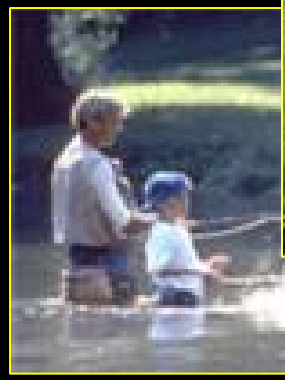
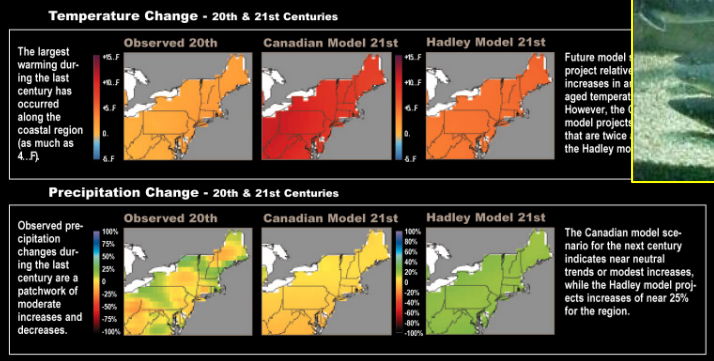
The Mid-Atlantic Coastal Wetland Assessment: Linking Tidal Wetland Status and Water Quality for New Jersey

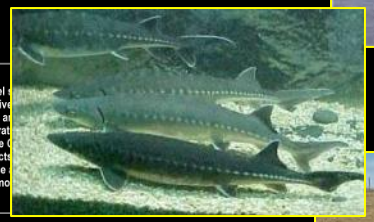
Danielle Kreeger
Partnership for the Delaware Estuary

Presented at: NJ Water Monitoring Council Meeting

May 19, 2010

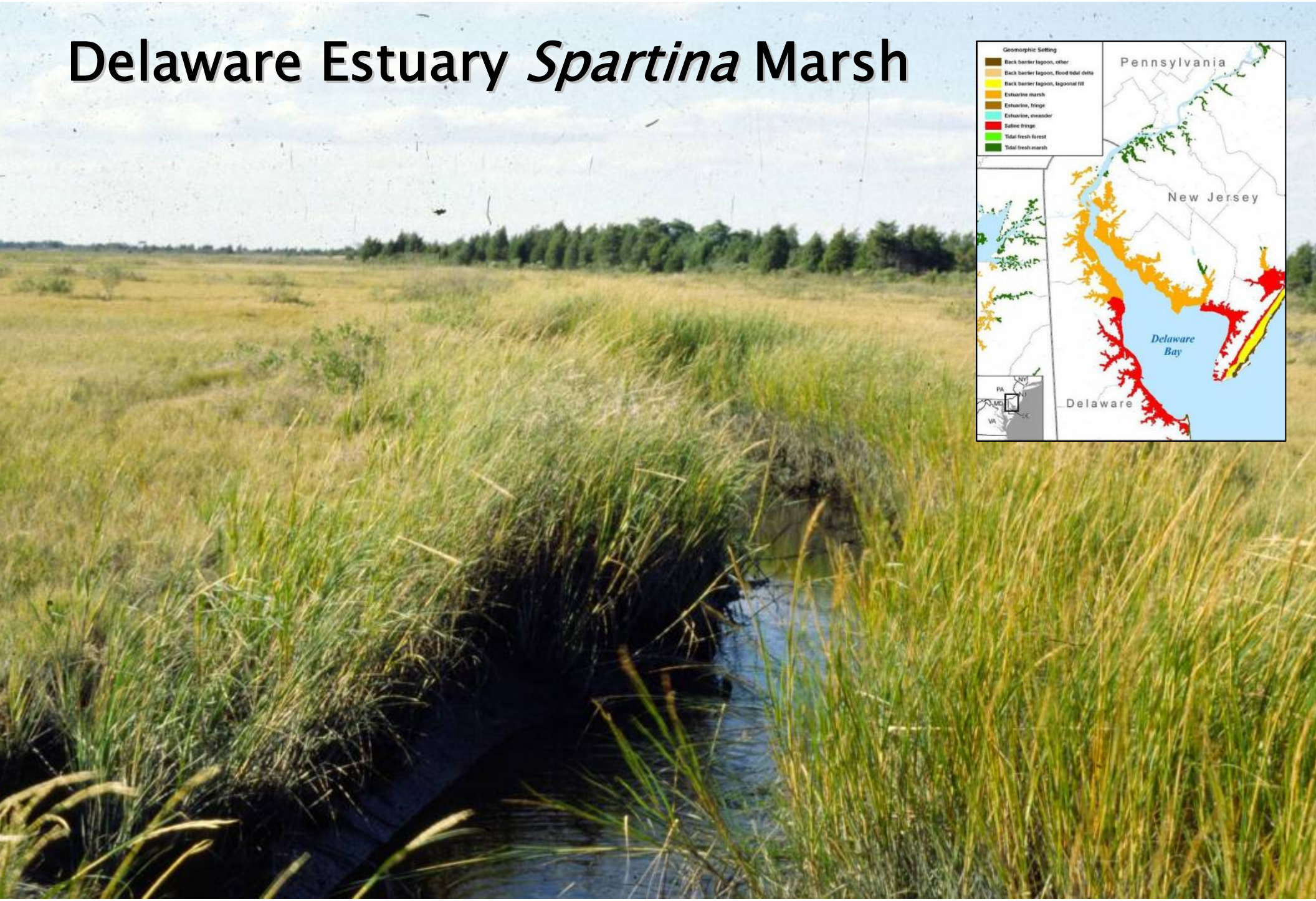




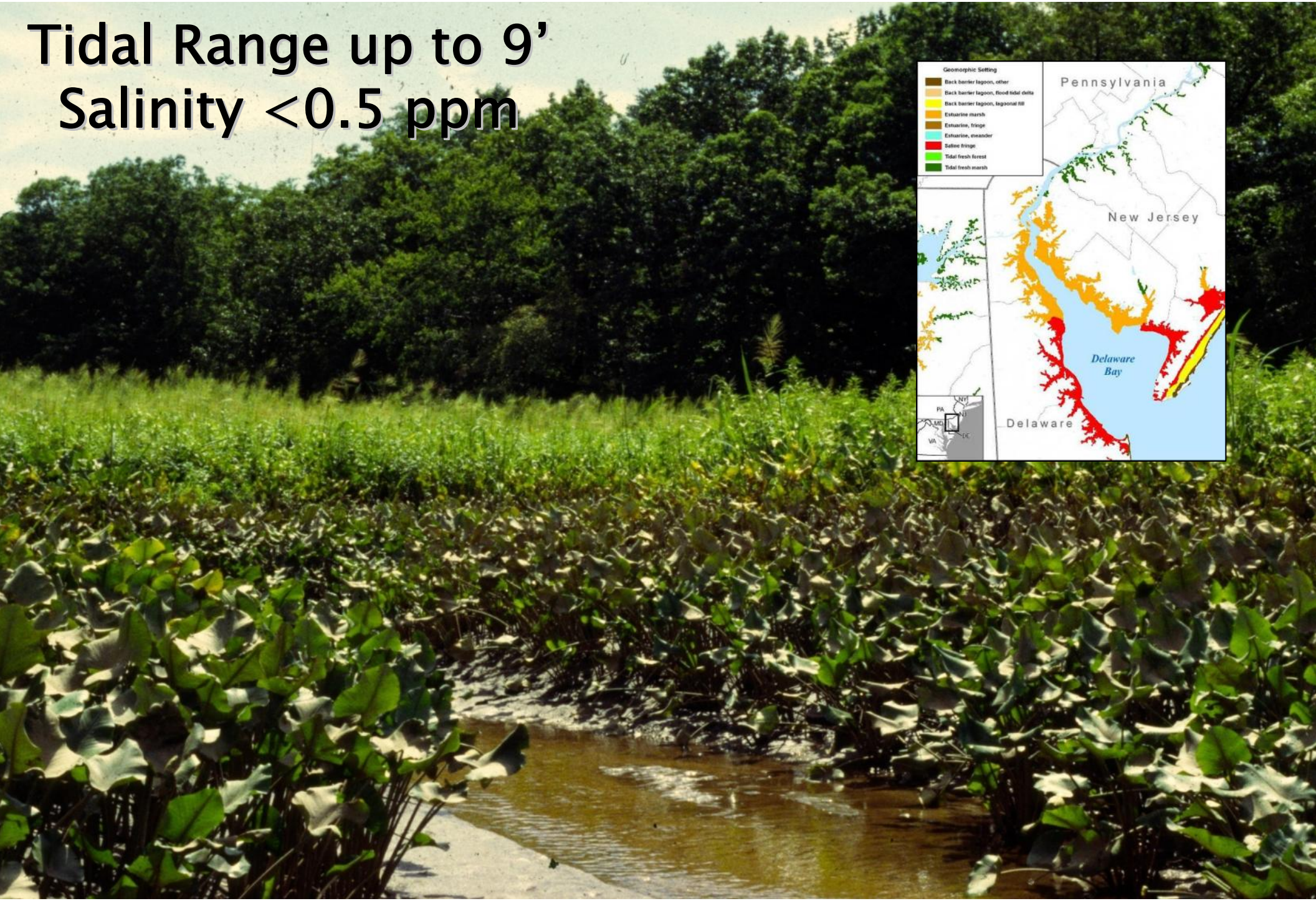


Importance of Tidal Wetlands

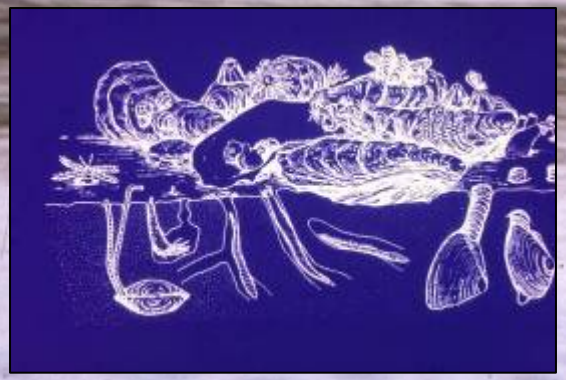
Delaware Estuary *Spartina* Marsh



Tidal Range up to 9’
Salinity <0.5 ppm



High Production



Nursery Habitat

Recreation

Tidal Wetlands

A Signature Trait of System

Near Contiguous Band

Diverse: *Freshwater Tidal Marshes*
Brackish Marshes
Salt Marshes

<u>Nature's Benefits</u>

- Flood Protection
- Fish and Wildlife
- Natural Areas
- Carbon Sequestration
- Water Quality

Wetland Benefits (Ecosystem Services)

Millenium Ecosystem Assessment 1º Service	2º Service	3º Service	4º Service
Provisioning	Food	Fisheries Support	
		Livelihoods ebrate production	
	Genetic Materials	Phragmites control research	
	Biochemical Products	Research in Antifungal Agents Health	
	Fiber and Fuel	Cellulose stock	
Regulating	Sequestration Health	Carbon	Carbon Caps, mitigation
	Sediment Stabilization	Erosion control	Meet TMDLs for sediment
	Storm Protection/ Wave Atten Lives Flood Protection	Protect Property Values and infrastructure	
	Gas Regulation	Carbon Sequestration	
		Oxygen production	
	Water Quality Health	Sequestration, Filtering	TMDLs: Nutrients, Pollutants
Cultural/ Spiritual Human Well Being	Recreation	Bird watching, hunting, boating	
	Spiritual and Inspirational	Native American Uses Health	
	Educational	University reasearch & scho projects/trips	
	Aesthetic Value	Landscape pictures, paintings, open space	
Supporting	Habitat	Wildlife, shellfish, insects	
	Biodiversity	Maintain Plant Communities	
	Production	Primary Production	
	Water Cycling/Hydrologic Regim Health		
	Nutrient Cycling/Biogeochemical Processes	Maintain trophic cycles, soil building	

e.g., Carbon Sequestration

Temperate wetlands accumulate 1.42 tons C ha^{-1} yr^{-1}

Wetlands represent the largest component of the terrestrial biological C pool

Average soil organic carbon density (Denmark)

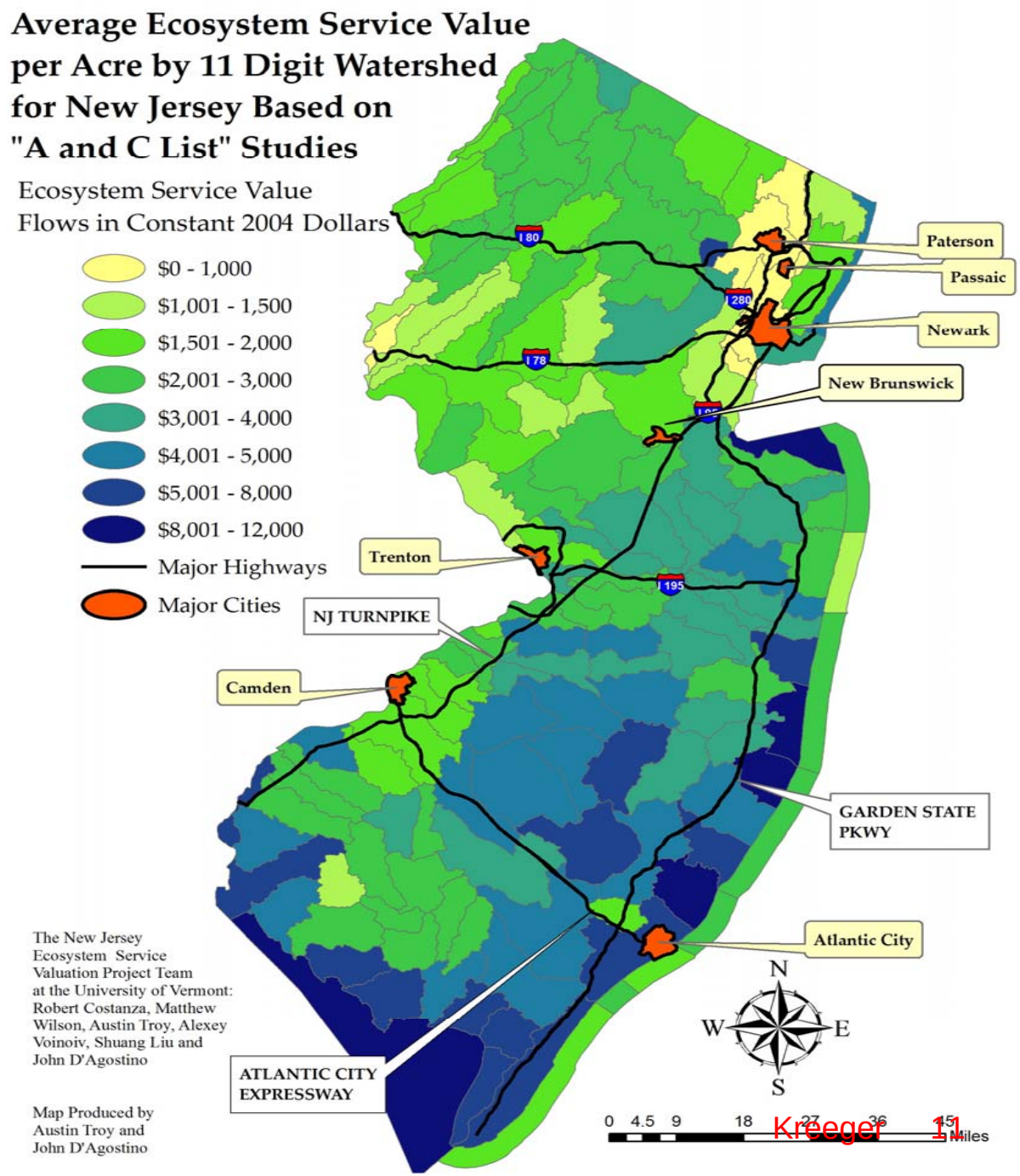
Wetlands: 35.6 kg m^{-2}
Forests: 16.9 kg m^{-2}
Agricultural areas: 14.0 kg m^{-2}

Conversion of agricultural lands to wetlands can enhance C sequestration

In contrast to other wetlands, tidal salt marshes release negligible amounts of greenhouse gases and store more carbon per unit area

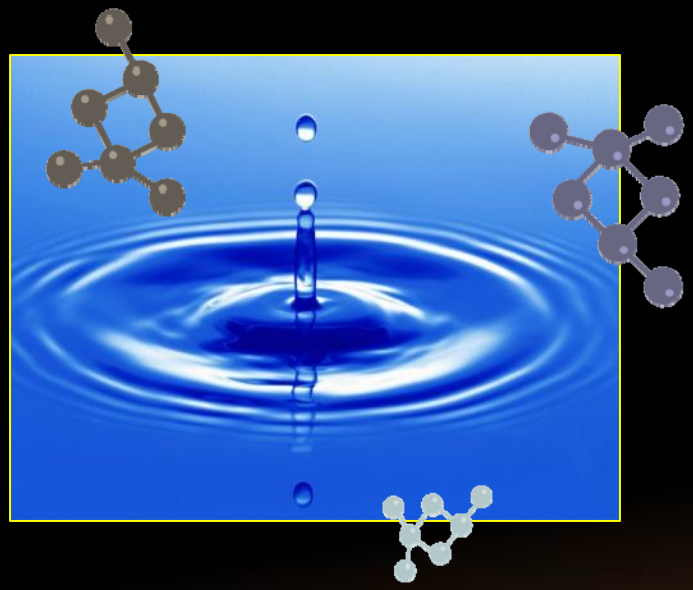
Valuation of New Jersey's Natural Capital and *Ecosystem Services*

New Jersey Department of Environmental Protection



Slide from Bill Mates, NJDEP

Water Quality - Wetland Interactions



- Alter Vegetation Types
- Impair Condition
- Affect Accretion
- Enhance Vulnerability

- Sinks for Sediments
- Sinks for Nutrients
- Detoxify Some Contaminants
- Sinks for Pathogens ?

