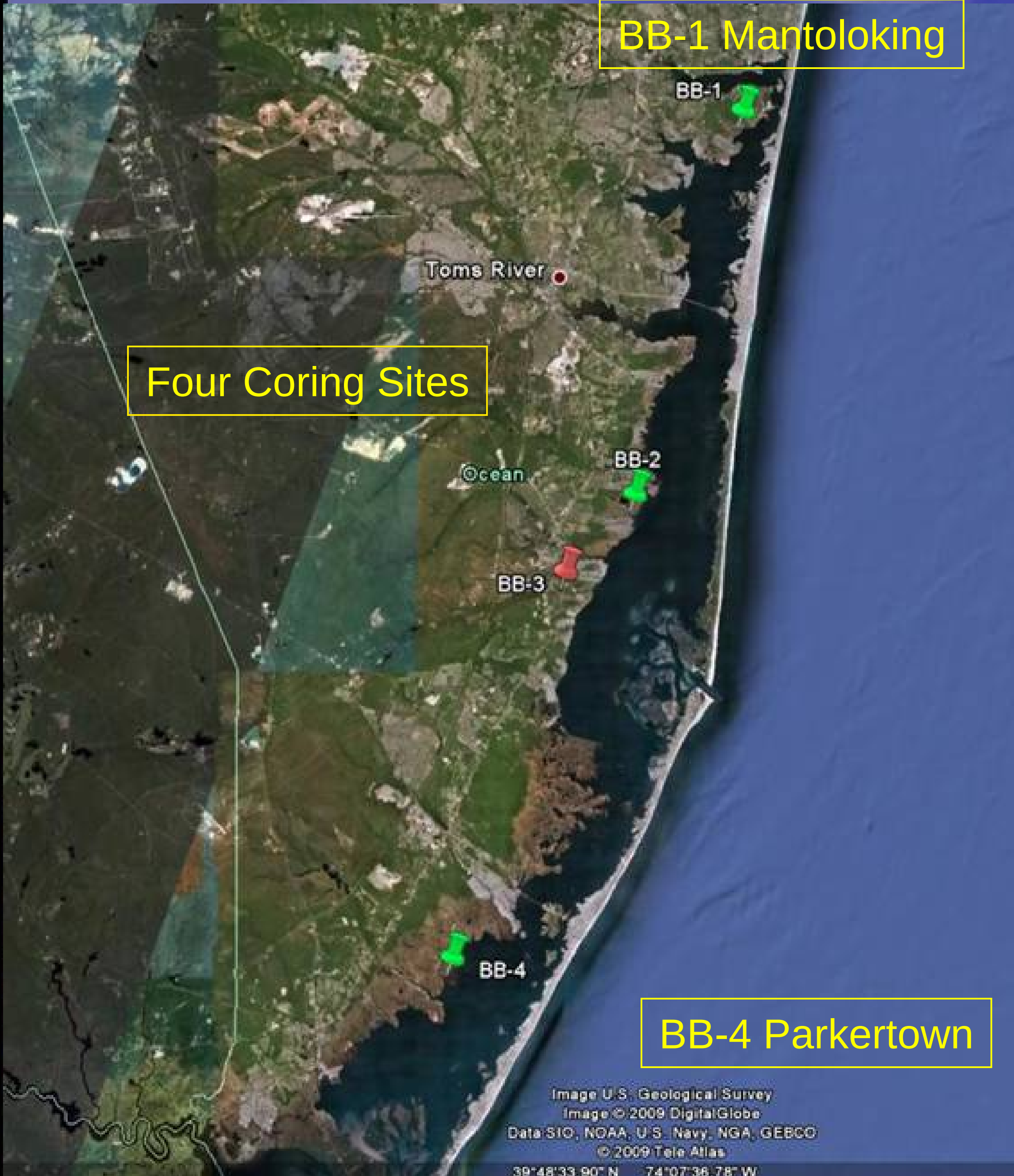
Philadelphia Academy of Natural Sciences & University of Delaware.

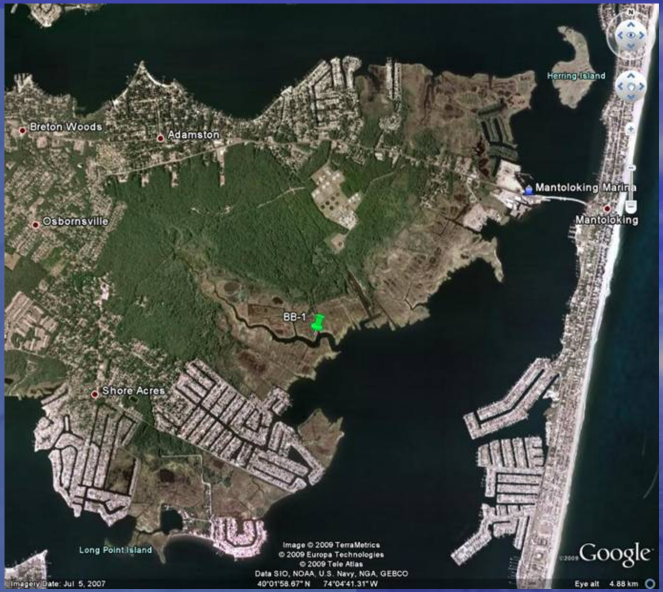
- How can nutrient-related environmental changes in Barnegat Bay be monitored over time and results used to manage the system?
- We need tools to look back in time AND predict future responses!
- Coring salt Marshes offers a solution by radio-dating and analyzing sediments for nutrients and algae laid down over the past two hundred years.
- Develop algal stressor models based on hind casting to more natural conditions