Tidal Wetlands

A Signature Trait of the Delaware Estuary System

Ecological Values:

Structural

habitat for fish and wildlife
nurseries for imperiled taxa

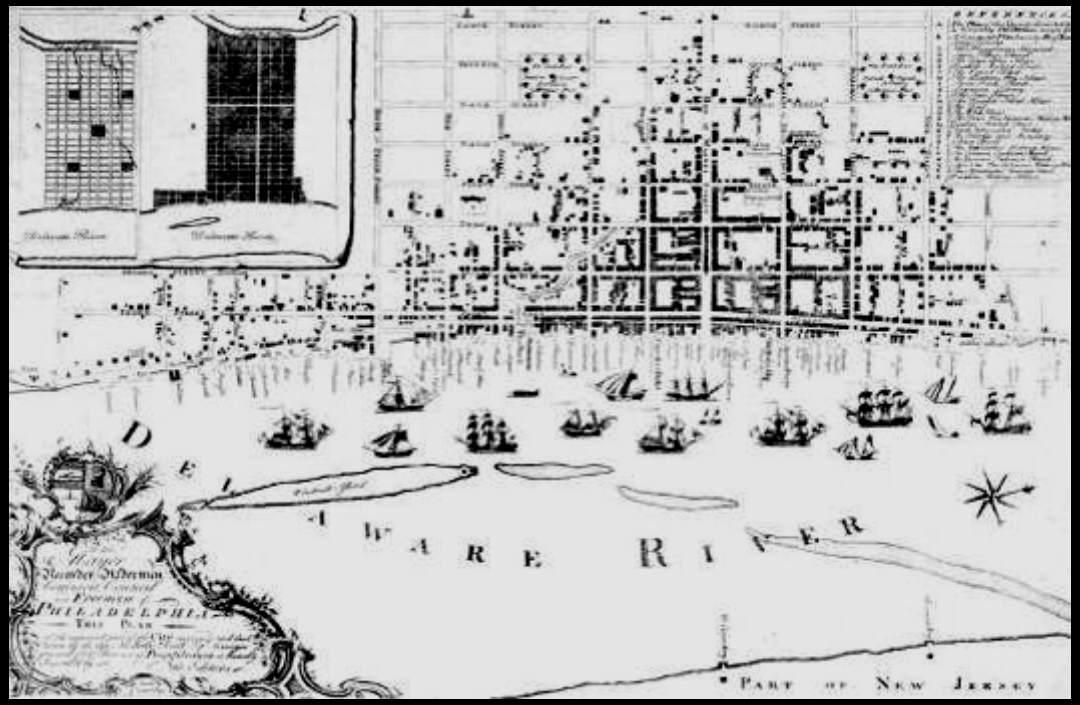
Functional

food web
water quality
flood protection

Concerns:

Degradation

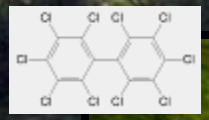
Rich History as a "Working River"



1762 map showing Philadelphia on the Delaware River

Slide adapted from Jonathan Sharp's

Degradation

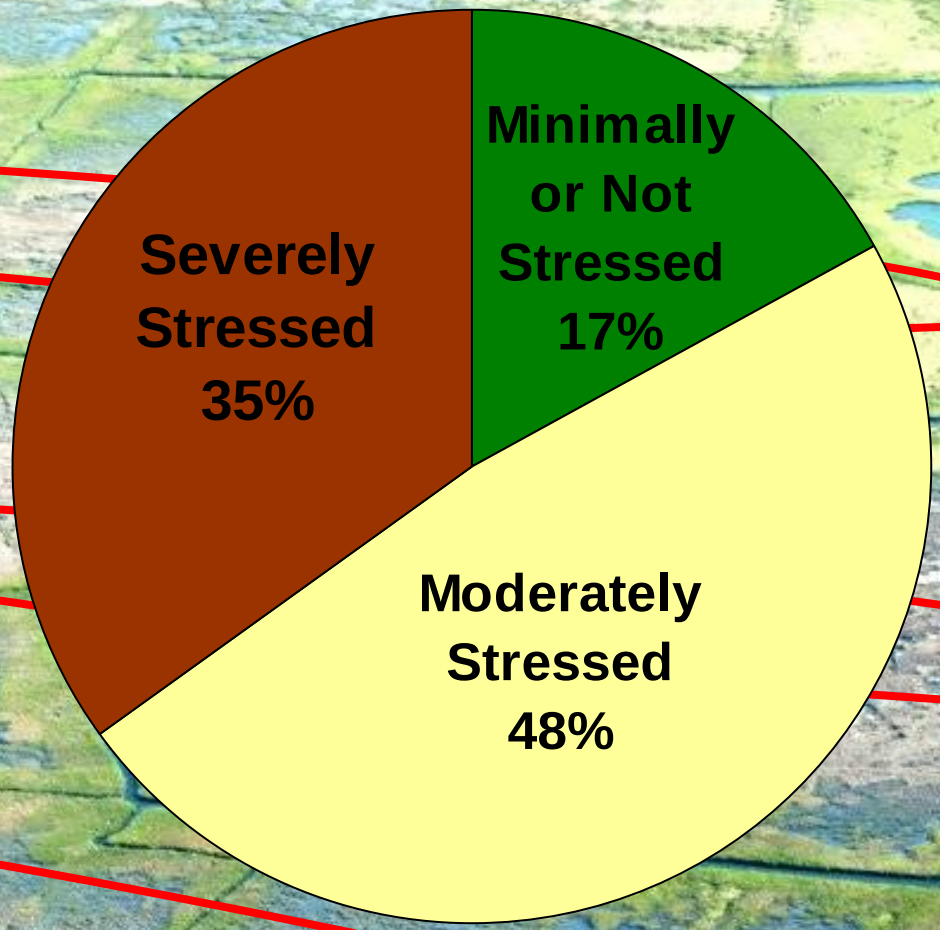


jamais d'eau

Summer, 2006

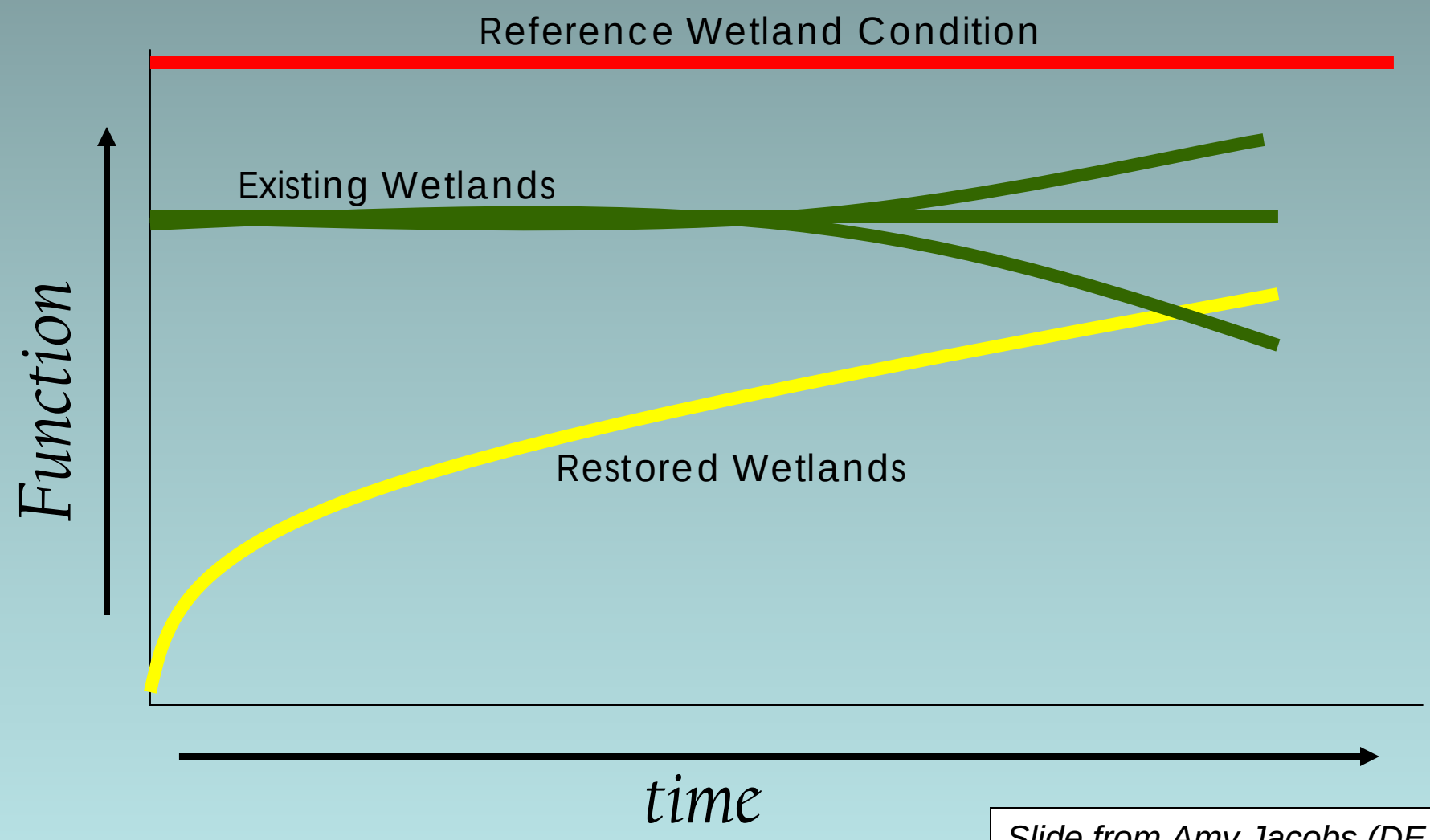
Angola Neck – Rehoboth Bay, DE

Sudden Wetland Dieback – Marsh Browning



Slide from Chris Bason and Amy Jacobs

Changes in Wetland Function
Natural versus Restored



Slide from Amy Jacobs (DE DNREC)

Tidal Wetlands

Ecological Values:

Structural
habitat
Functional
food web
water quality
flood protection

Concerns:
Degradation

Conversion & Loss

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Freshwater Tidal Wetland Acreage

Past and Present

Pre-Settlement *?*

1973 (Patrick et al.) *2310 ha*

1981 (NWI) *9347 ha (all classes)*
597 ha (emergent)

1988 (Tiner & Wilen) ***1000 ha***

New data soon (NWI, States, LU/LC)

Estimated < 5% remains

Tidal Wetlands

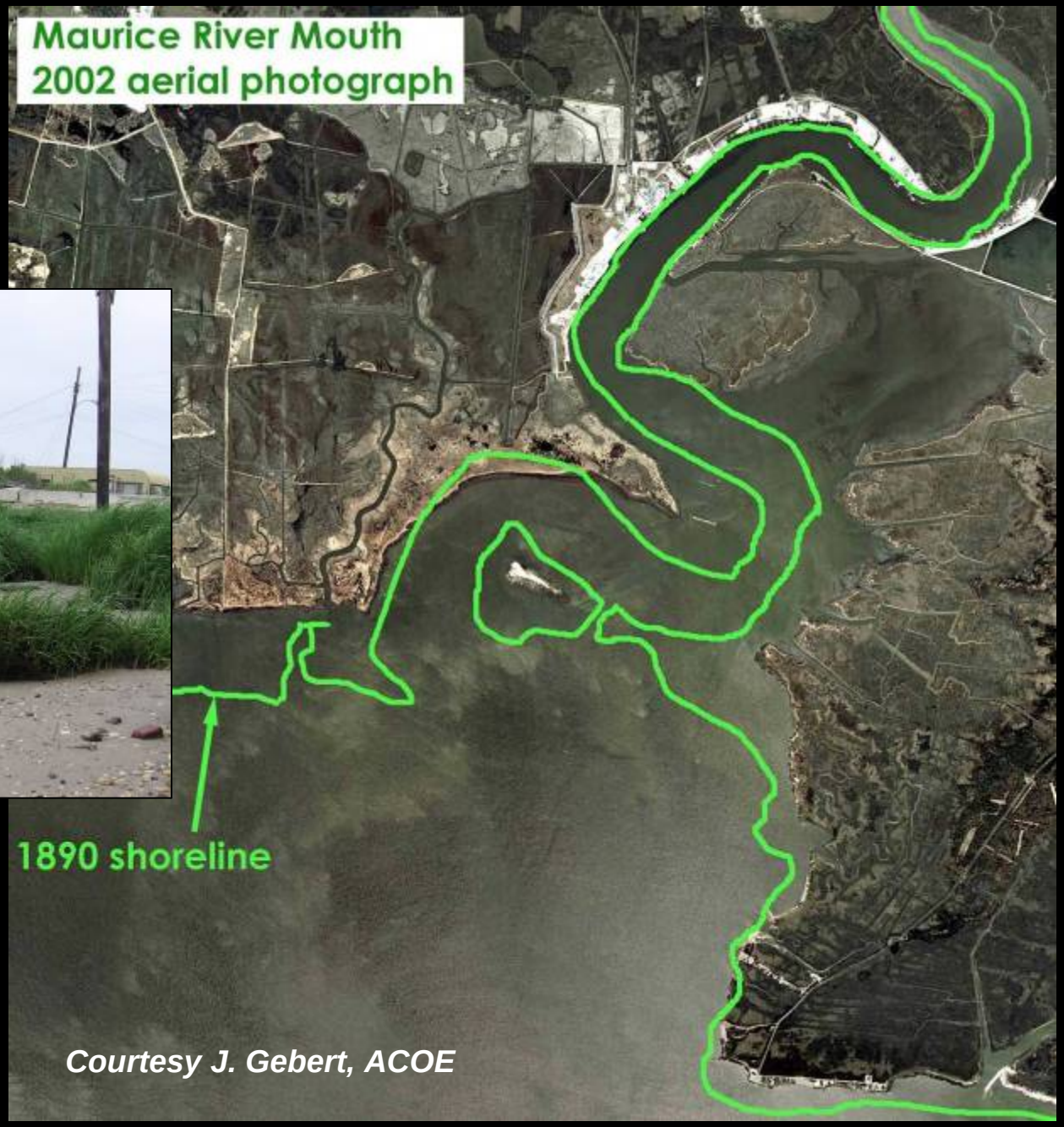
Ecological Values:

Structural
habitat
Functional
food web
water quality
flood protection

Concerns:
Degradation
Conversion & Loss
Sea level rise
Salinity rise

Shoreline Erosion

Courtesy D. Bushek, Rutgers



Courtesy J. Gebert, ACOE

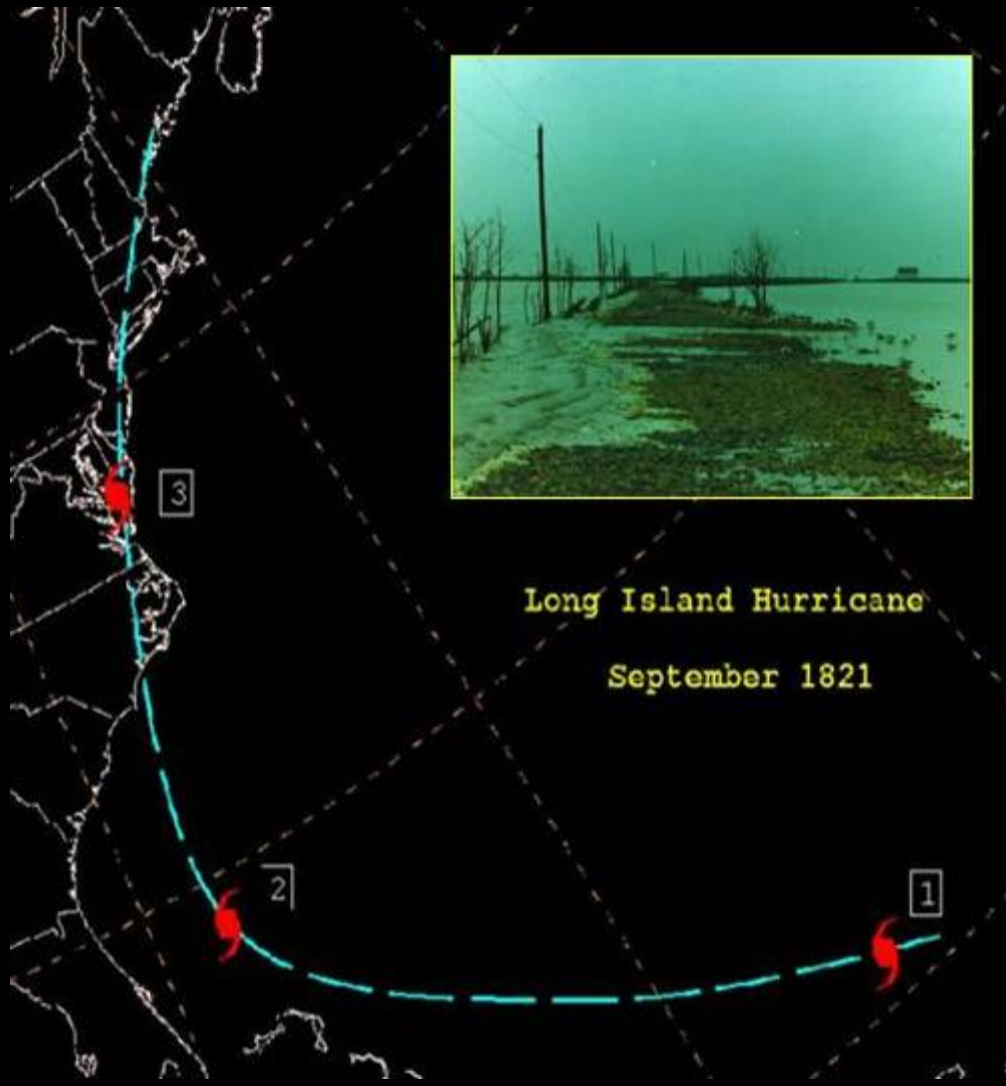
Tidal Wetlands

Ecological Values:

Structural
habitat
Functional
food web
water quality
flood protection

Concerns:
Degradation
Conversion & Loss
Sea Level Rise

Storms



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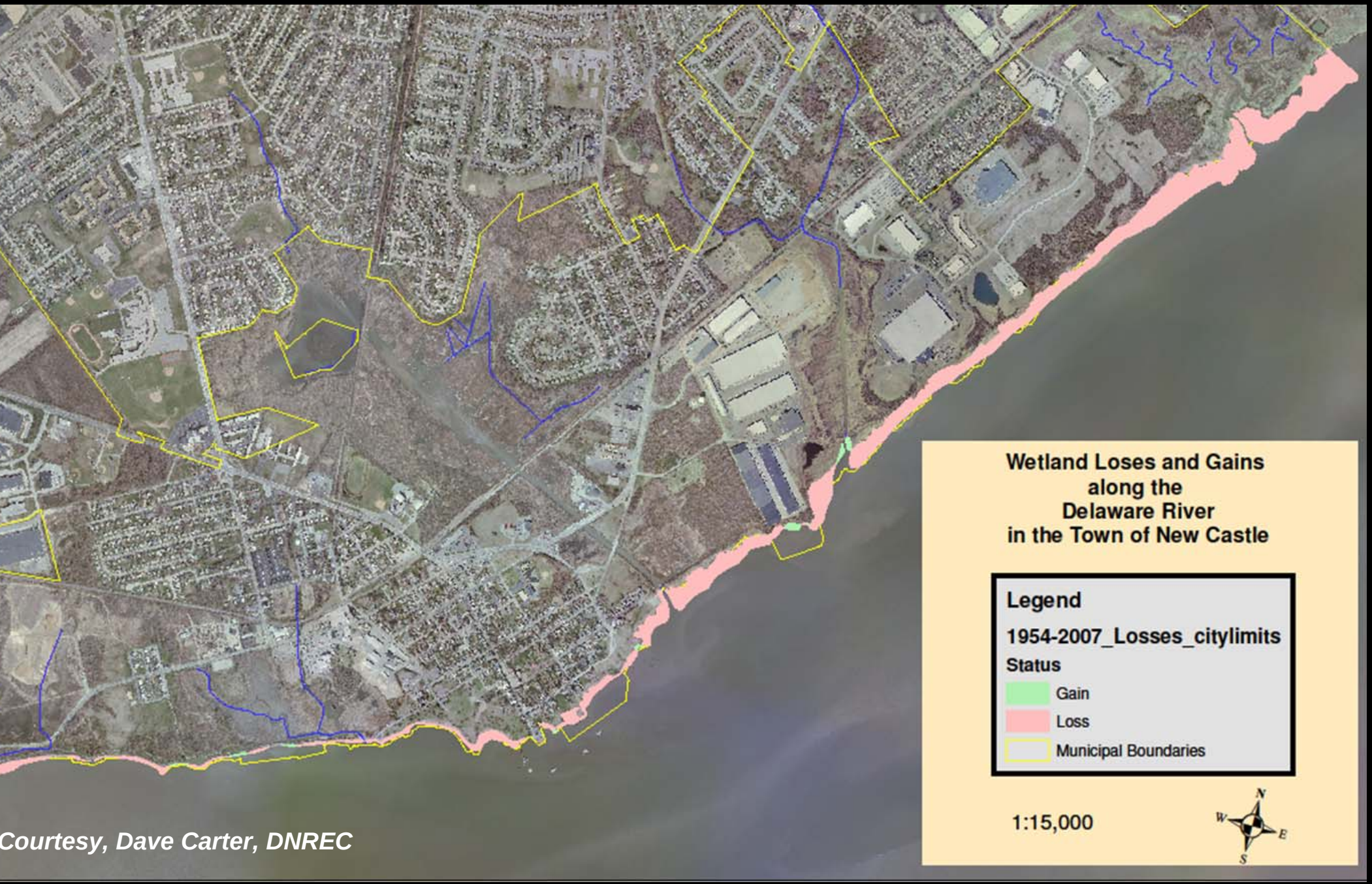

Courtesy, Dave Carter, DNREC

Tidal Wetlands

Ecological Values:

- Structural
  - *habitat*
- Functional
  - *food web*
  - *water quality*
  - *flood protection*

Concerns:

- Degradation
- Conversion and Loss
- Sea Level Rise
- Storms

** Sediment budget

Tidal Wetlands

Concerns:

- Degradation
- Conversion and Loss
- Sea Level Rise
- Storms

Sediment budget

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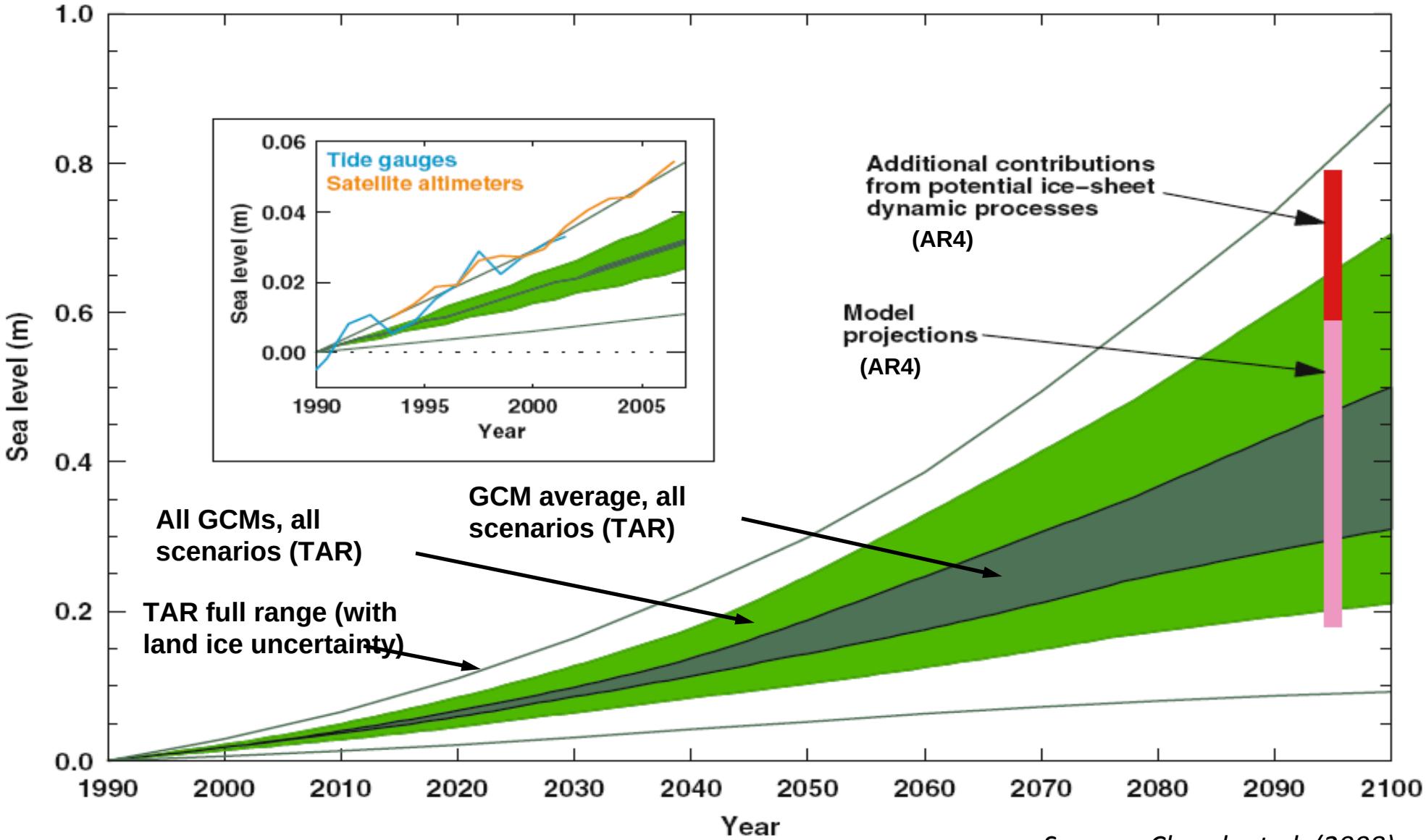
Living Shorelines 2008

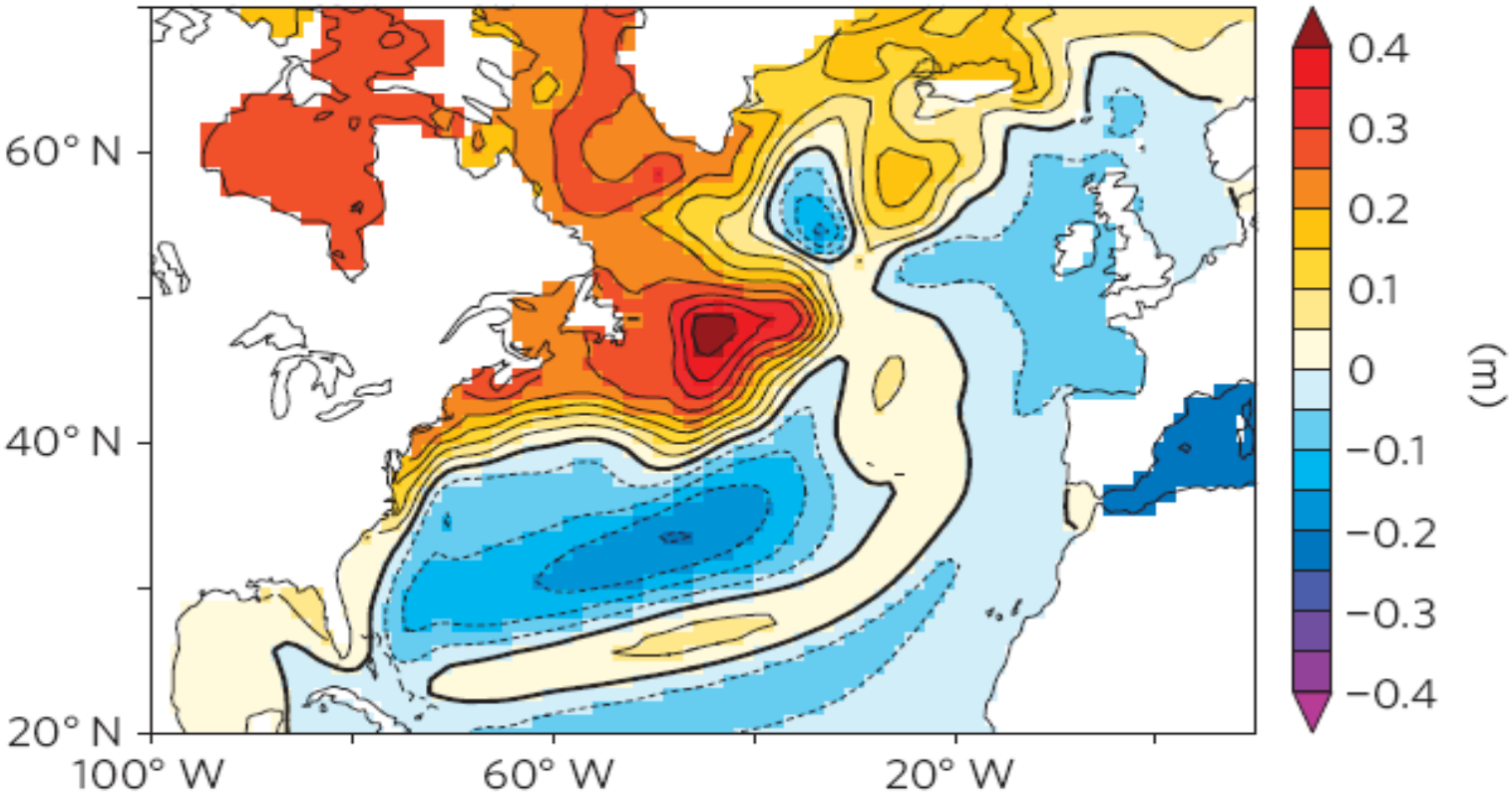
Global changes—future



Source: Church et al. (2008)
Slide: Ray Najjar, PSU (2009)

Future regionality due to changing ocean currents

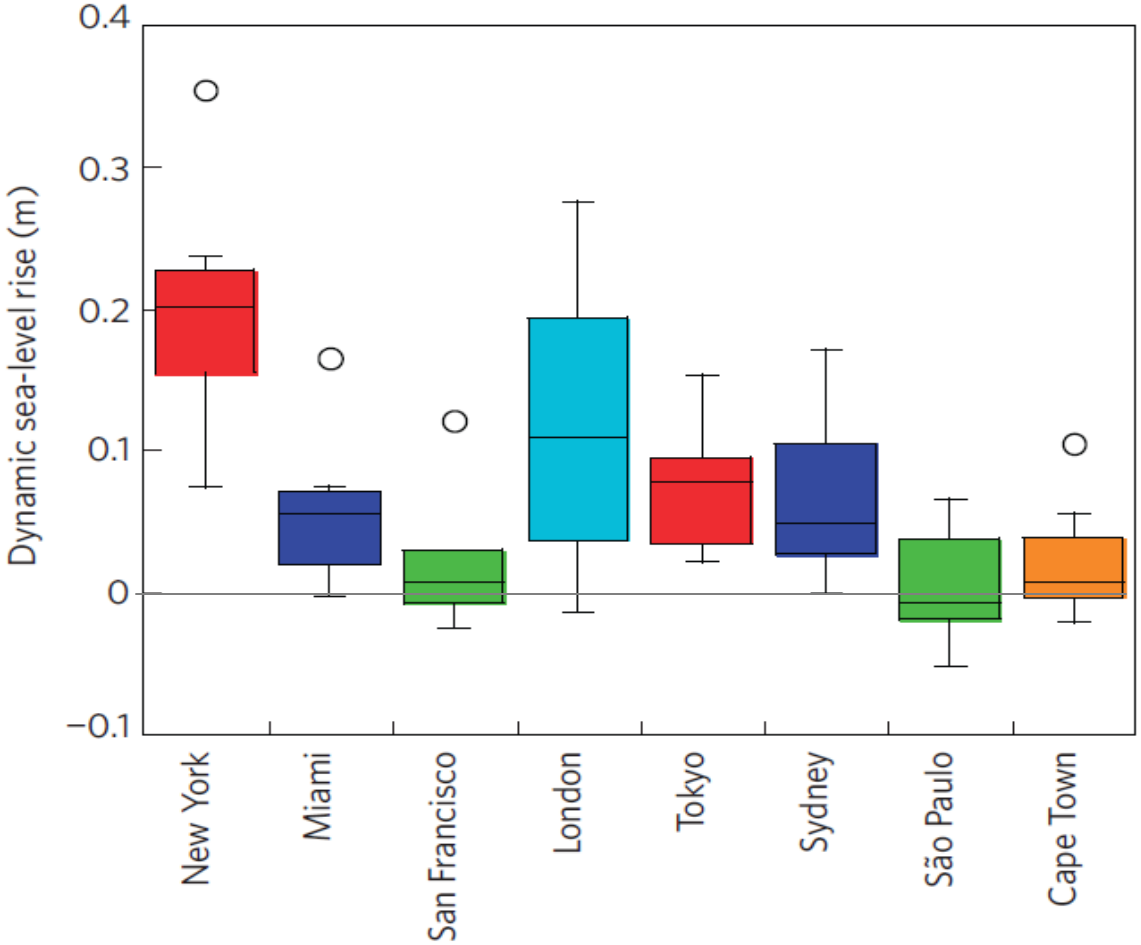
Projected 21st century change in dynamic sea level from the GFDL CM2.1 model (A2 scenario)



Source: Yin et al. (2009)

Slide: Ray Najjar, PSU (2009)

Future regionality due to changing ocean currents



Dynamic sea level changes over 21st Century from 10 AR4 models under the A1B scenario.

+ Subsidence

Source: Yin et al. (2009)

Slide: Ray Najjar, PSU (2009)

Climate & Other Changes Together

DK 31

- Marcellus Shale
- Dredg
- Withdrawals
- Wind Farms
- Land Use Change
- Development
- Emerging Pollutants

- Ecological Flows
- NRDA

Added Complexity

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11/27/2004

White Paper Top Ten

1. **Contaminants** (forms, sources, fates & effects for different classes)
2. **Tidal Wetlands (status, trends and relative importance of different types)**
3. **Ecologically Significant Species & Critical Habitats** (benthos, horseshoe crabs)
4. **Ecological Flows** (effects of flow changes on salt balance & biota)
5. **Physical-Chemical-Biological Linkages** (e.g., sediment budgets, toxics & biota)
6. **Food Web Dynamics** (key trophic connections among functional dominant biota)
7. **Nutrients** (forms, concentrations and balance of macro- and micronutrients)
8. **Ecosystem Functions** (assessment and economic valuation of ecosystem services)
9. **Habitat Restoration and Enhancement** (science & policy)
10. **Invasive Species** (monitoring, management & control)

So What Are We Doing?

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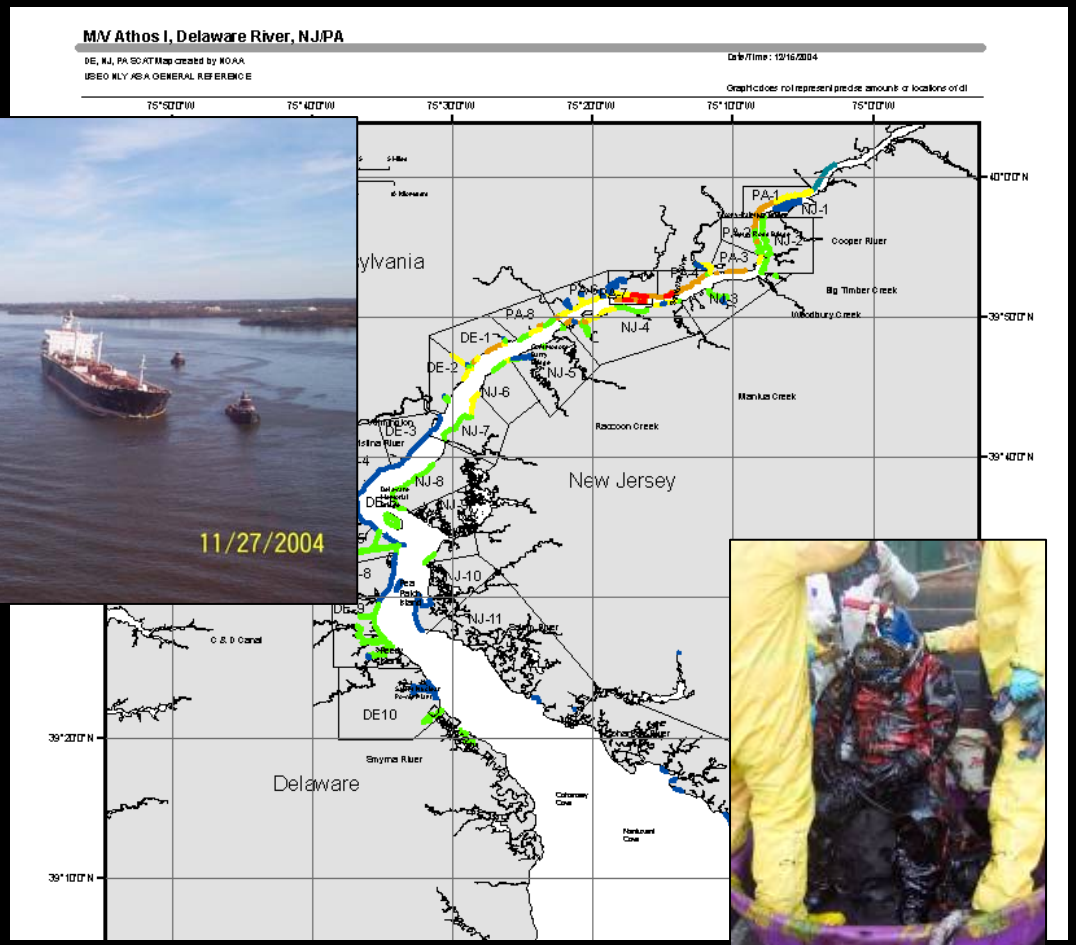
Priority

What Can We Do?

1. Build Resiliency

Protect and Conserve (CCMP)

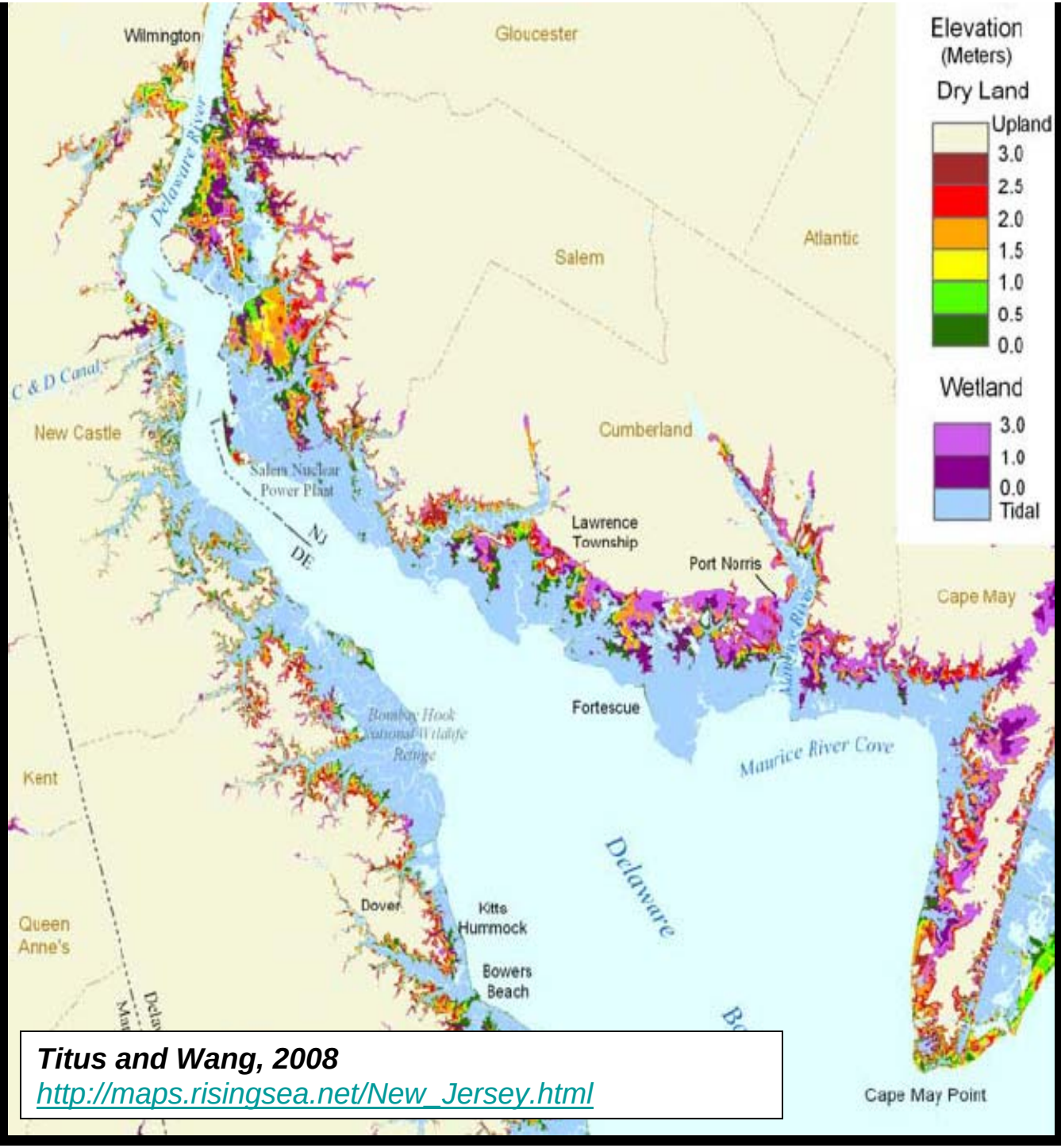


Tidal marshes need to move:

1) <u>horizontally</u>
(landward)

and/or

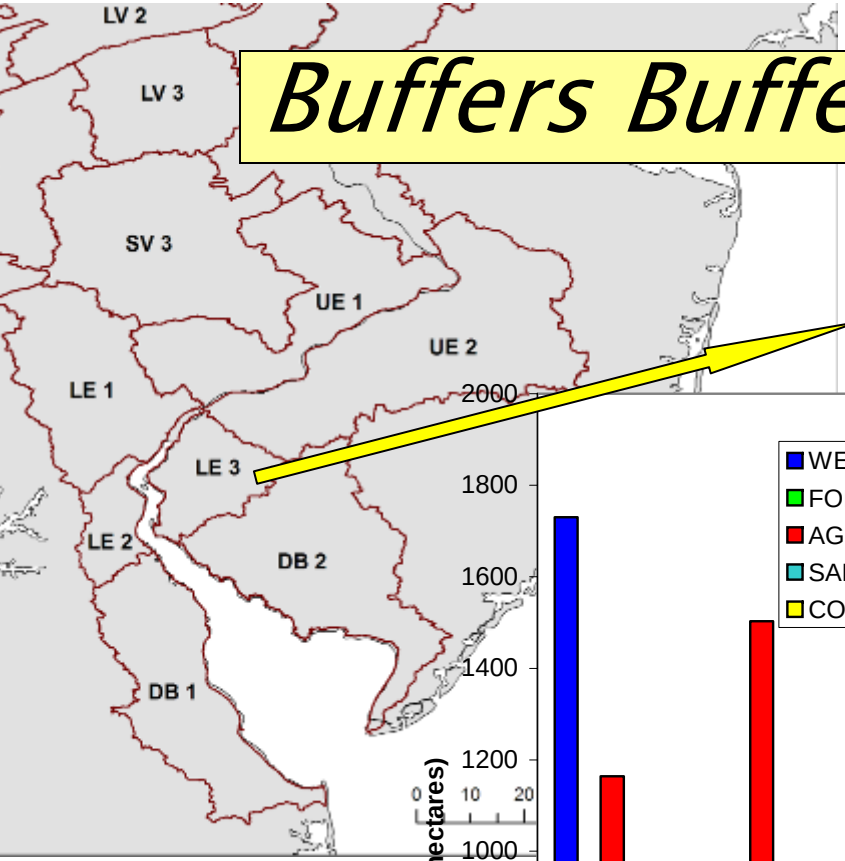
2) <u>vertically</u>
(to keep pace)

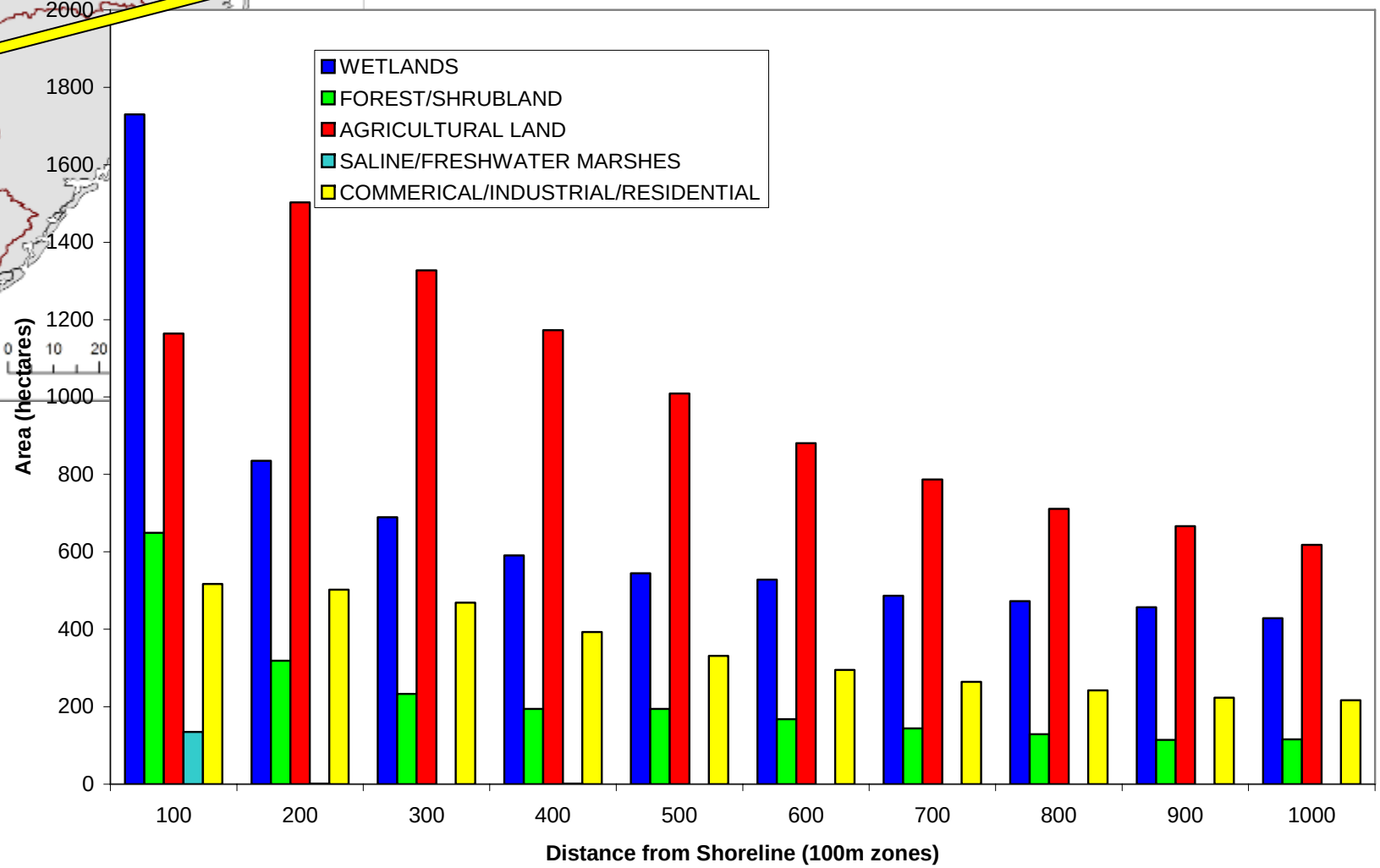


Titus and Wang, 2008
http://maps.risingsea.net/New_Jersey.html

Buffers Buffers Buffers = Resiliency

Land Use in Tidal Marsh Buffer Zone in the Lower Estuary of NJ (LE3)





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What Can We Do?

2. Maintain, Enhance, Restore…

…But Smartly

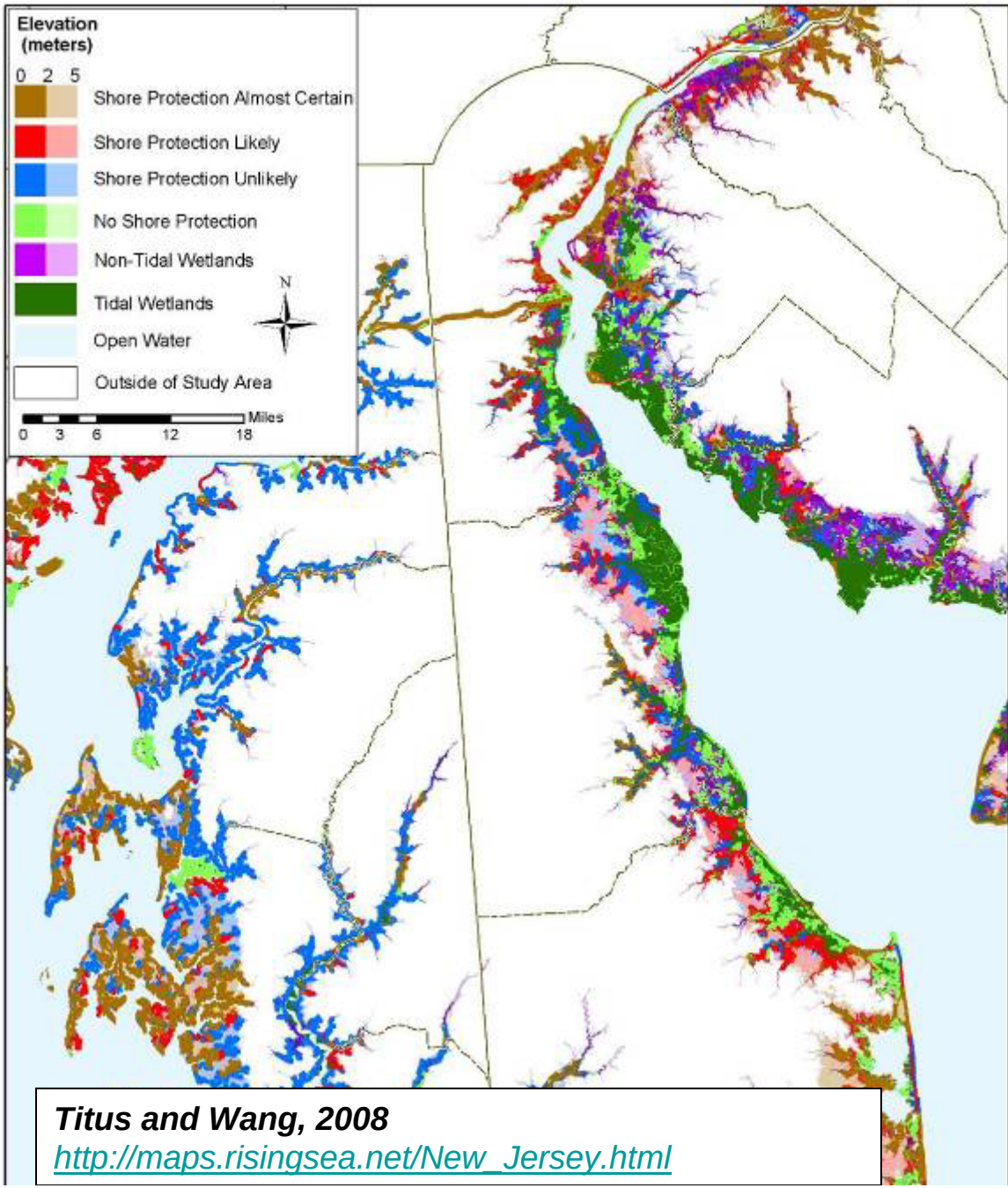
Regional Restoration Planning

US Climate Change Science Program
Draft Prospectus Section 4.1

Coastal Elevations and Sensitivity to Sea Level Rise

http://www.climatescience.gov/

DELAWARE SEA LEVEL RISE PLANNING MAP



Titus and Wang, 2008
http://maps.risingsea.net/New_Jersey.html

Restoration for the Future

Restore, conserve or otherwise enhance ecosystem structure and function, targeting areas that can sustain maximum natural capital value