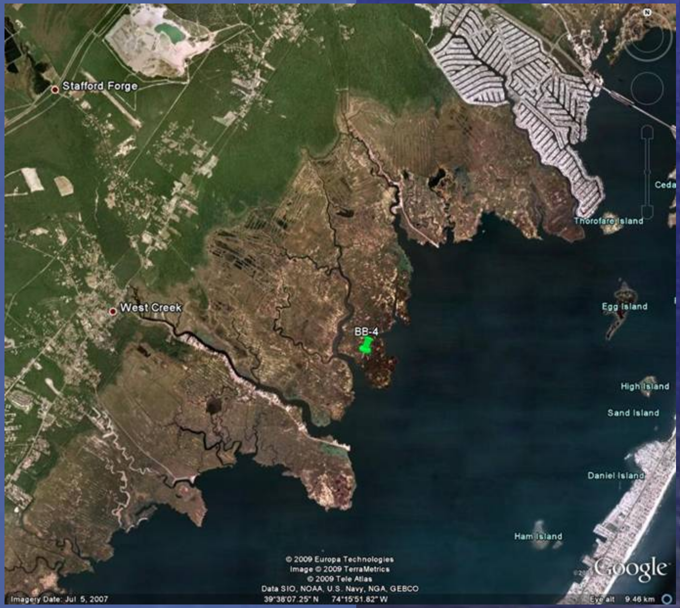


BB-1 Mantoloking

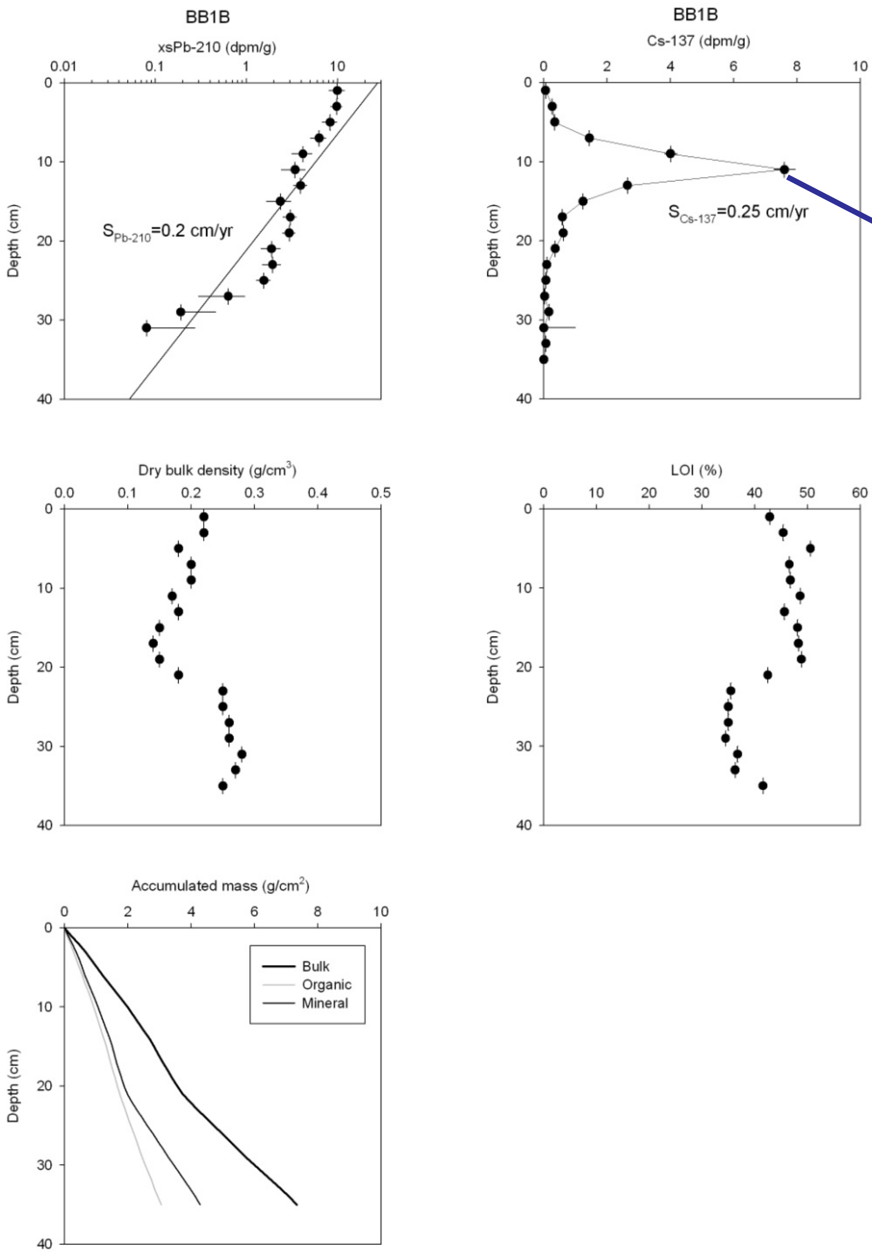
Four Coring Sites

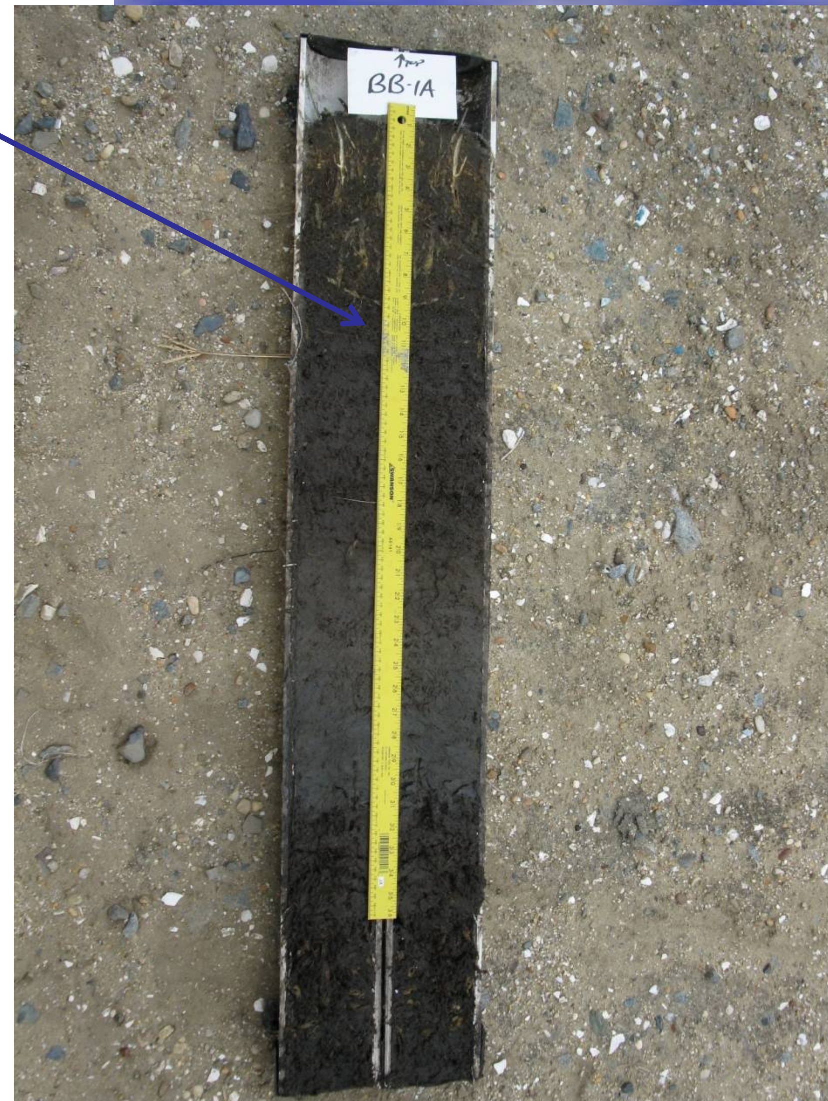


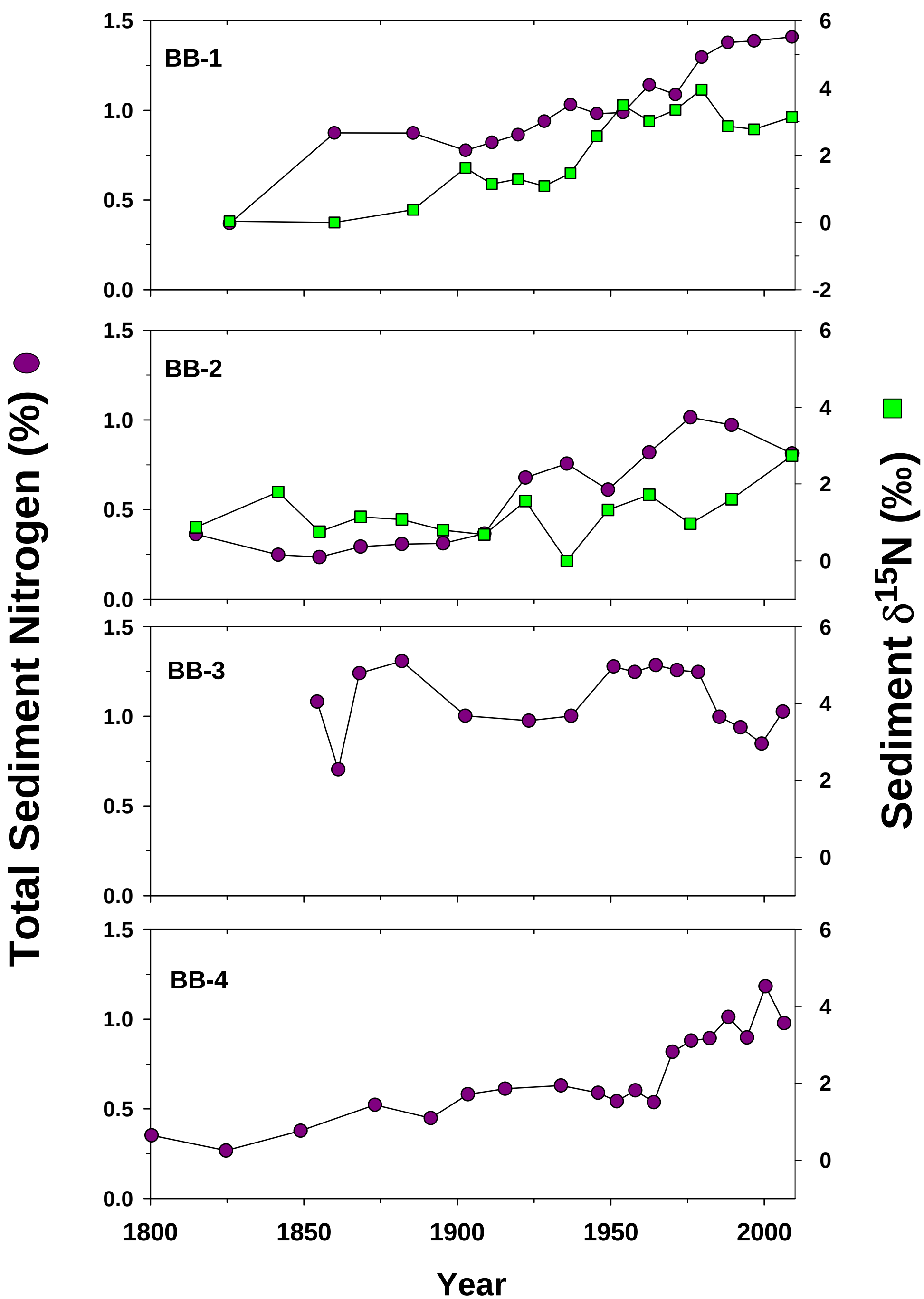




BB-4 Parkertown


BB1B
xsPb-210 (dpm/g)
S_{Pb-210}=0.2 cm/yr
BB1B
Cs-137 (dpm/g)
S_{Cs-137}=0.25 cm/yr
Dry bulk density (g/cm^3)
LOI (%)
Accumulated mass (g/cm^2)
Bulk
Organic
Mineral
Depth (cm)


BB-1A



BB-1
BB-2
BB-3
BB-4
Total Sediment Nitrogen (%)
Sediment δ15N (‰)
Year
1800
1850
1900
1950
2000
0.0
0.5
1.0
1.5
-2
0
2
4
6

Preliminary Results

• Sediment accretion rates on average (0.25 cm/yr) seem to be keeping up with sea level rise, although southern bay may not (0.39 cm/yr).

• Total sediment N and P concentrations at the upper site exhibit an increase towards the surface starting at about 40 cm or 1865 when cranberry cultivation and fertilization start after Civil War.

• Stable isotopes of N in the upper two cores show increase human influence as shown by the increase in $\delta^{15}N$.

Future Work

•Estimate storage loads by multiplying TN and TP concentration times the accumulated mass (g/cm/yr). Compare with in-stream loads from USGS to calculate nitrogen trapped in the marshes from upland sources and determine how much is then available for biological uptake in bay.

•Finish algal/foraminfera identification work, identify indicator species, and develop bio-response models for predicting nutrient impacts to bay.

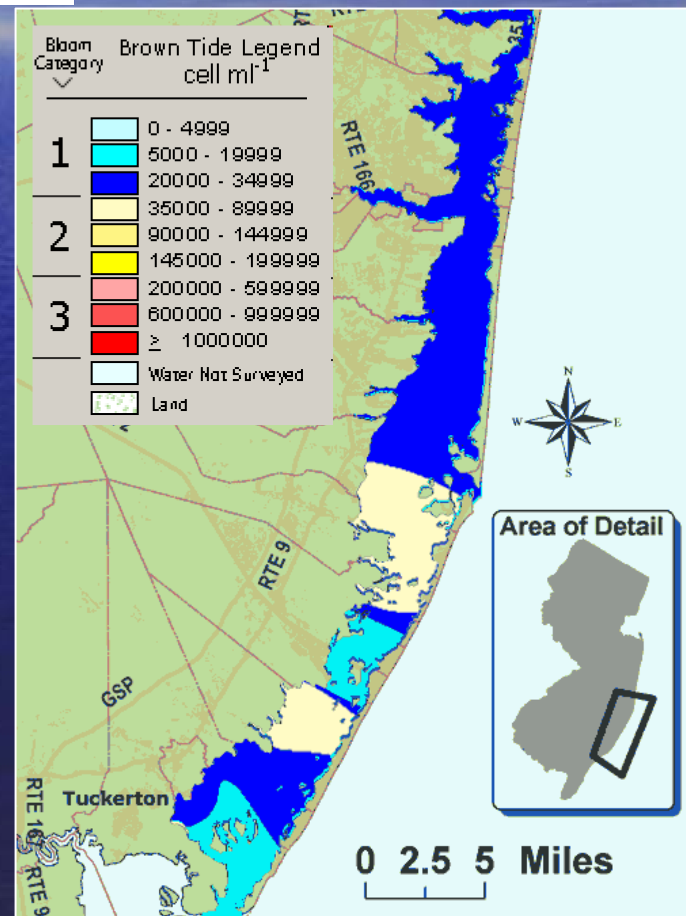
Eutrophication

Harmful Algal Blooms: Brown Tide Assessment Project

- NJDEP Office of Science and Rutgers University
- Evaluated brown tide occurrence and influencing factors, 2000 – 2004.
- Found that the brown tide was favored by dry weather conditions.
- Significant brown tides did not occur in any month where the Toms River flow exceeded 200 ft^3 sec^{-1} .