Case Studies

CLIMATE READY ESTUARIES EPA

Delaware Estuary Pilot

Vulnerability and Options

↓

Future Status

↓

Rankings

↓

Recommendations

Tidal Marshes

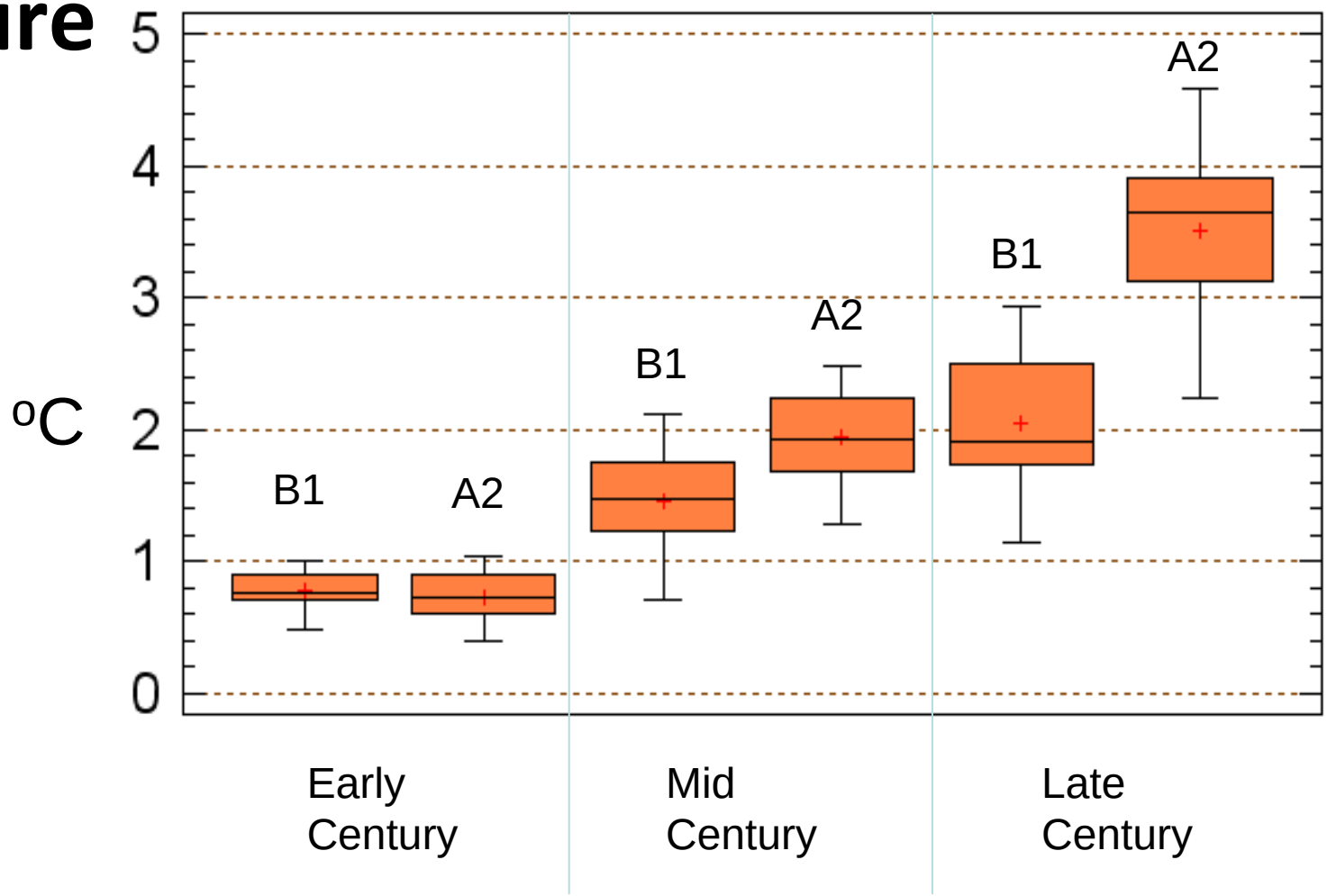
Bivalve Shellfish

Drinking Water

Temperature

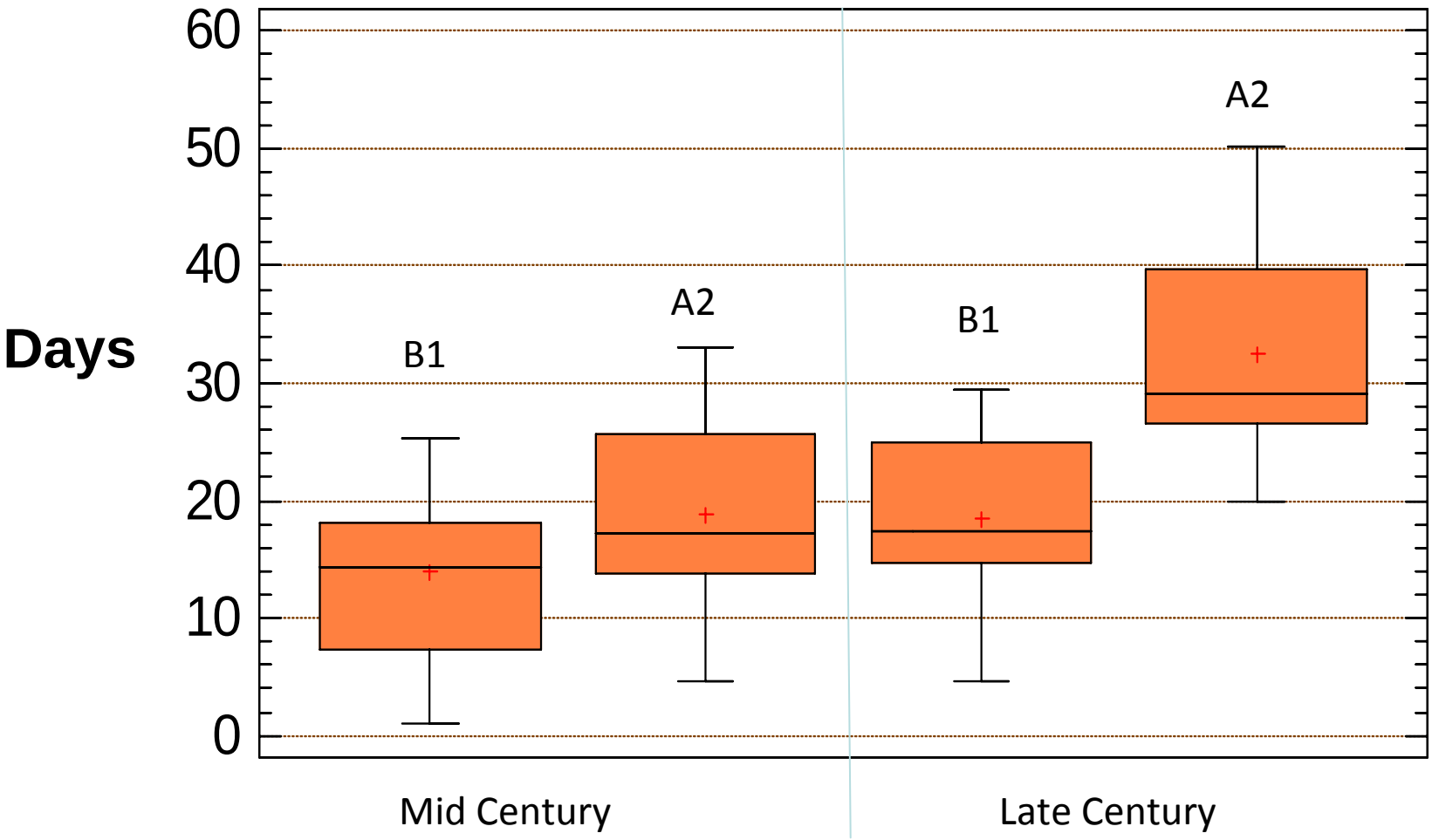
B1 = Low Emissions

A2 = High Emissions



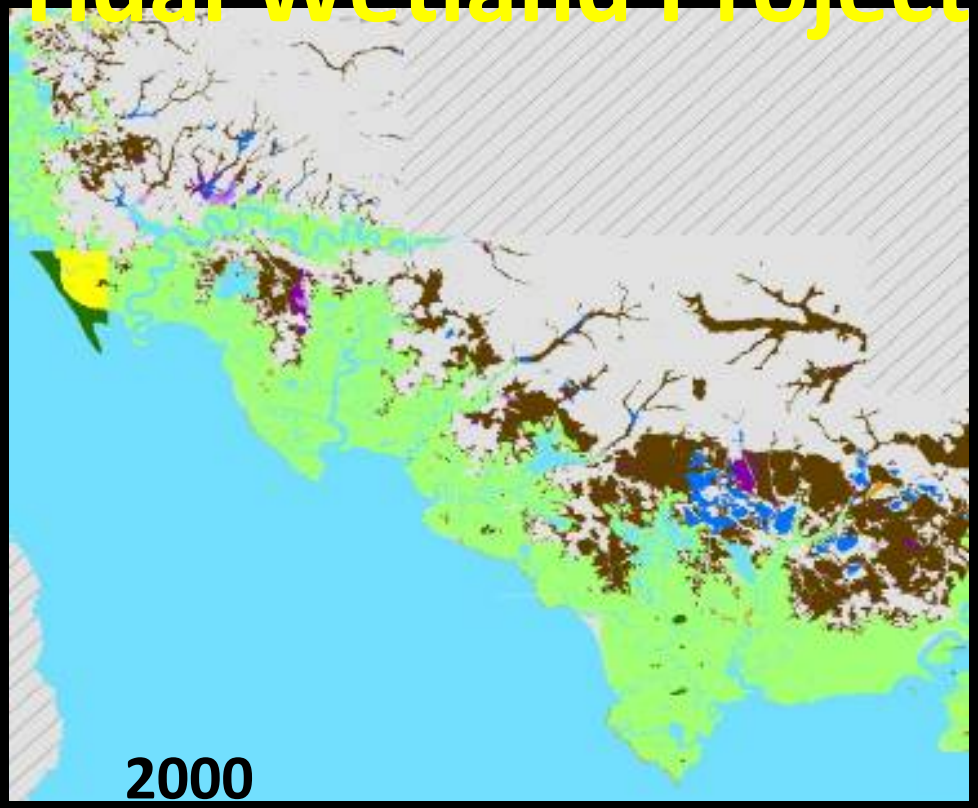
- More warming in summer than winter
- Scenario differences minor until late century
- However, late century scenario differences very important for life
- Due to climate momentum, we must plan for warmer conditions

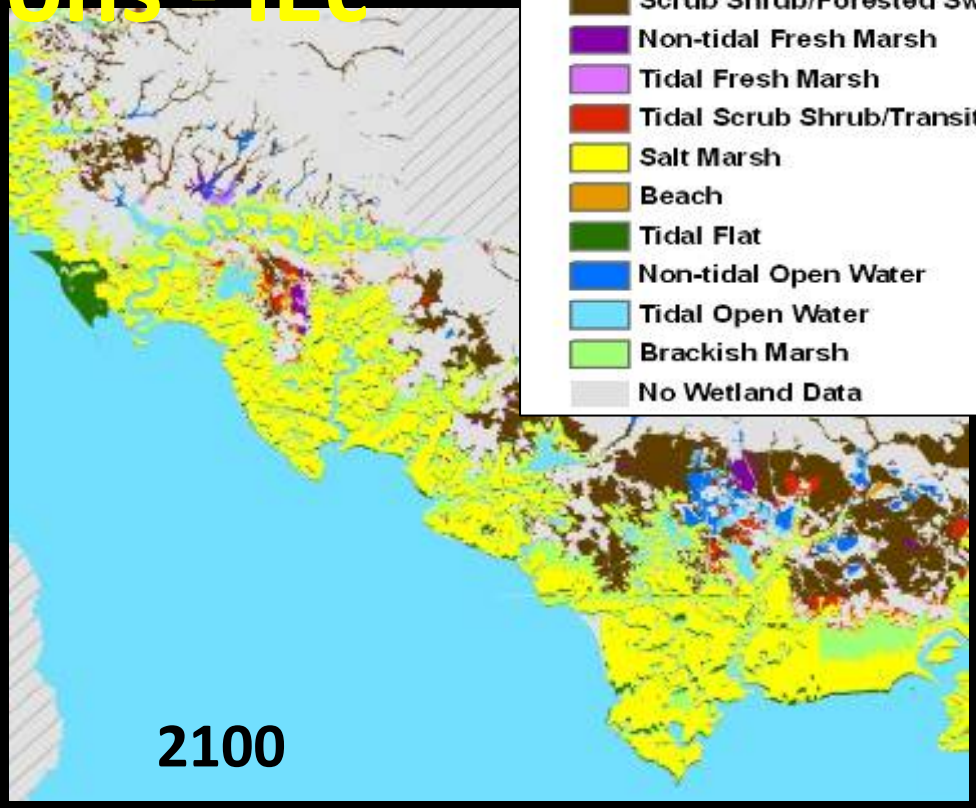
Growing Season Length



§ Opposite pattern for number of frost days

Tidal Wetland Projections - IEc





Legend
- Scrub Shrub/Forested Swamp
- Non-tidal Fresh Marsh
- Tidal Fresh Marsh
- Tidal Scrub Shrub/Transitional
- Salt Marsh
- Beach
- Tidal Flat
- Non-tidal Open Water
- Tidal Open Water
- Brackish Marsh
- No Wetland Data

SLAMM V.6 Findings:

- 26% loss of 42,558 hectares of tidal wetlands
- loss of 50,236 hectares of adjacent uplands and non-tidal wetlands
- gain of 106,529 hectares of open water and tidal flats
- net loss of >60,000 metric tons/year of primary production services

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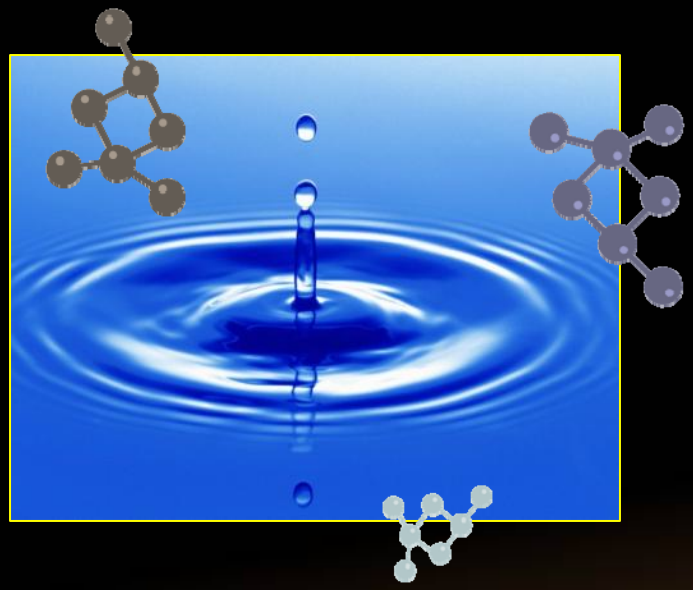
Water Quality - Wetland Interactions



- Alter Vegetation Types
- Impair Condition
- Affect Accretion
- Enhance Vulnerability

- Sinks for Sediments
- Sinks for Nutrients
- Detoxify Some Contaminants
- Sinks for Pathogens ?

Would Nutrient Criteria Need to be More Protective Without Wetlands?

Tidal Wetland Vulnerability?

Freshwater Tidal Marshes

- Salinity Rise Causes Conversion to Brackish
- Barriers to Landward Migration
- Others

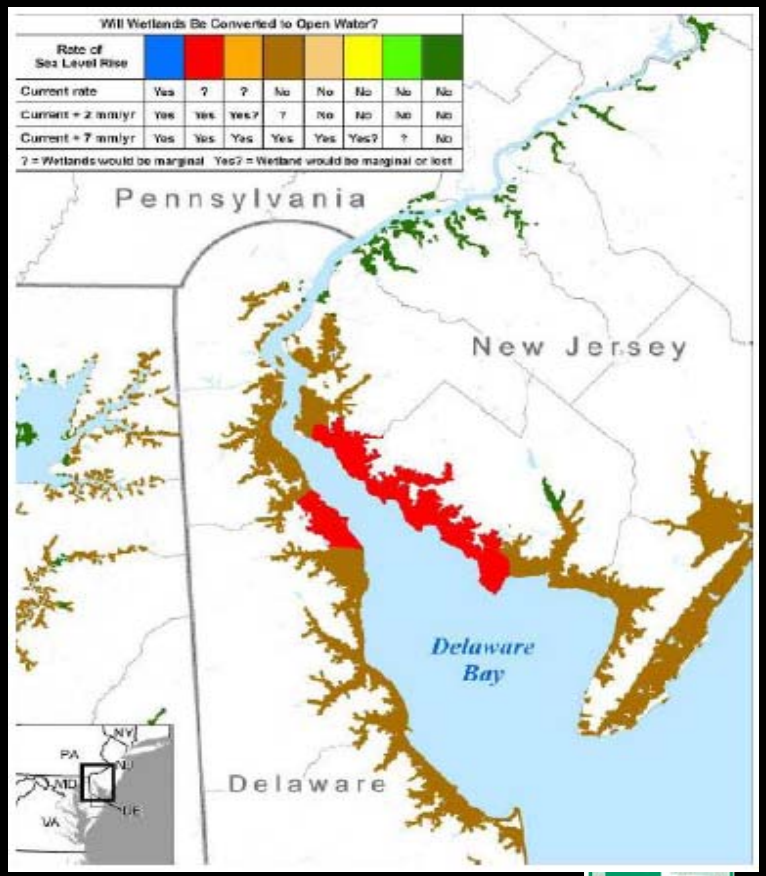
Salt Marshes

- Sea Level Rise, Subsidence and Sediment Deficits Lead to Drowning
- Storms and Wind Wave Erosion
- Barriers to Landward Migration
- Others

Tidal Wetlands Adaptation Planning

Goal: Maximize long-term ecosystem health and resiliency

Will Wetlands Be Converted to Open Water?								
Rate of Sea Level Rise								
Current rate	Yes	?	?	No	No	No	No	No
Current + 2 mm/yr	Yes	Yes	Yes?	?	No	No	No	No
Current + 7 mm/yr	Yes	Yes	Yes	Yes	Yes	Yes?	?	No
? = Wetlands would be marginal Yes? = Wetland would be marginal or lost								



Tough Choices

- Where will wetlands will be converted to open water?
- Where can we save them ?
- Where is strategic retreat the best option?