Table 1. Annual mean and monthly maximum abundance (cells ml^{-1}) of *Aureococcus anophagefferens*, 2000-2004.

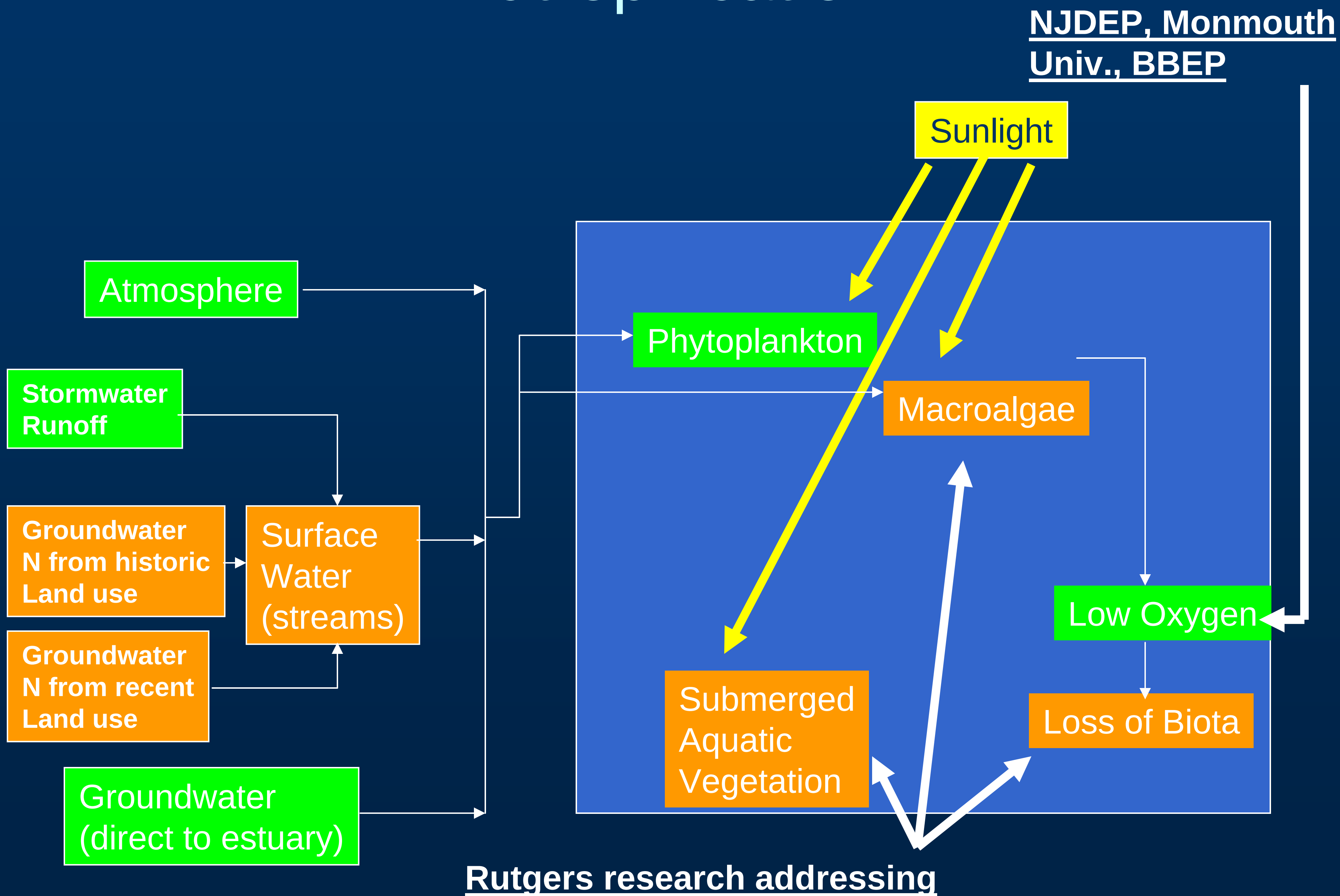
Year	Overall Mean (cells ml^{-1})	Monthly Maximum (cells ml^{-1}) [June of each year]
2000	190,500	2,155,000
2001	246,500	1,883,000
2002	281,900	1,561,000
2003	8,900	54,000
2004	15,700	49,000



For further information: http://www.state.nj.us/dep/dsr/browntide/bt.htm

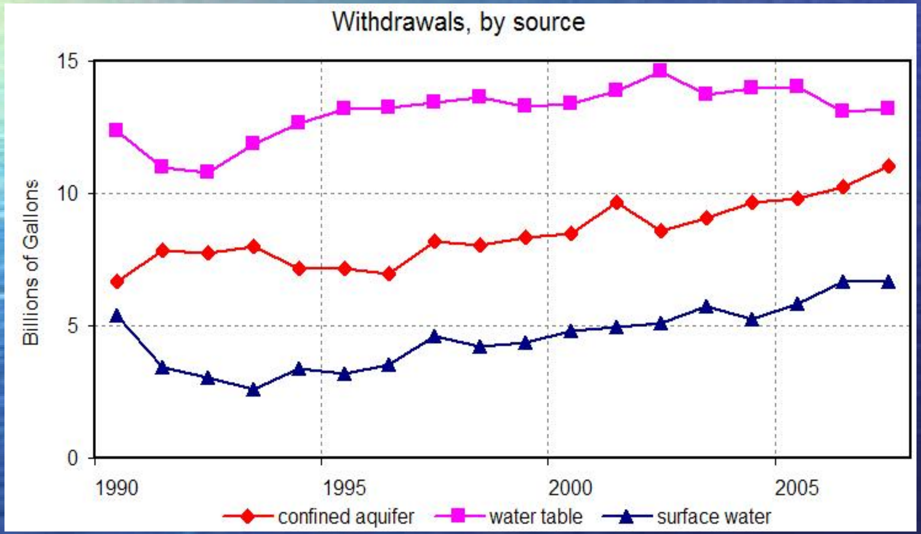
http://www.crssa.rutgers.edu/projects/btide/index.html