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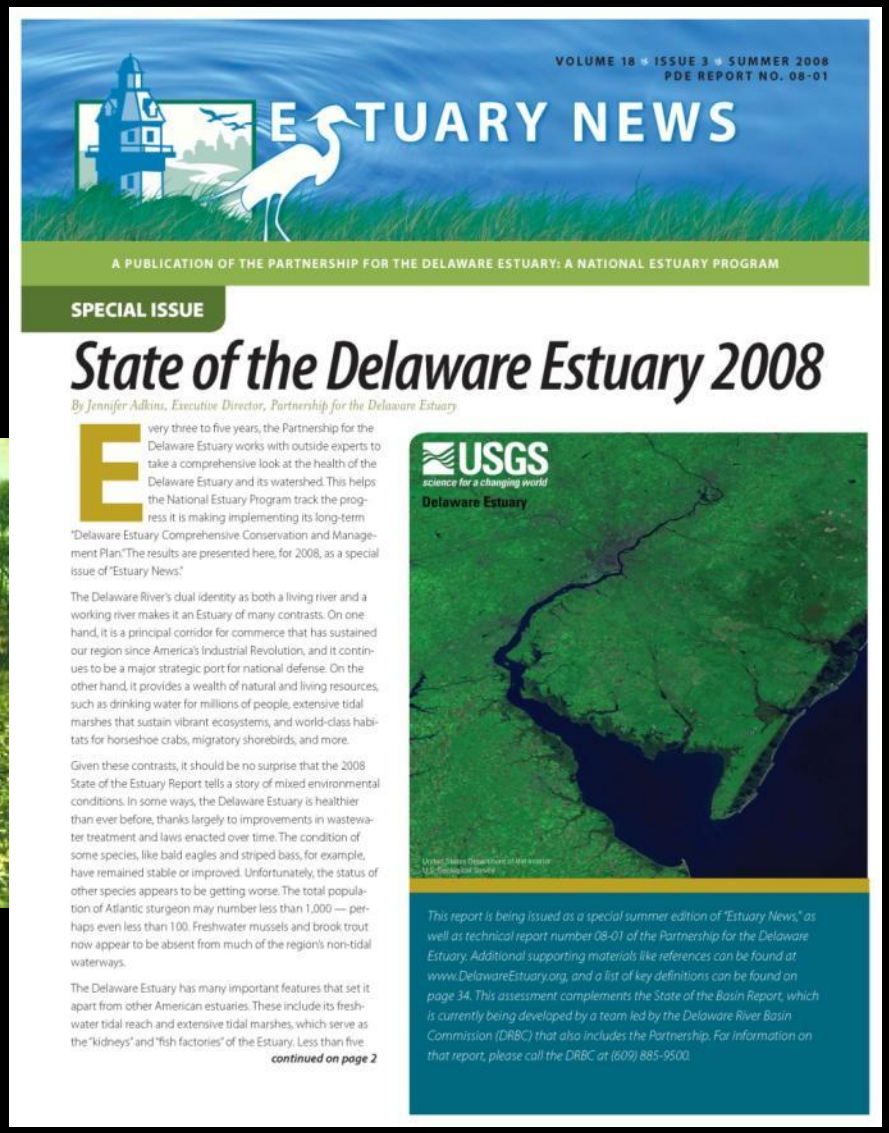
What Can We Do?

3. Monitor & Study



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PDE REPORT NO. 08-01

ESTUARY NEWS

A PUBLICATION OF THE PARTNERSHIP FOR THE DELAWARE ESTUARY: A NATIONAL ESTUARY PROGRAM

SPECIAL ISSUE

State of the Delaware Estuary 2008

By Jennifer Adkins, Executive Director, Partnership for the Delaware Estuary

Every three to five years, the Partnership for the Delaware Estuary works with outside experts to take a comprehensive look at the health of the Delaware Estuary and its watershed. This helps the National Estuary Program track the progress it is making implementing its long-term "Delaware Estuary Comprehensive Conservation and Management Plan." The results are presented here, for 2008, as a special issue of "Estuary News."

The Delaware River's dual identity as both a living river and a working river makes it an Estuary of many contrasts. On one hand, it is a principal corridor for commerce that has sustained our region since America's Industrial Revolution, and it continues to be a major strategic port for national defense. On the other hand, it provides a wealth of natural and living resources, such as drinking water for millions of people, extensive tidal marshes that sustain vibrant ecosystems, and world-class habitats for horseshoe crabs, migratory shorebirds, and more.

Given these contrasts, it should be no surprise that the 2008 State of the Estuary Report tells a story of mixed environmental conditions. In some ways, the Delaware Estuary is healthier than ever before, thanks largely to improvements in wastewater treatment and laws enacted over time. The condition of some species, like bald eagles and striped bass, for example, have remained stable or improved. Unfortunately, the status of other species appears to be getting worse. The total population of Atlantic sturgeon may number less than 1,000 — perhaps even less than 100. Freshwater mussels and brook trout now appear to be absent from much of the region's non-tidal waterways.

The Delaware Estuary has many important features that set it apart from other American estuaries. These include its freshwater tidal reach and extensive tidal marshes, which serve as the "kidneys" and "fish factories" of the Estuary. Less than five

continued on page 2

USGS
science for a changing world
Delaware Estuary

This report is being issued as a special summer edition of "Estuary News," as well as technical report number 08-01 of the Partnership for the Delaware Estuary. Additional supporting materials like references can be found at www.DelawareEstuary.org, and a list of key definitions can be found on page 34. This assessment complements the State of the Basin Report, which is currently being developed by a team led by the Delaware River Basin Commission (DRBC) that also includes the Partnership. For information on that report, please call the DRBC at (609) 885-9500.

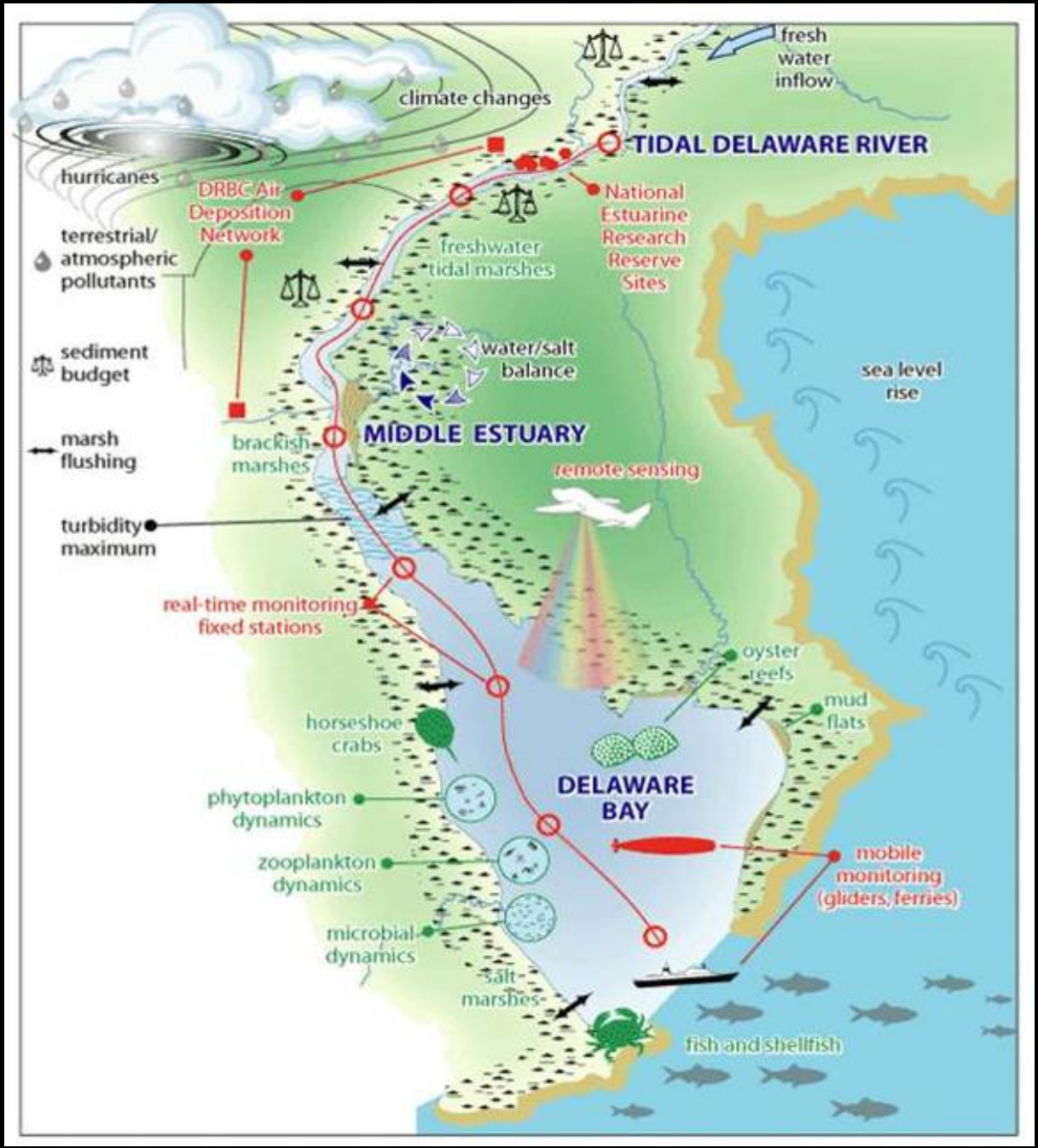
Status, Trends, Vulnerability?
We Couldn't Say
Slide from Chris Bason (Center for Inland Bays, DE)

Monitoring Infrastructure

The Delaware Estuary Watershed to Ocean Observing System (DEWOOS)

A Planning Concept from:
Delaware River Basin Commission
University of Delaware
Rutgers University
US Geological Survey
NOAA
States of New Jersey and Delaware
Partnership for the Delaware Estuary
DE, NJ and PA Sea Grant

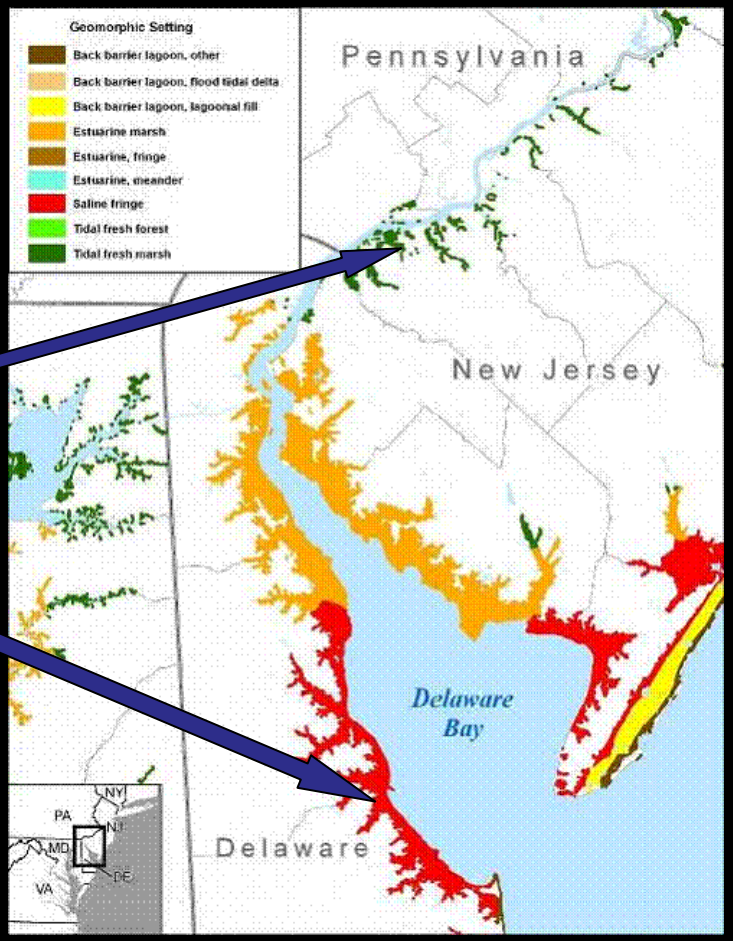
Wetland Component Included



Delaware Estuary Wetland Monitoring & Assessment Program (DEWMAP)

Freshwater Tidal Marsh

Salt Marsh

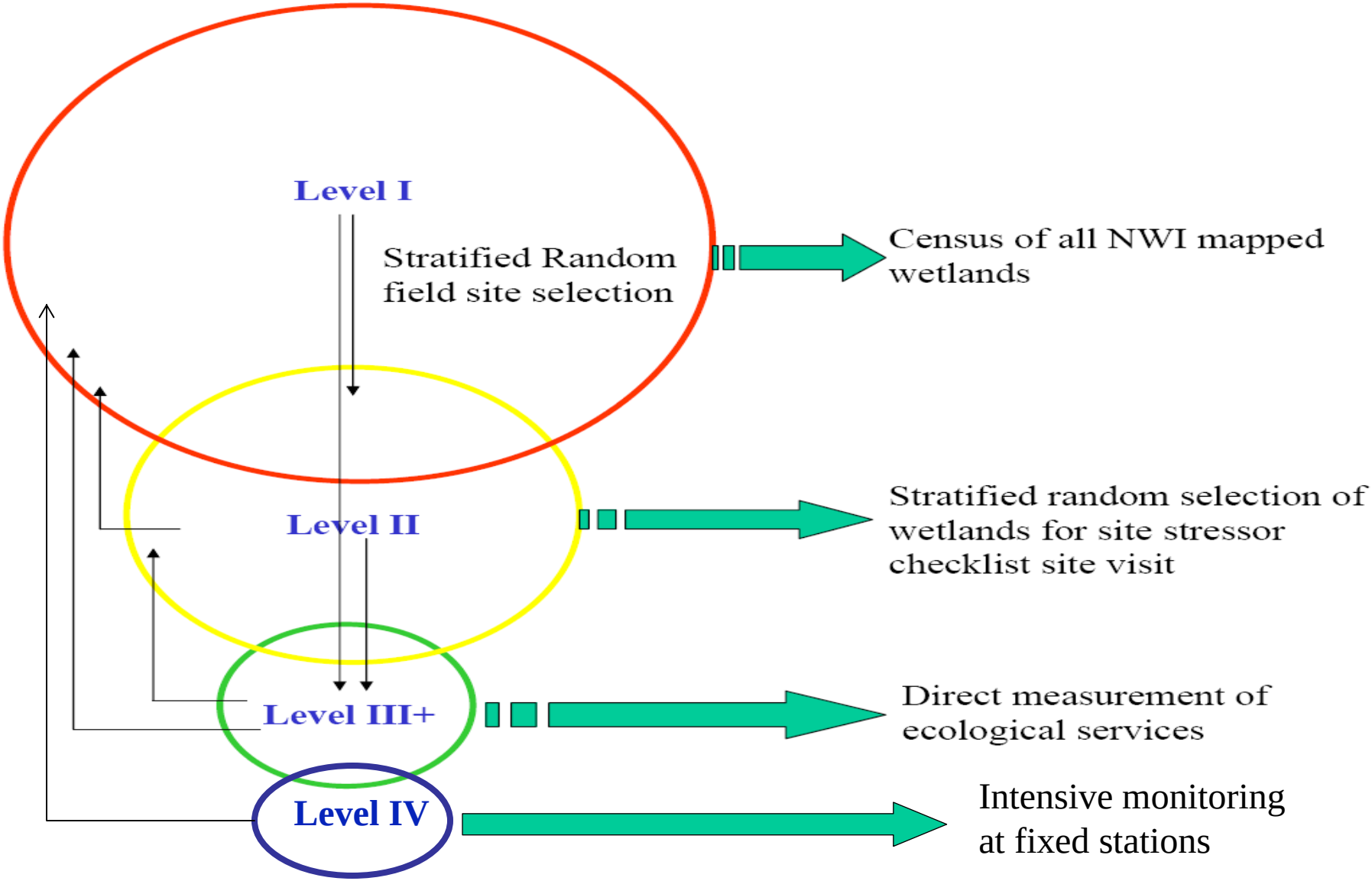


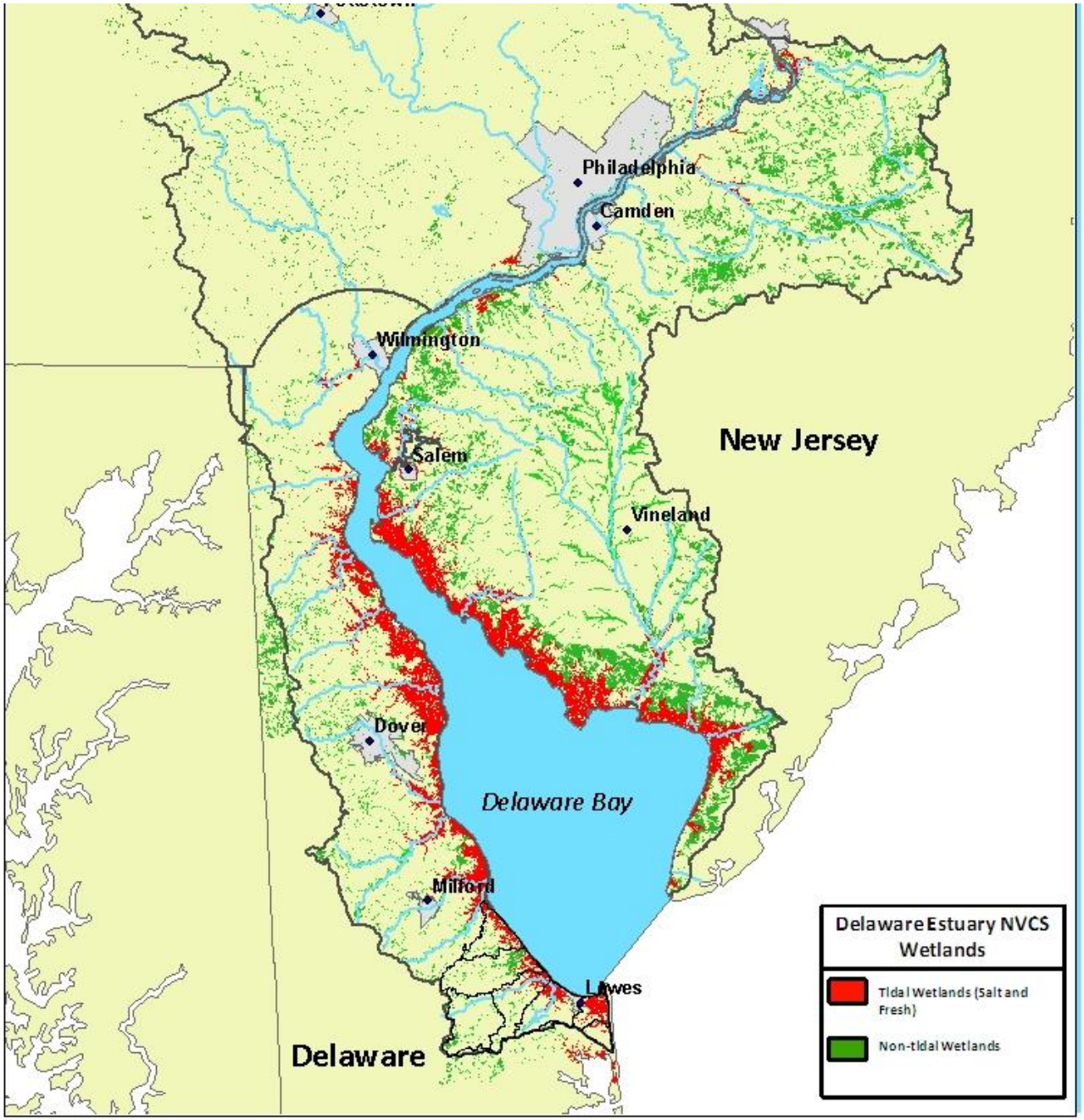
The Delaware Estuary Wetland Monitoring and Assessment Program (DEWMAP) :