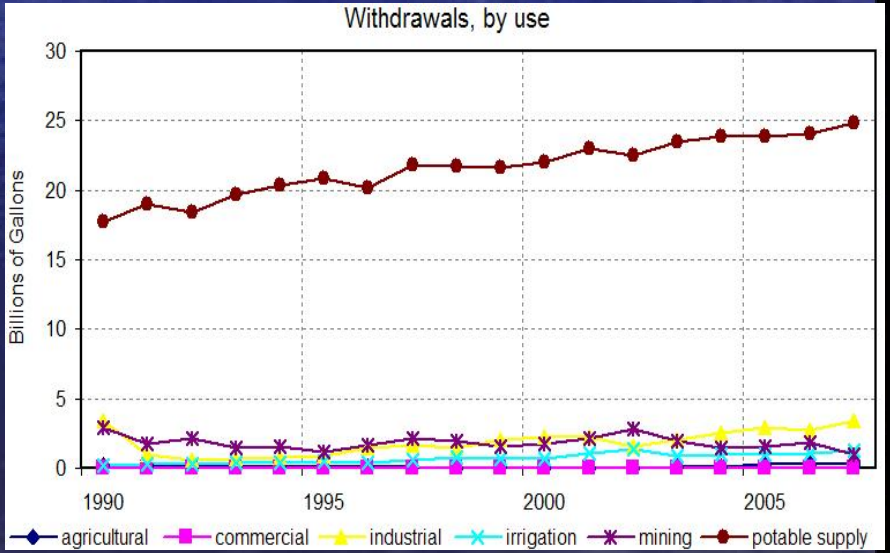
Eutrophication



Water Supply & Geological Survey

- update of Water Supply Plan
- water withdrawals, use, and transfers

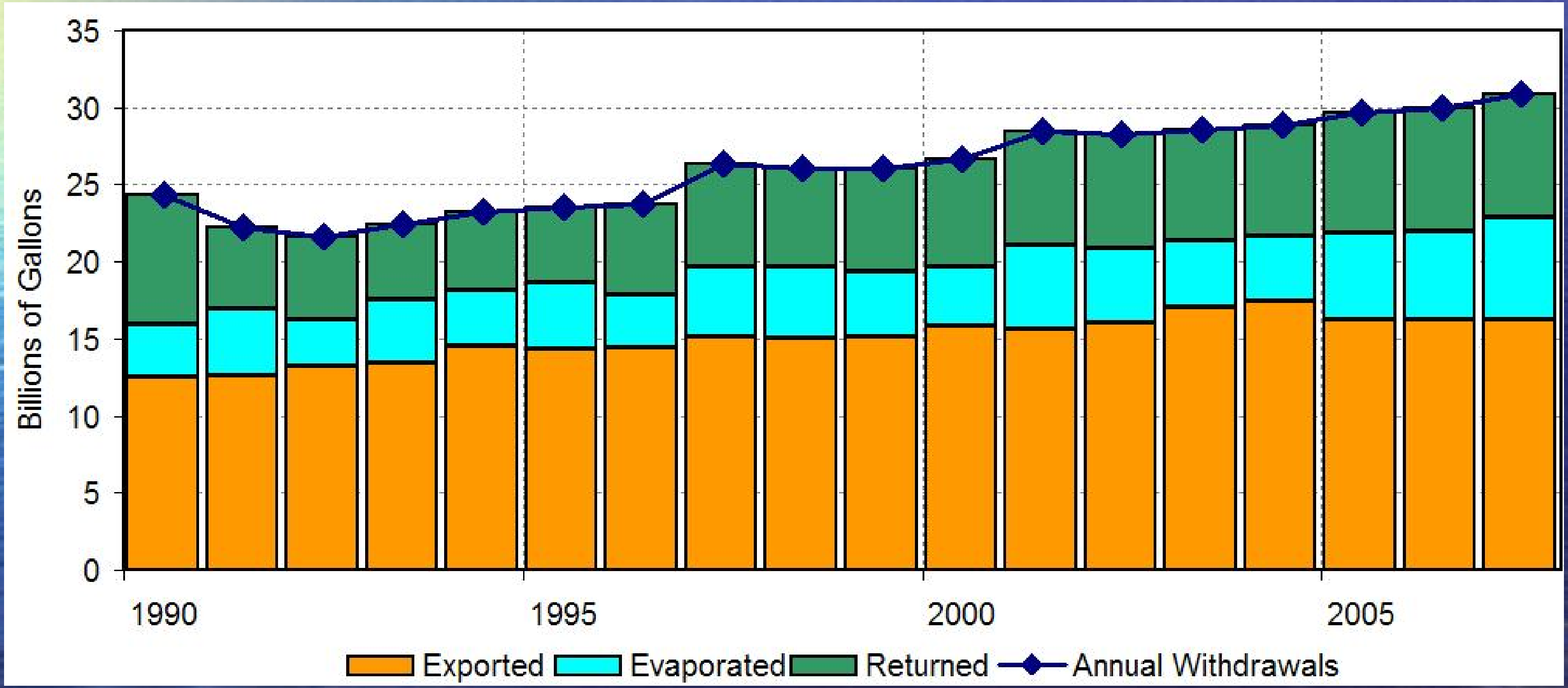




Where does the withdrawn water go after use?

Three destinations:

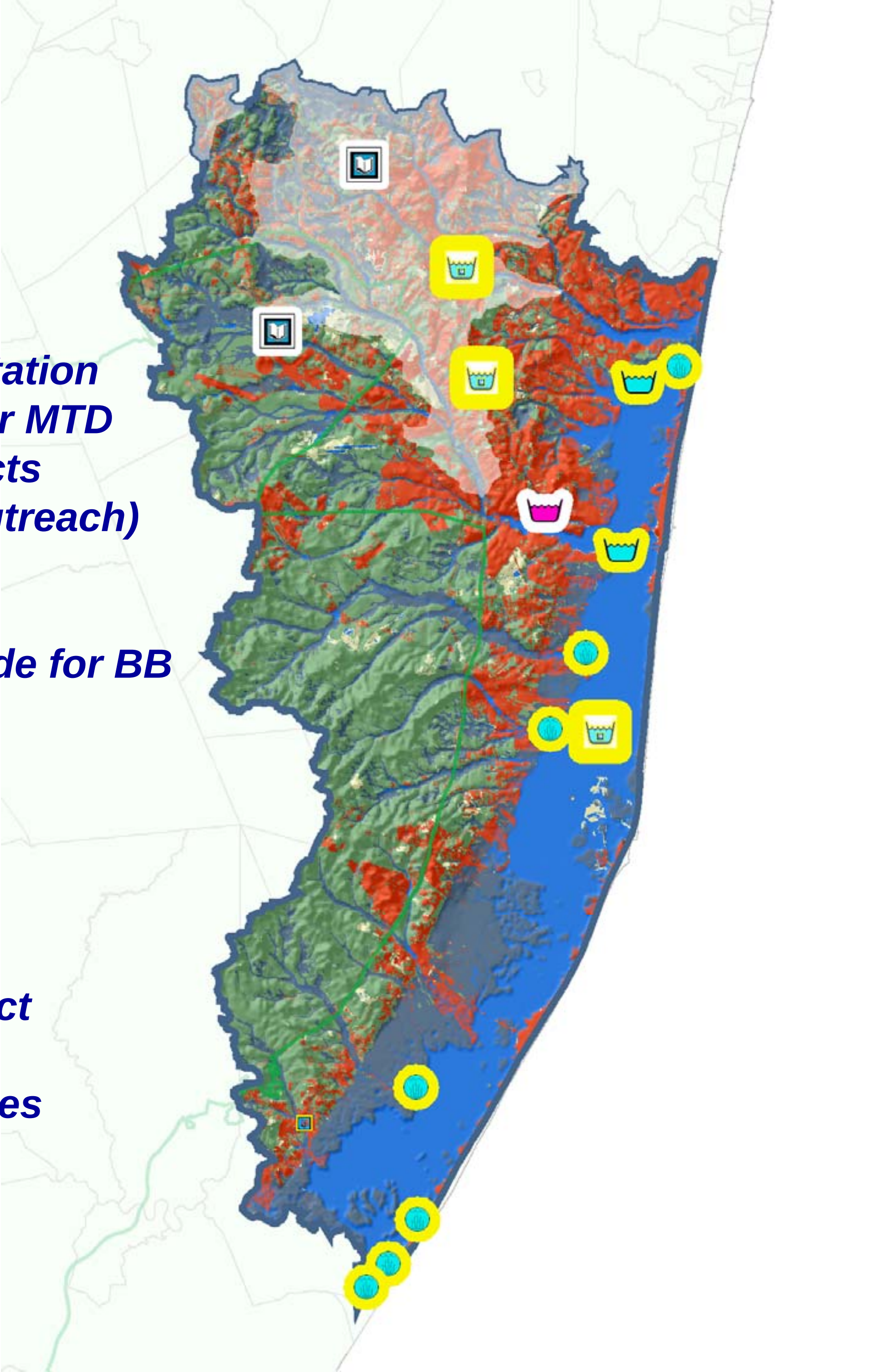
1) Exported from the watershed for treatment and discharge.
2) Evaporated during use.
3) Returned to the watershed after use.



Net water loss is sum of evaporated and exported.

General Location of Restoration Activities

Montclair State Univ. Submerged Aquatic Vegetation
Ocean County Planning Department Stormwater MTD
OCSCD Shoreline/Roadside Stabilization Projects
OCSCD Specific Activity Guide (Educational Outreach)
Lake Carasaljo Feasibility Study
OCSCD Stewardship of Soil Health
RU/OCSCD Low Maintenance Landscaping Guide for BB
Baywood Marina Stormwater BMP's
OCSCD District Shoreline Stabilization
OCPD Stormwater Basin Retrofits
Lake Pohatcong Feasibility Study
Long Swamp Creek(LSC) Restoration Plan
OCSCD LSC Subwatershed Action Project
Bey Lea Golf Course BMP Demonstration Project
OCVTS Wetland Enhancement Project
NJ Clean Vessel Act Program Pump Out Facilities



Additional Planning, Implementation and Research Projects Funded in Response to the NJDEP Action Plan

When	Who	What	Funding	
			Amount	Source
6/2009	Metedeconk WRPP and Implementation Project with Brick MUA	Address TMDLs, identify, prioritize and implement highest priority stormwater BMP's projects throughout the entire watershed	$666,000 $475K for implementation	CBT
9/2009	Ocean County Planning Department	Stormwater BMP's & Retrofit Projects focused in the upper portions of the estuary	$371,482	319(h)
9/2009	Ocean County Soil Conservation District	Completed two additional Stormwater Basin Retrofits in the Fall of 2009 Under the Long Swamp Creek Subwatershed Action Projects grant	$256,150	CBT
11/2009	Ocean County Planning	5th Pump Out Boat to service central portions of Barnegat Bay and Enhance No Discharge Area - Anticipated Operation Summer 2010	$65,000	NJ Clean Vessel Act
6/2010	Ocean County College	Assess the condition of coastal wetlands where wetlands may play a critical role in maintaining water quality by functioning as non-point source capture and potential treatment zones (coordinated with tidal marsh coring and wetlands assessment projects.	$150,000	319(h)

NJPDES Permit Overview
Oyster Creek Generating Station

Susan Rosenwinkel
Bureau of Surface Water Permitting
NJ Department of Environmental Protection
Susan.rosenwinkel@dep.state.nj.us

Presentation Overview

- Goals of presentation
  - Facility description (intake and discharge)
  - Impingement and entrainment
  - Regulatory statutes and applicable regulations
  - Status of NJPDES permit

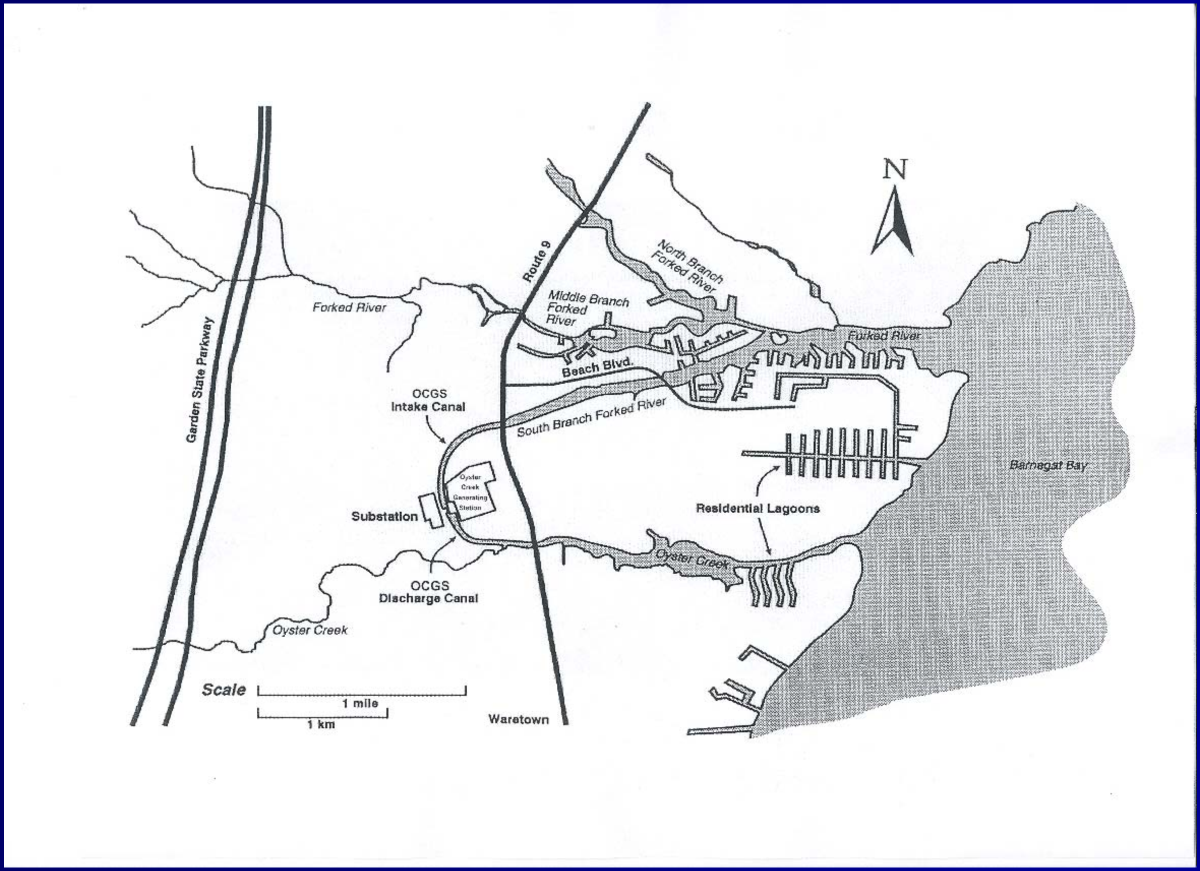
Presentation Overview

- Presentation will not address
  - – Nuclear safety concerns (outside of scope of NJPDES)
  - – Content of final permit (deliberative)
  - – Specific impingement and entrainment data from OCGS

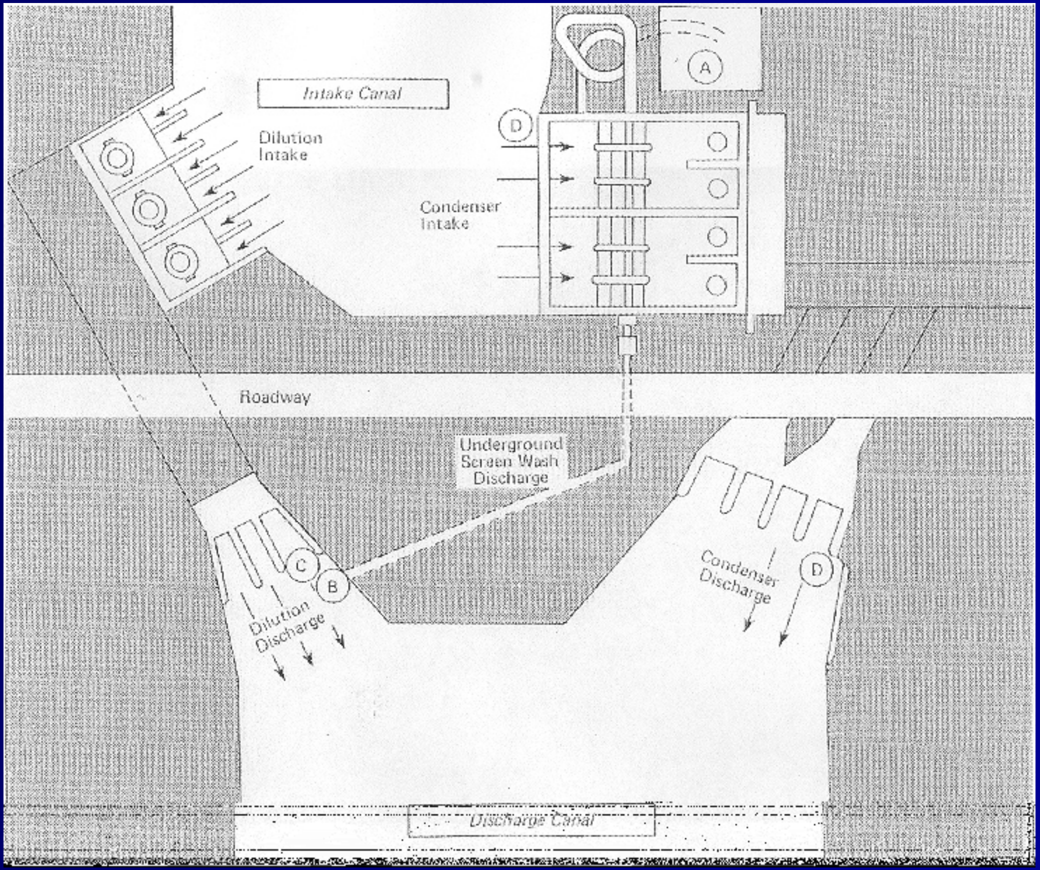
Facility Description

- Base Load Facility, Capacity Utilization Rate greater than 90%
- Commercial Operation began in 1969
- Generating Output is 641 MWe
- Intake Design Flow is 1,785 MGD
  - Circulating Water – 662 MGD
  - Dilution Water – 1,123 MGD

Oyster Creek Generating Station



Intake and Discharge Canals



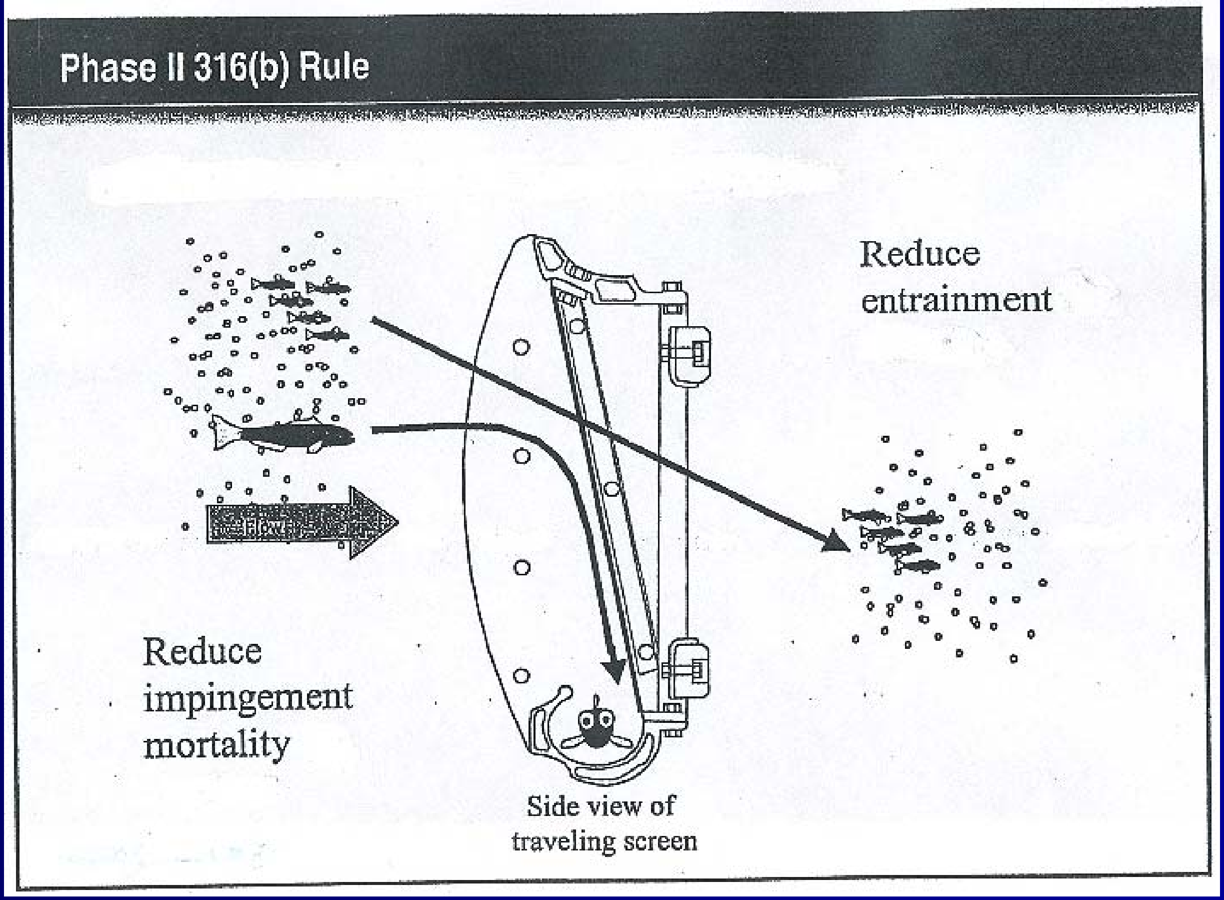
NJPDES Permit

- Permit is the regulatory mechanism to regulate the intake and discharges
- Section 316(a) of the Clean Water Act – regulates thermal discharge
- Section 316(b) of the Clean Water Act – regulates intake

Section 316(b)