- <u>Sample Frame</u>
  all tidal wetlands in the Delaware Estuary

- <u>Subpopulations</u>
  wetland type (oligohaline, mesohaline, polyhaline)
  state (DE, NJ, PA)

Guidance from EPA





Regional Wetlands Monitoring Sites - Delaware Estuary

DEWMAP Design:

Tier 1

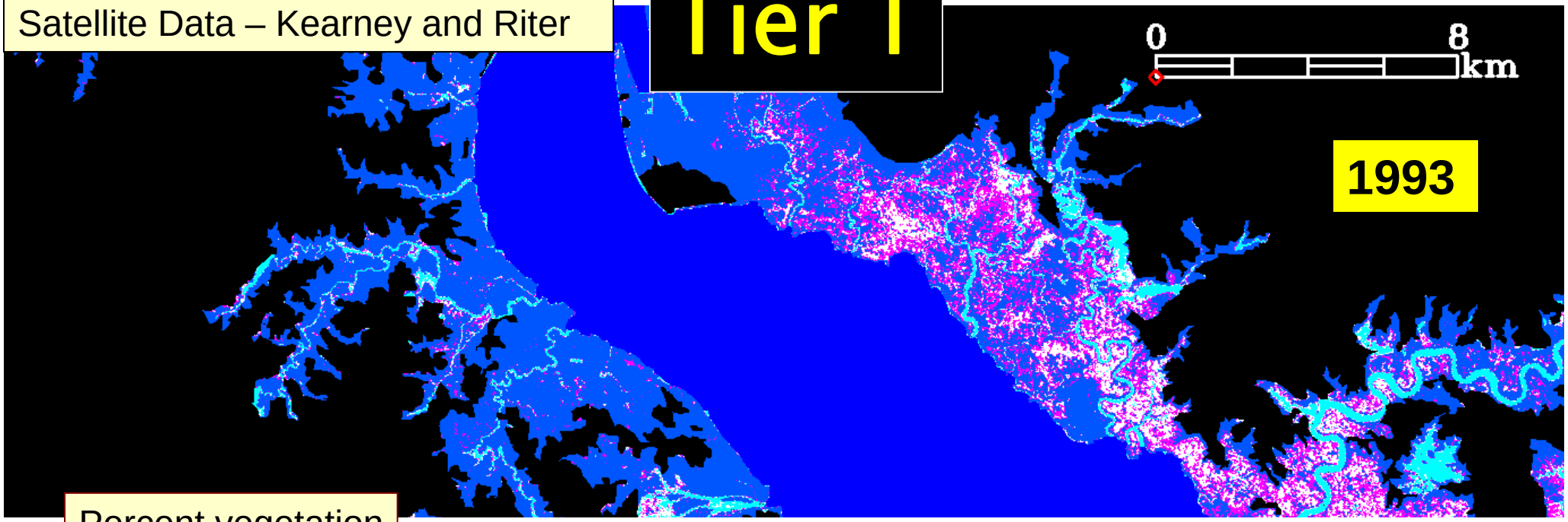
Tier 2

Tier 3/4

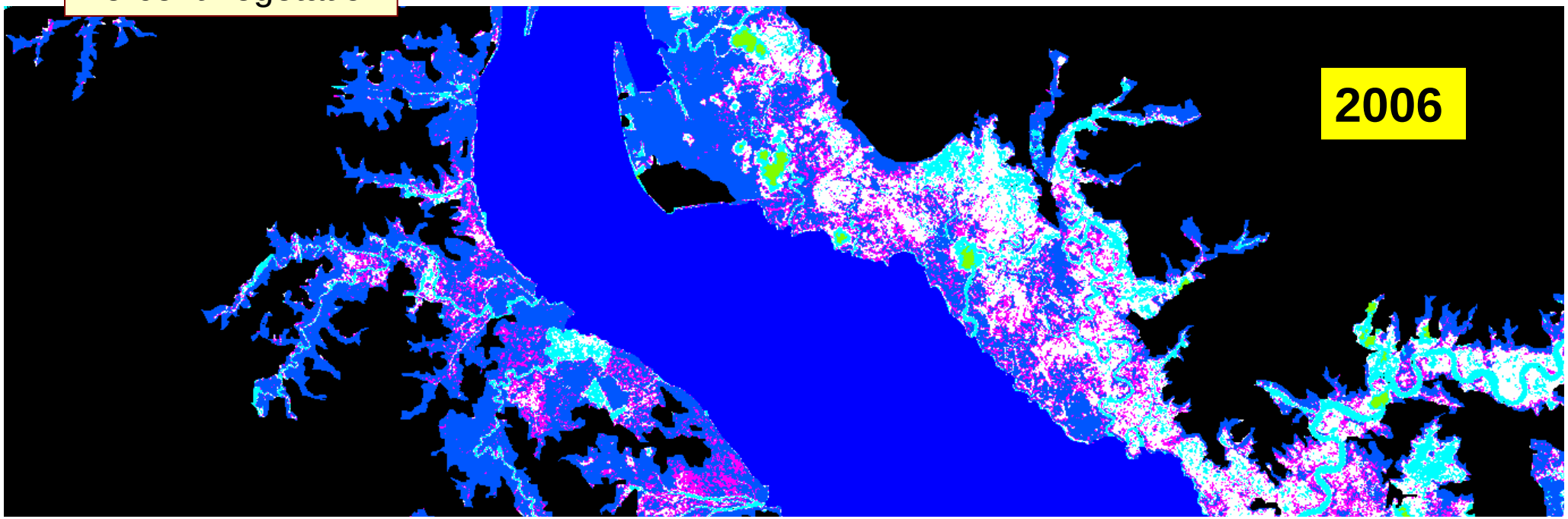
Design Component	Example Indicators	Example Metrics
Tier 1	Wetland Extent	wetland acreage (hectares) per subpopulation and NWI attribute type
	Wetland Buffer Condition	adjacent land use (e.g., % natural vs. developed in 100m band)
	Wetland Contiguousness	connectivity (inter/intra); patch sizes and fragmentation
	Historic Change	loss or gain in acreage for different subpopulations & attributes
	Wetland Morphology	percent open water; edge to area ratios
	Plant Community Integrity	vegetation community/type (e.g., *Phragmites* vs. *Spartina*, high marsh vs. low marsh, bare soil, open water)
	Shoreline Condition	edge status (e.g., hardening, erosion)
	Anthropogenic Alterations	channel straightening, ditching, tide gates, groundwater withdrawals
Tier 2	Plant Community Integrity	vegetation community type (description of species assemblage)
		invasive species (percent cover of *Phragmites*)
		species list (floristic quality assessment index)
		vegetation structure board
	Primary Production	below and above ground biomass
	Wetland Morphology	percent open water; edge to area ratios
	Invertebrate Community Integrity (sessile species)	presence and relative abundance of functional dominant and bioindicator species
	Wildlife Habitat Integrity (mobile species)	evidence of fish and mobile shellfish; avian IBI
	Hydrological and Shoreline Integrity	evidence of hydrological alterations or impairment (e.g. depressions, dikes, rip rap)
	Substrate Integrity	percent organic matter and sediment description
	Elevation and Sediment Budget	relative elevation, evidence of accretion or subsidence, wrack accumulation
Tier 3	Water Quality	fixed monitoring stations in second order tidal creek (temperature, specific conductivity, pH, turbidity, DO, water level)
		grab samples in tidal creek for dissolved nutrients and seston quantity & quality, ebb & flood tides (TSS, chlorophyll, proximate biochemistry and stoichiometry)
	Biogeochemical Cycling	sediment porewater nutrient concentrations, forms, stoichiometric ratios; denitrification rates
	Carbon Storage	carbon sequestration in belowground biomass; litter accumulation
	Elevation and Sediment Budget	Sediment Elevation Table (SET), elevation relative to sea level (in addition to Tier 2 metrics)
	Plant Community Integrity	vegetation robustness (percent cover and stem counts per species) (in addition to Tier 2 metrics)
	Functional Dominant Fauna Integrity	invertebrate and vertebrate species lists along intertidal edge and high marsh, biofiltration capacity of bivalves

Satellite Data – Kearney and Riter

Tier 1



Percent vegetation



Current Focus

Tier 1

Tier 2
Rapid Assessments

Tier 3/4
Fixed Station Monitoring

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National Wetland Monitoring & Assessment Work Group

NWMAWG

Mid-Atlantic Wetland Work Group

MAWWG

STAC Wetland Work Group

DEWWG

- *Focus on Tidal Marshes*
- *Link to Adjacent Estuaries (Network)*

The Mid-Atlantic Coastal Wetland Assessment (MACWA)

- Sample Frame

  all tidal wetlands in the sub-region from coastal NJ to coastal MD including the Delaware Estuary

- Subpopulations

  wetland type (oligohaline, mesohaline, polyhaline)

  state (DE, MD, NJ, PA)

Capture diverse stressor gradients and types

MACWA

Delaware Estuary

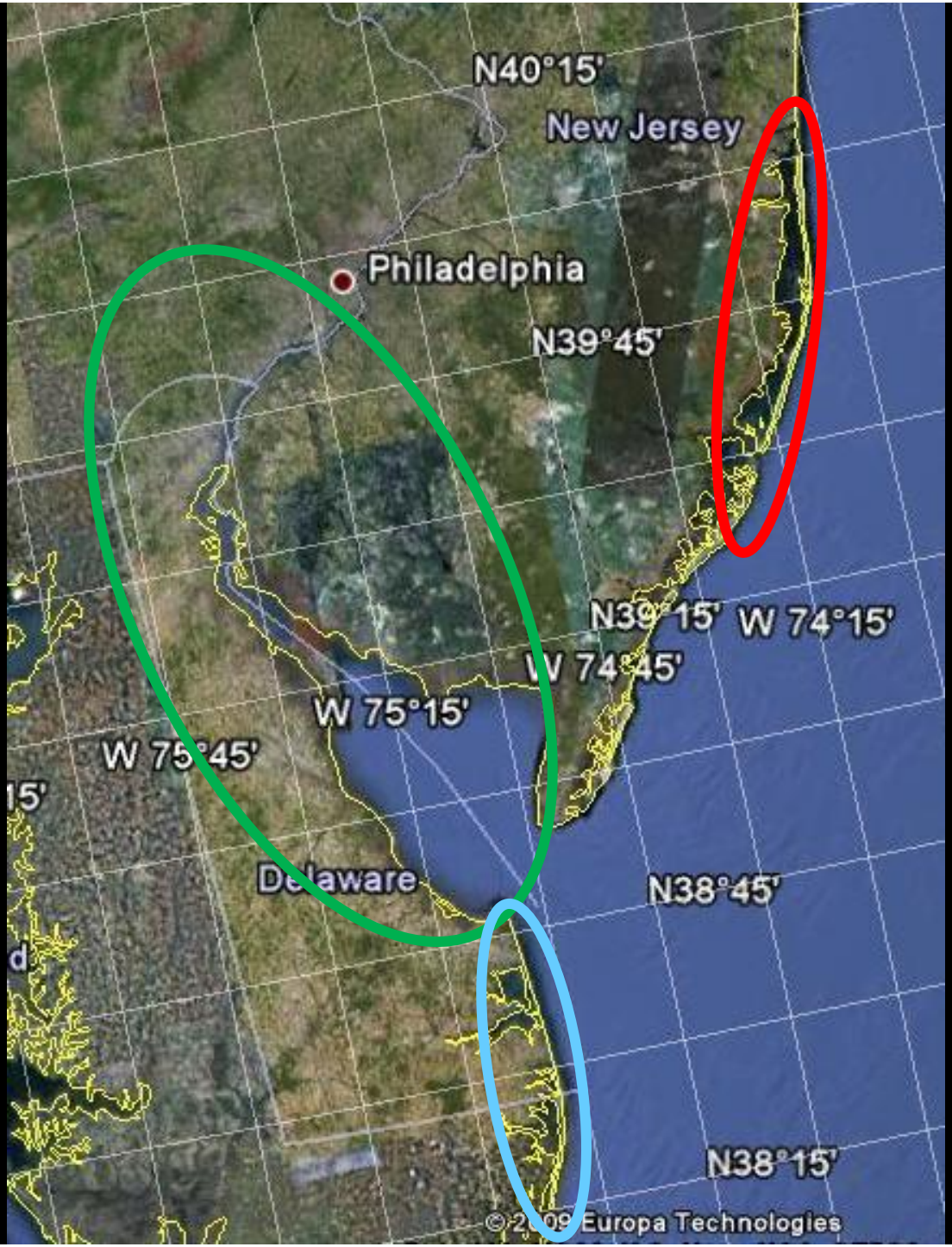
Barnegat Bay

DE Inland Bays

MD Coastal Bays

Others?

Other NJ Coastal



RAM Efforts

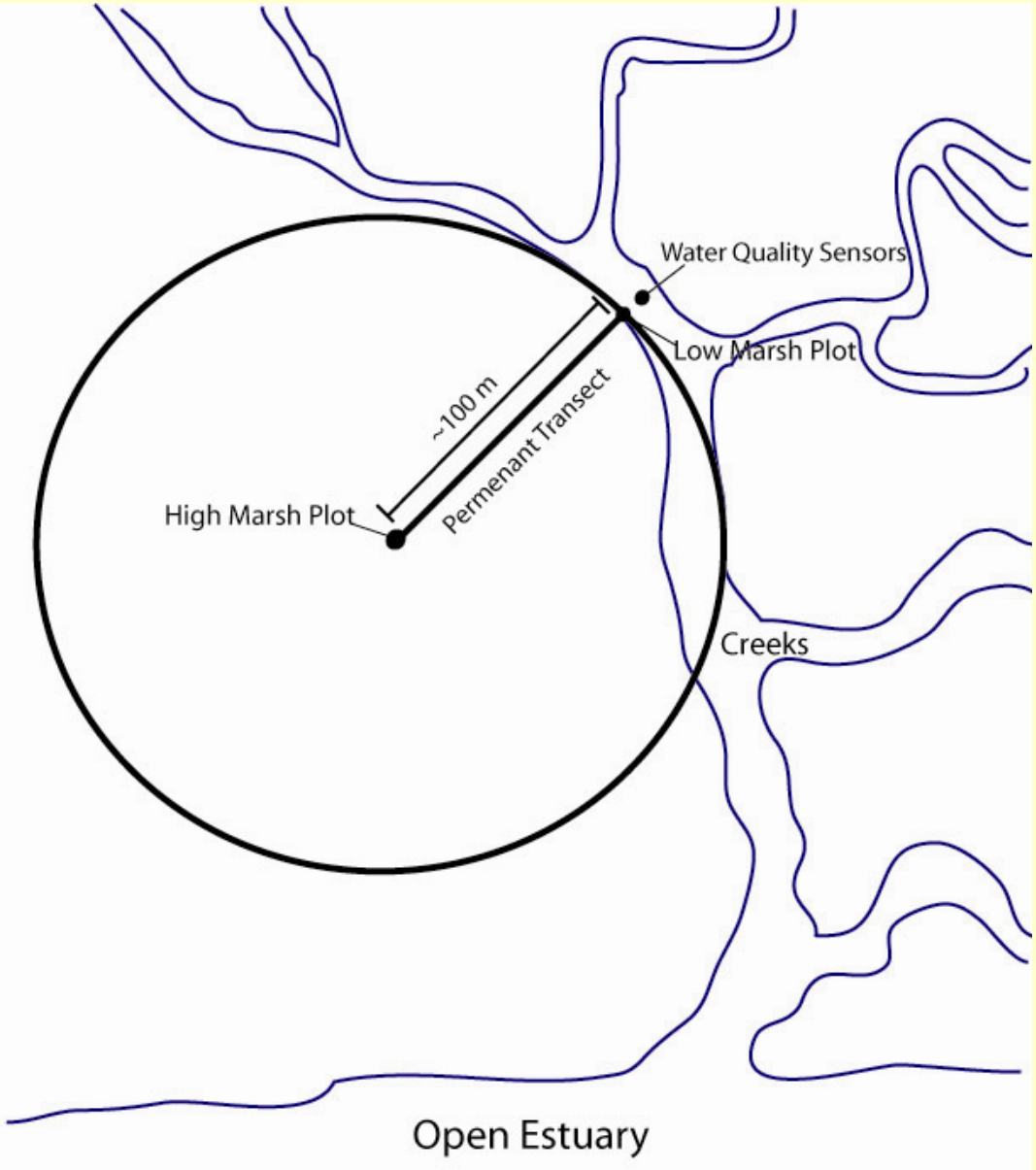
- MidTRAM Training
- QAPP Modification
- Buying/Building Gear
- Tests in Vicinity of Fixed Stations