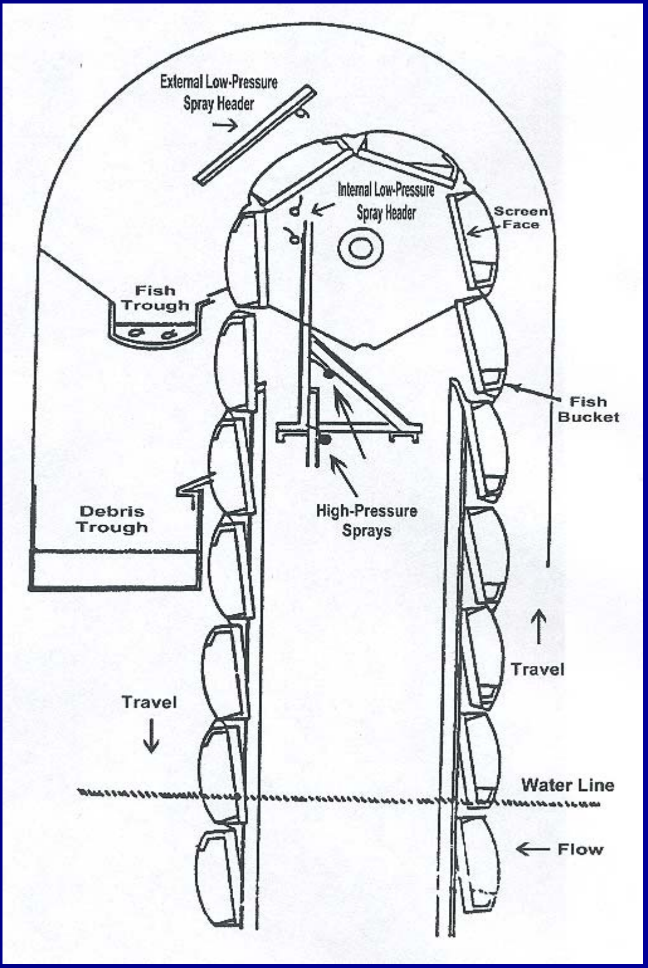
- *Statute* (not a regulation)
- Impingement occurs when fish are trapped against the screens at the intake
- Entrainment occurs when smaller fish and larvae are sucked through the intake

Impingement and Entrainment



Current Technology

- Ristroph Traveling Screens at Oyster Creek with Fish Return System



Other Intake Protection Technologies

- Wedgewire Screens
- Flow Reductions
- Seasonal Outages
- Closed-Cycle Cooling

Timeline of Regulatory Requirements

- 1972 Clean Water Act Statute
- 1976 EPA Final Regulations
- 1977 EPA Development Document to implement 1976 regulations which provided for facility-by-facility determination of adverse environmental impact.
- 1977 Appalachian Power Co. v. Train – Fourth Circuit Court determined that information in Development Document violated the Administrative Procedure Act due to improper public notice.

Timeline of Regulatory Requirements (continued)

- 1977 to 2004 – no federal regulations, relevant case law
- 2004 Phase 2 Regulations
- 2007 Second Circuit Court Determination finds fault with 2004 Regulations
- EPA Repeals Regulations in 2007

Timeline of Regulatory Requirements (continued)

- In absence of regulations EPA directs states to implement best technology available in accordance with "best professional judgment"
- 2009 Supreme Court determination upholds use of cost benefit determination for use in preparing federal regulations

316(b) Rule and Phases

- Phase 1 (2001) new facilities
- Phase 2 (2004) large existing electric generating plants
- Phase 3 (2006) new offshore oil and gas extraction facilities with a design intake flow of > 2 million gallons per day (MGD) and that withdraw at least 25 percent of the water for cooling purposes

316(b) Statute

- Technology Driven
- 2004 rule (now suspended) does not require population data for area surrounding discharge
- Plant-related data is required regarding reductions in impingement and entrainment
- Frustrating to biologists – reduction in numbers of organisms impinged and entrained looks like an improvement in technology or operations but it could just be due to a decline in the surrounding population densities

NJPDES Permit

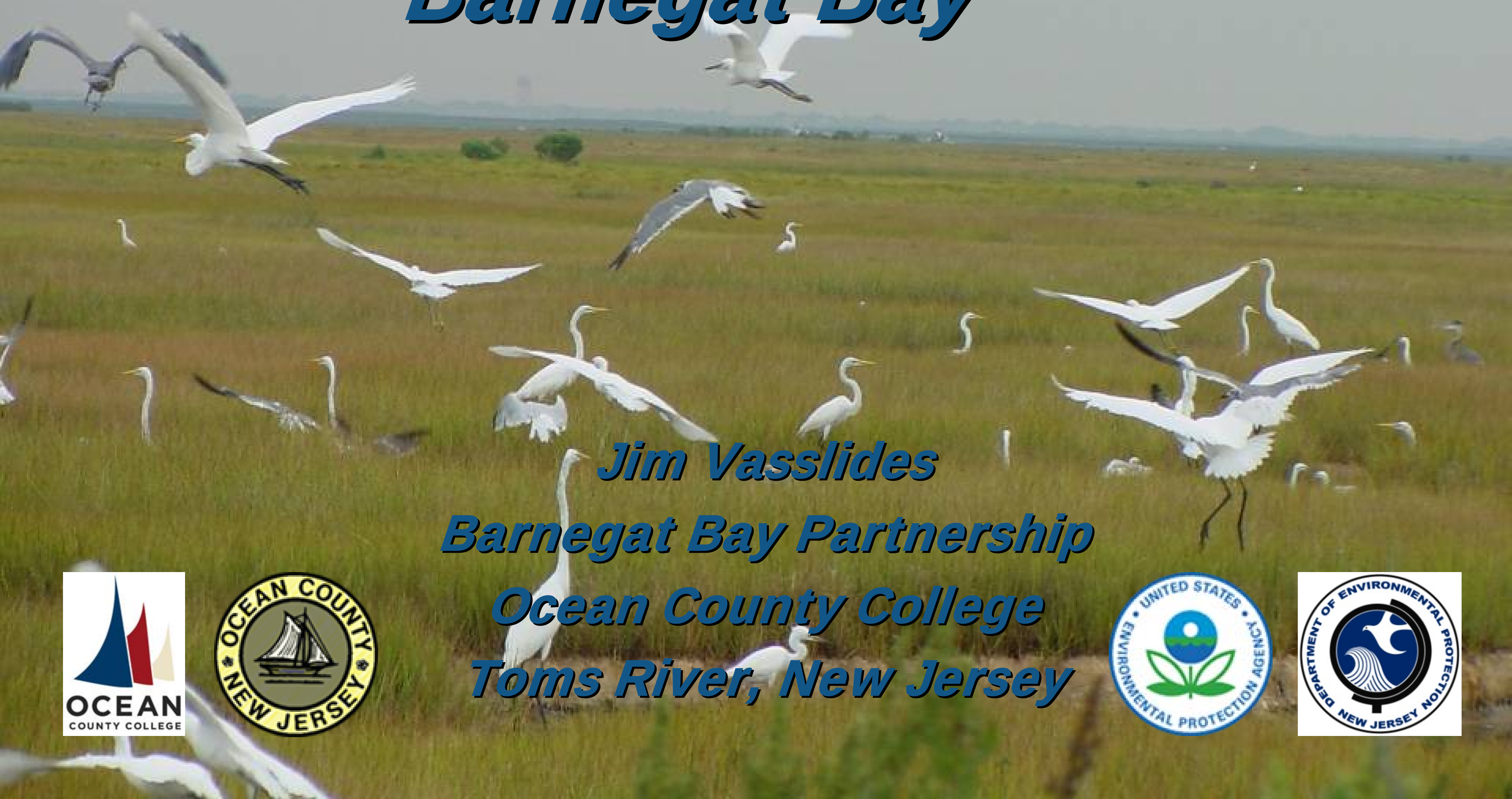
- Existing permit continues
- Draft permit was issued in January 2010 requiring cooling towers
- Extensive public hearings and public comments
- While the public comment period closed on March 15, 2010, the draft NJPDES permit is still available at www.state.nj.us/dep under “Featured Topics”.

Justification for Closed-Cycle Cooling

- Closed-cycle cooling constitutes best technology available for the Oyster Creek Generating Station in accordance with best professional judgment.
- Significant impingement and entrainment losses are documented in both historic and current data. Closed-cycle cooling will reduce water intake usage significantly thereby decreasing impingement and entrainment effects.
- Closed-cycle cooling is one of the few technologies available to target entrainment effects.

Thank you for your attention.

National Estuary Program Activities in the Barnegat Bay



Jim Vasslides

Barnegat Bay Partnership

Ocean County College

Toms River, New Jersey

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The Barnegat Bay NEP

- **1987: Barnegat Bay Study Act (Chapter 387)**

  "…require a study of the nature and impacts that extensive development was causing on the bay…"

- **1995: USEPA approves State's nomination to establish the BBNEP**

- **2002: BBNEP Management plan (CCMP)**

  Action plans: Water Quality and Water Supply; Habitat and Living Resources; Human Activities and Competing Uses; Public Participation and Education

- **2008: BBNEP 2008-2011 Strategic Plan**

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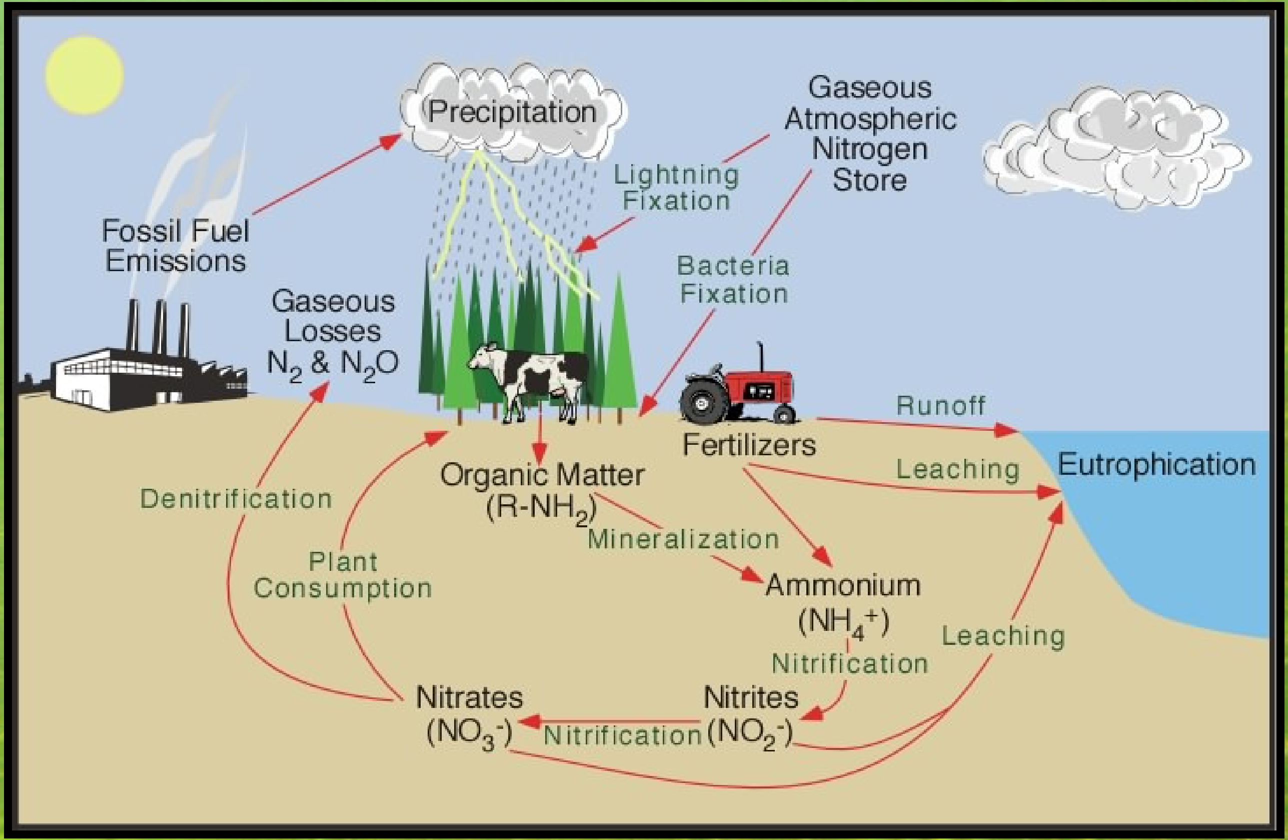
2008-11 Strategic Plan

Environmental Priorities

- **Reduce eutrophication & improve water quality.**
- **Address water supply & flow issues.**
- **Prevent habitat loss & support habitat restoration.**
- **Address fisheries declines.**

Reduce eutrophication



Eutrophication: an enhanced rate of biological production (usually due to excessive nutrient inputs, nitrogen and phosphorus).

Photo courtesy of Rutgers University

Reduce eutrophication & improve water quality

BBNEP/BBP-funded water quality projects…

USGS (7): water quality and nutrient assessment

stream and well data, N-loading estimates

Rutgers (3): water quality monitoring and/or

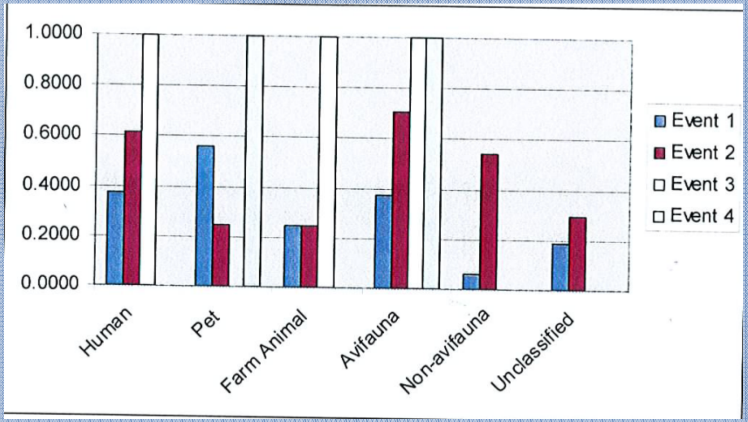
stormwater projects

MU-UCI/others (2): bacterial-source tracking

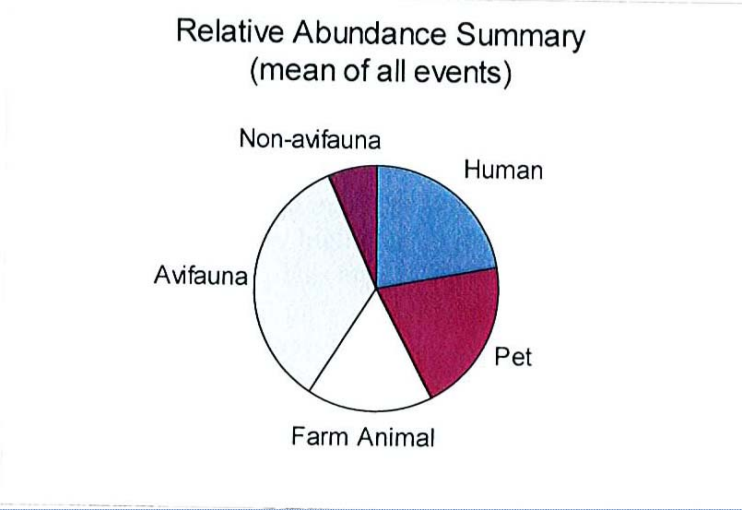
Improve water quality

Silver Bay BST Study

Study estimated nutrient loadings from a landscape model and assessed antibiotic resistance in coliform bacteria to identify pollutant sources at 10 sites



Undeveloped sites (*e.g.*, near Cattus Island) had low nutrient inputs; 6 sites exhibited "development" signatures (*i.e.*, high human and/or pet bacterial types.



Additional work necessary to explicitly identify sources (*e.g.*, failed septic system or damaged sewer line, *etc*.) and needed management actions; **<u>Regional WQMP</u>**

Tiedemann *et al*., 2007; BEI and MU-UCI, 2007.

Improve water quality

Long Swamp Creek Study

Delineated 4 major sub-watersheds based on existing land use patterns, stormwater problems, and physical characteristics.

Detailed a list of priority action items for future restoration work, many of which have been subsequently undertaken, including:

- Riparian and wetland revegetation on the OCVTS campus in the headwater area;
- BMP operation and maintenance at the Bay Lea Golf Course to restore vegetated buffers and reduce goose herbivory

Improve water quality

An analysis of pollution reduction capability of existing BMPs located in the TR sub-watershed of BB (American Littoral Society)

Evaluate the nutrient reduction and recharge performance capabilities of exiting stormwater basins and identify inadequately functioning basins that could potentially be upgraded and retrofitted to improve their nutrient removal capabilities

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Water Supply/Flow

Metedeconk River Watershed Protection & Restoration Plan

Over-riding goal: *"to preserve the Metedeconk River as a viable water supply source for the region, protect the health of the Barnegat Bay Estuary, eliminate water quality impairments and attain compliance with the surface water quality standards throughout the watershed"*

Task 2: Visual Assessment Project Plan (VAPP)

Visual inspection of the stream (82 sites)

Identify potential problem areas and possible mitigation areas

Task 3: Technical Analysis

Build upon existing data and recent reports

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Habitat Alteration Effects

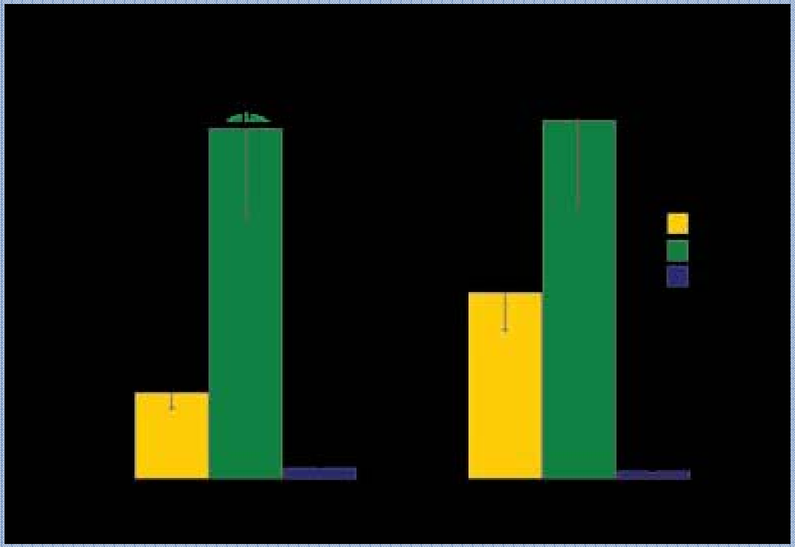
The impact of artificial shorelines on species diversity, secondary production and habitat quality in Barnegat Bay

>36% of the natural shoreline in Barnegat Bay has been bulkheaded

Faunal communities along bulkheads

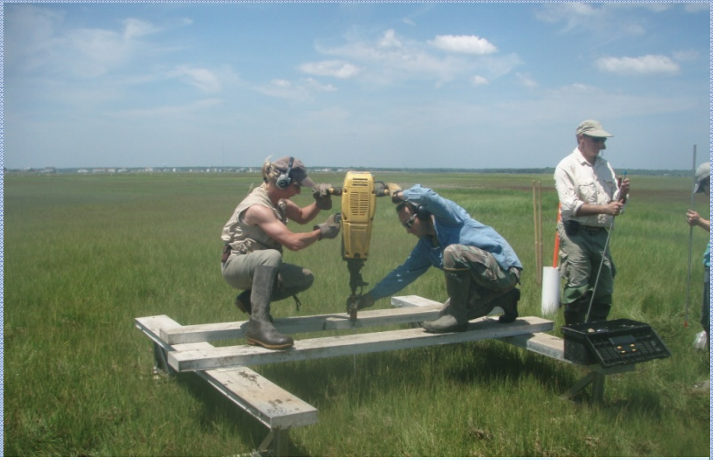
… differed from those of natural shorelines.

… are not as biologically rich as in natural shoreline habitats and may function differently; the “nursery role” of these areas appears altered.



Habitat Alteration Effects

Mid-Atlantic Coastal Wetland Assessment Program (MACWAP)



- Utilize USEPA three-tier wetlands monitoring guidance
- Establish a network of fixed monitoring stations (SET and WQ) over a range of marsh types, conditions and stressors.
- Conduct intensive geomorphology, biota and WQ (Tier 3) monitoring
- Test Rapid Assessment Methodologies (RAM)

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Fisheries Declines

Assessing Population Structure, Reproductive Potential and Fishing Efforts for Blue Crab in Barnegat Bay (Dr. Paul Jivoff, Rider; 2008-2010)

Assessing Population Structure, Reproductive Potential and Movement of adult Blue Crab in BB (Dr. Paul Jivoff, Rider; 2009-2011)

Fecundity of BB Blue Crab: the influence of size, seasons and relative fishing efforts (Dr. Paul Jivoff, Rider; 2010-2012)

Fisheries Declines

Assessment of Sea Nettle Polyps in BB (Dr. Paul Bologna, Montclair; 2010-2011)

Status and Trends of Shellfish Populations in BB (Dr. Monica Bricelj, Rutgers; 2010-2011)

American Eel Passage on Existing Dams (Dr. Ken Able, Rutgers; 2011-2012)

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What's next?

Comprehensive Water Quality Monitoring

Bay-wide continuous water quality monitoring

Targeted Watershed Studies

Nutrient sources and distribution, nutrient load models, estuary circulation model

Water Supply / Flow

Tertiary treatment assessment

Biotic Monitoring and Assessment

Fish, crabs, jellyfish, shellfish, benthic invertebrates, SAV

Land Use Assessment and Restoration

Soil health assessment and restoration, shoreline stabilization

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USGS
science for a changing world

OCEAN
COUNTY COLLEGE

American Littoral Society
Coastal Conservation

Ocean County
Soil Conservation District
New Jersey Natural Resources Conservation Program

NRCS Natural Resources Conservation Service

Ocean County Mayors' Association

New Jersey Marine Sciences Consortium
Sea Grant New Jersey

Urban Coast Institute
MONMOUTH UNIVERSITY
where leaders look forward℠

Jacques Cousteau
National Estuarine Research Reserve

United States Environmental Protection Agency

Marine Trades Association of New Jersey
1972

Ocean County New Jersey

Ocean County New Jersey
Ocean County Health Department

US Army Corps of Engineers®

ShoreBuilders
Association of Central New Jersey, Inc.

The Ocean County Utilities Authority
Clean Water
New Jersey

U.S. Fish & Wildlife Service
Department of the Interior

Jersey Coast Anglers Assn.
Conservation • Environment • Education

The Trust for Public Land

RUTGERS
Institute of Marine and Coastal Sciences

NOAA FISHERIES
NATIONAL MARINE FISHERIES SERVICE
NOAA

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Barnegat Bay Development

Urbanization: the major watershed stressor

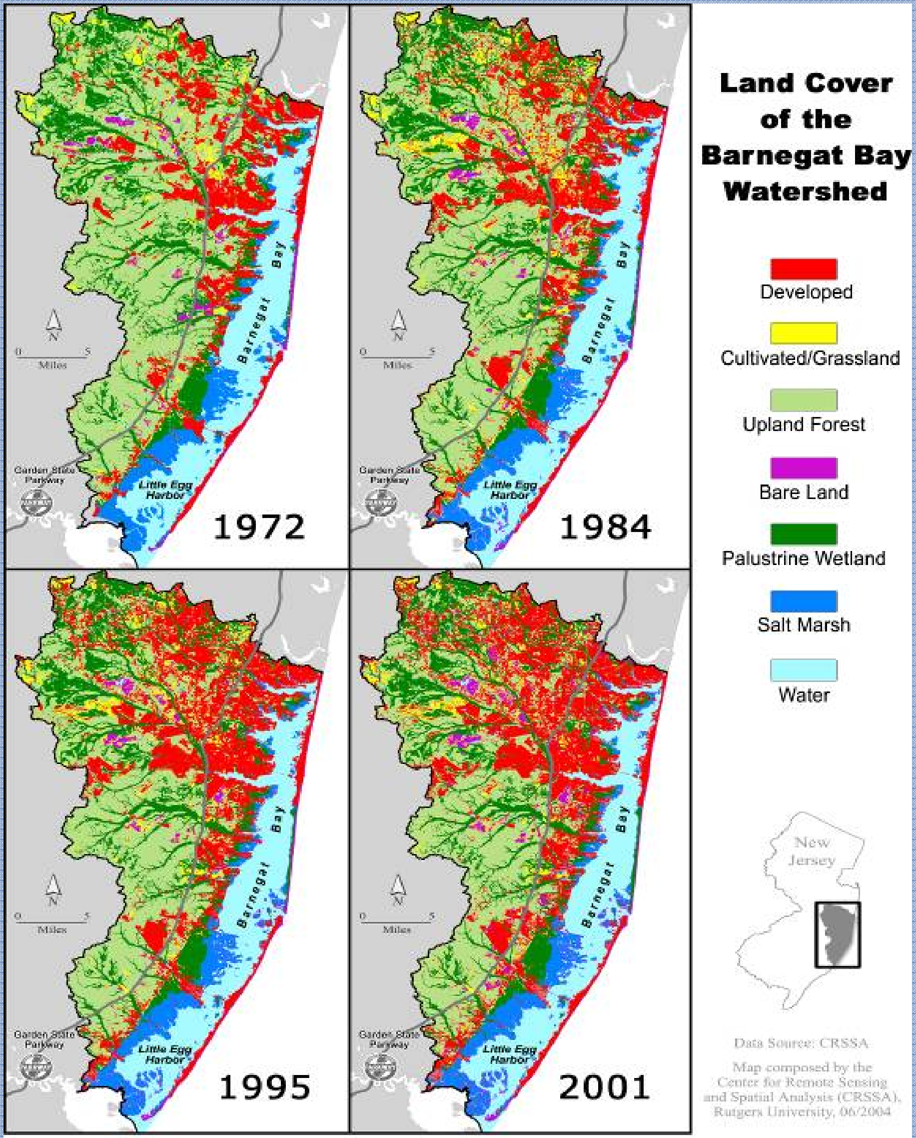
Current development is > 30%; a widely recognized tipping point for losing biodiversity, ecological functioning, and resources.

Urbanization

alters the patterns, quantities, and quality of surface and groundwater flows;

increases nutrients and contaminant loads; and

causes habitat loss, fragmentation, and alterations.



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The Bay & its Watershed

Physiography

Bay = 75 sq-miles

Bay mean depth = 5 ft

Watershed = 660 sq-miles

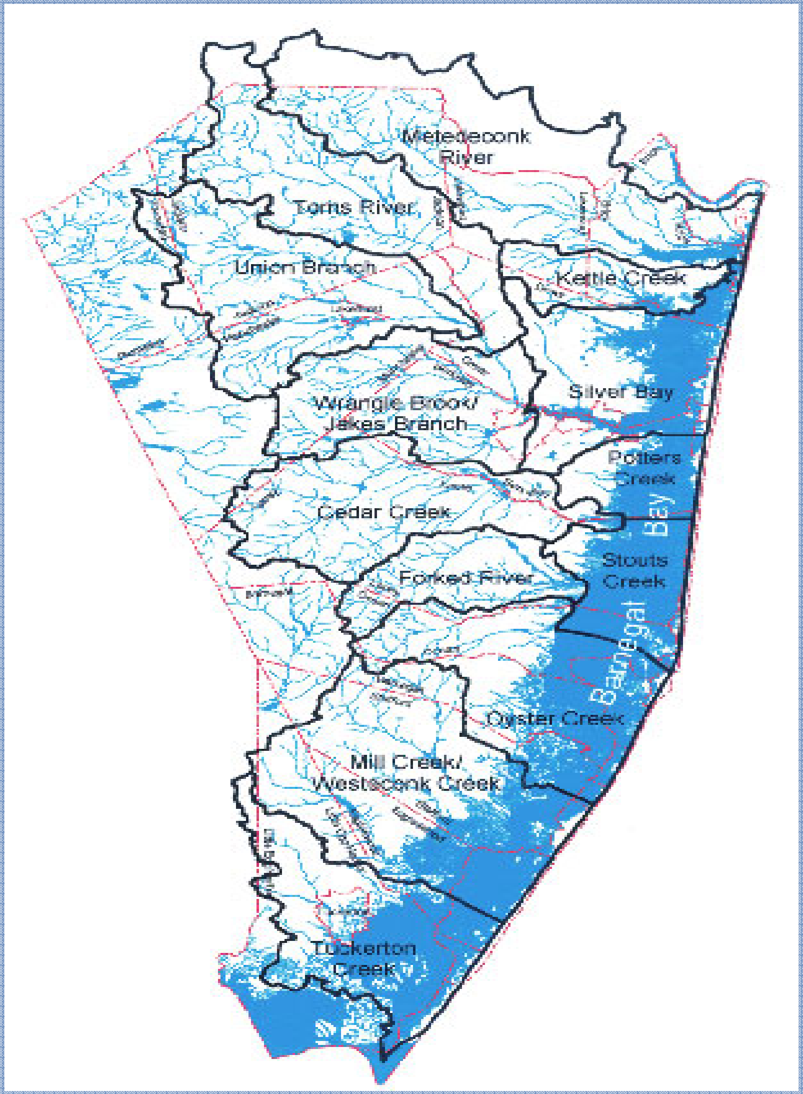
Hydrology

Lagoon: little fw surface flow,
< 3% of the tidal prism

Tidal prism variable, unequal

Tides: 3-5 ft; semidiurnal but variable (lunar, weather)

Long, poorly known turnover time (27-71 days); SLR effects



Guo et al., 1997; Chant, 2001; Kennish, 2001

Barnegat Bay National Estuary Program

Address water supplies/flows

<u>Better public recognition</u> of:

1) limited local water supplies,

2) the need to conserve and reuse water.

<u>Better understanding of the effects of altered flows</u>:

1) groundwater withdrawals,

2) offshore sewage effluent diversions,

3) dams/reservoirs, and

4) Oyster Creek NGS.