- 2010 – Broadkill, PA
- 2011 – Maurice, Christina, Barnegat

Fixed Station Efforts

- Site Selection
- QAPP
- Coordination
  - ANSP on phys/chem
  - NEPs on bio
- <u>2010</u>
  - Baseline monitoring
  - SETs
  - WQ Meters
- <u>2011</u>: Expansion

Fixed Station Assessment Area



Tier 4 Example Metrics

Water Quality	**Elevation and Sediment Budget**
Biogeochemical Cycling	**Plant Community Integrity**
Carbon Storage	**Functional Dominant Fauna Integrity**

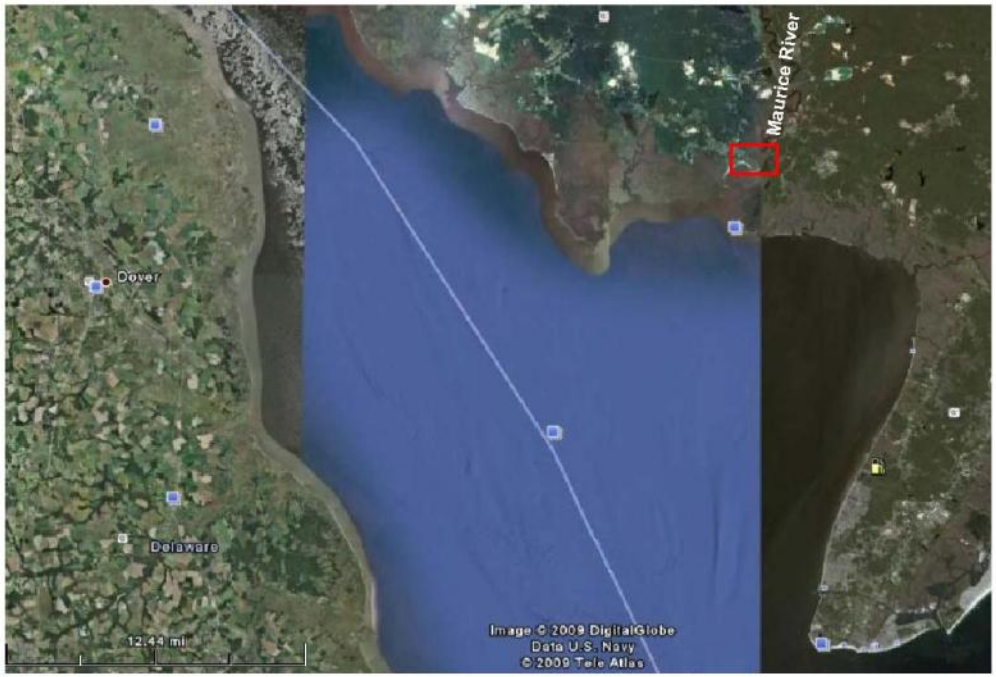
Tier 4 Fixed Stations:

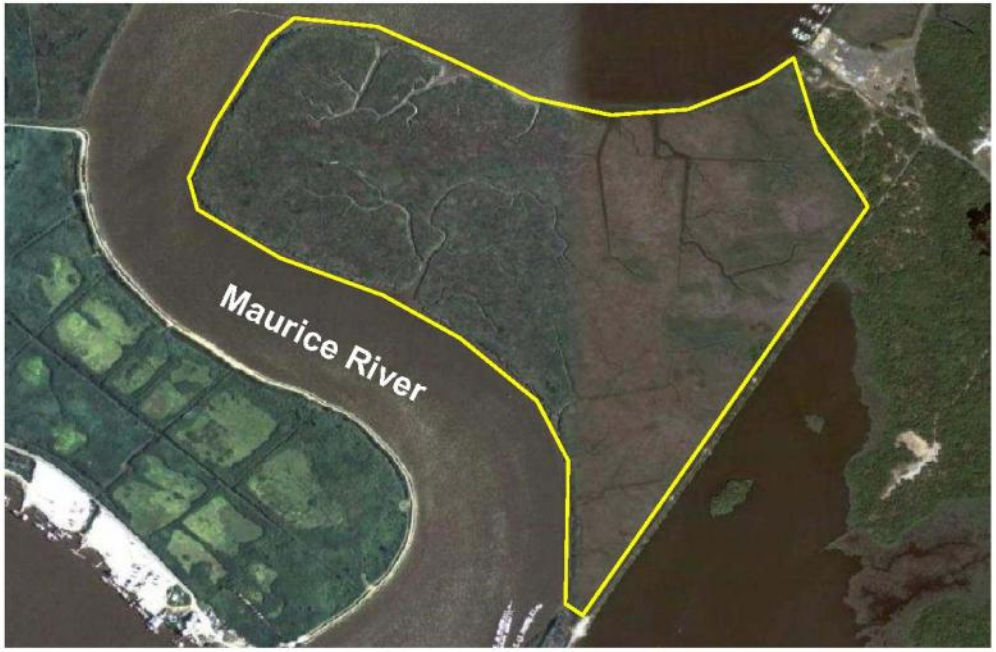
Station	Location	State	Lead Entities	Description
1	Tinicum NWR	PA	PADEP/ANSP	Oligohaline, freshwater tidal marsh
2	Christina River	DE	DNREC/ PDE	Mesohaline, brackish tidal marsh
3	St. Jones River	DE	DNREC	Euryhaline, *Spartina* salt marsh
4	Maurice River	NJ	Rutgers	Euryhaline, *Spartina* salt marsh

NJ Expansion - up to 3 stations in Barnegat Bay and up to 3 more in the Delaware Estuary

- Crosswicks Creek, Dennis Creek, Stow Creek

Heislerville WMA





MACWA Partners (so far)

Academy of Natural Sciences
Barnegat Bay Estuary Program
DNREC
EPA HQ, Regions2 and 3
NJDEP + NJ Coast Zone Program
PADEP
PDE (Coordinator)
Rutgers University
Villanova University
Wetland Associates

MACWA

One size fits all?

No: include both "Core" and "Supplemental" metrics for both RAM and station monitoring

- Compare only core metrics for climate and other *sub-regional* monitoring needs
- Use core + supplemental metrics for *local or watershed* specific needs

MACWA Funding

Wetland Monitoring Informs Other NEP Programs

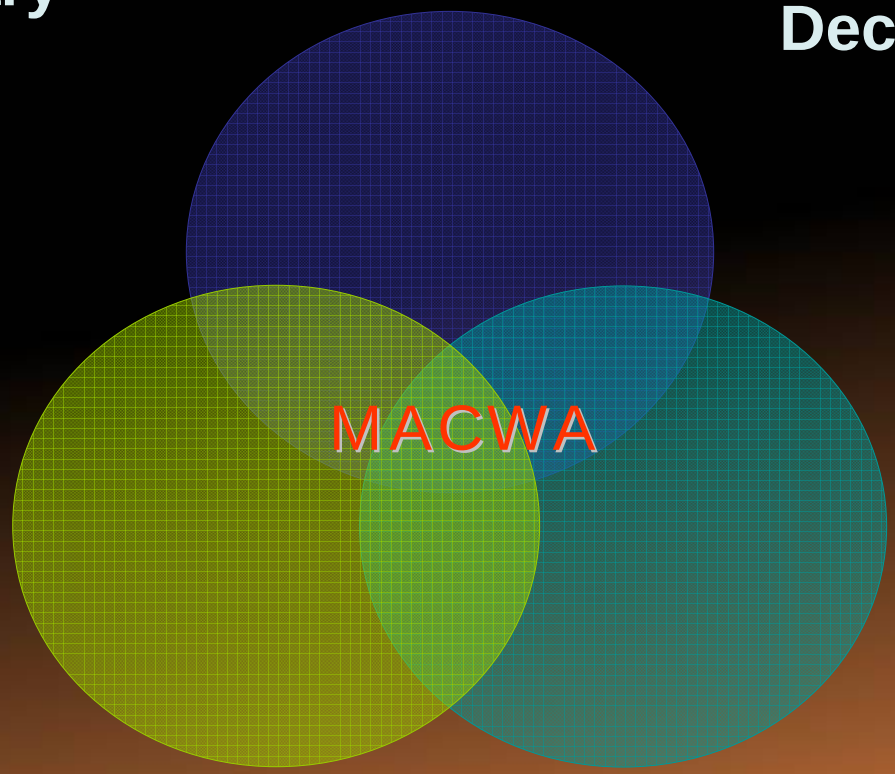
Regional Restoration

State of Estuary Reporting

Regulatory Decision-Making

Fish and Wildlife Management

Water Quality Management

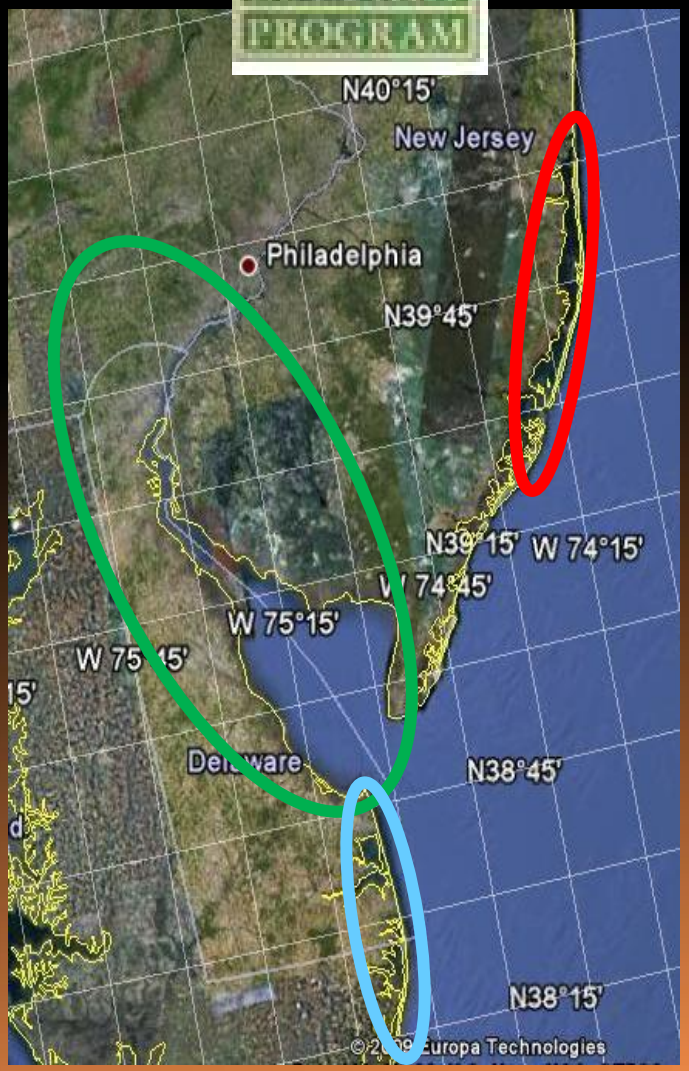


Climate Adaptation

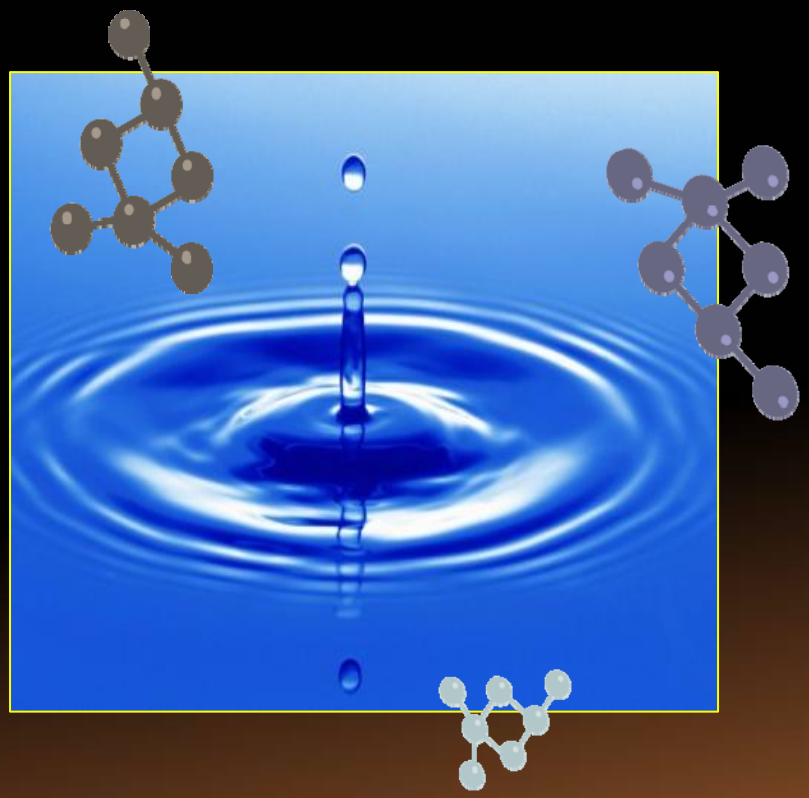
Targeted On-the-Ground Projects

Summary

- Wetlands are a hallmark feature of the Delaware Estuary and coastal mid-Atlantic, particularly tidal marshes
- These wetlands provide critical services that sustain lives and livelihoods
- Improved efforts to monitor wetland status and trends will assist in managing and sustaining them into the future
- Sub-regional coordination will strengthen information products and funding

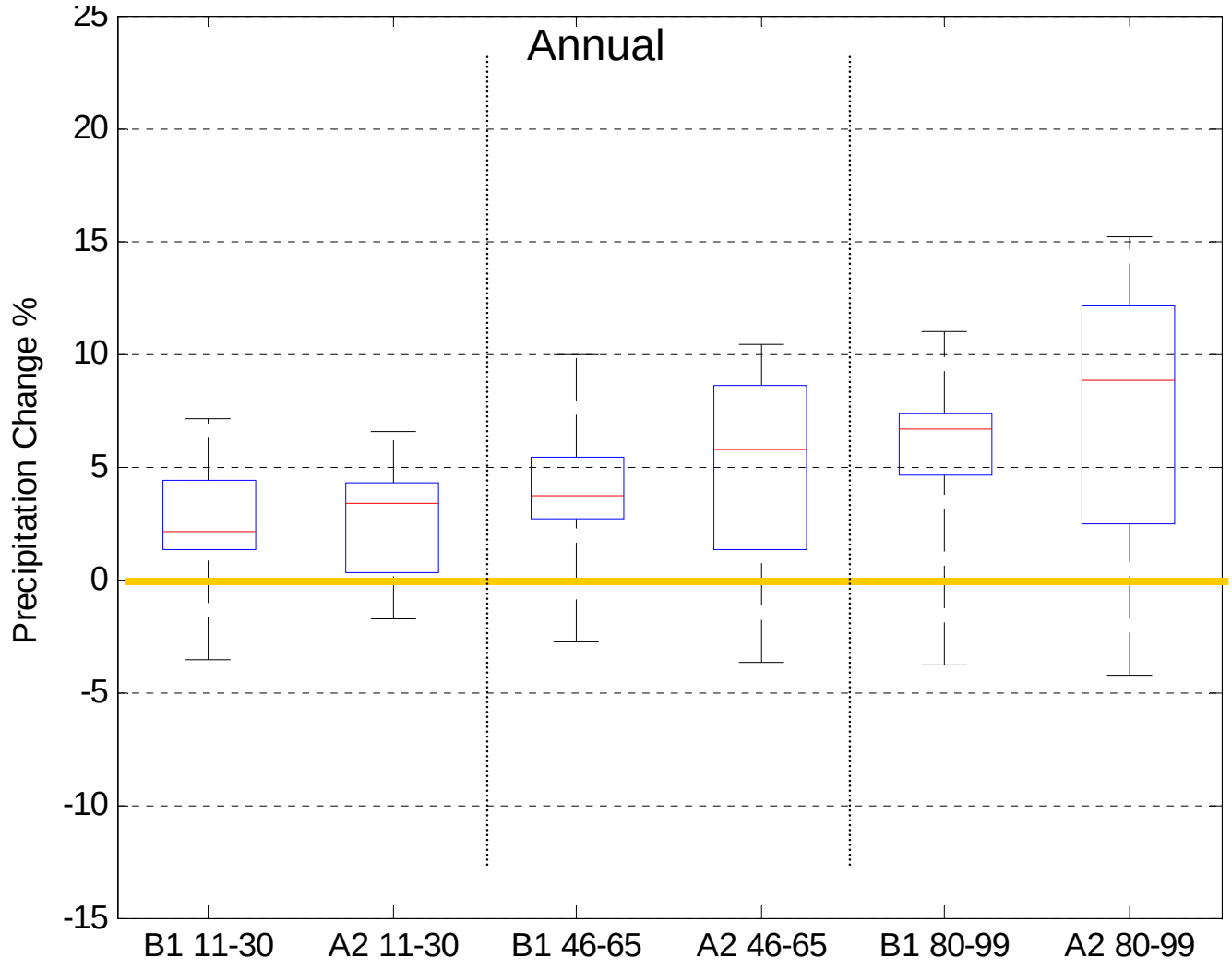


Water Quality - Wetland Interactions



Precipitation

- More precipitation, especially in cooler seasons
- Models are less in agreement for summer

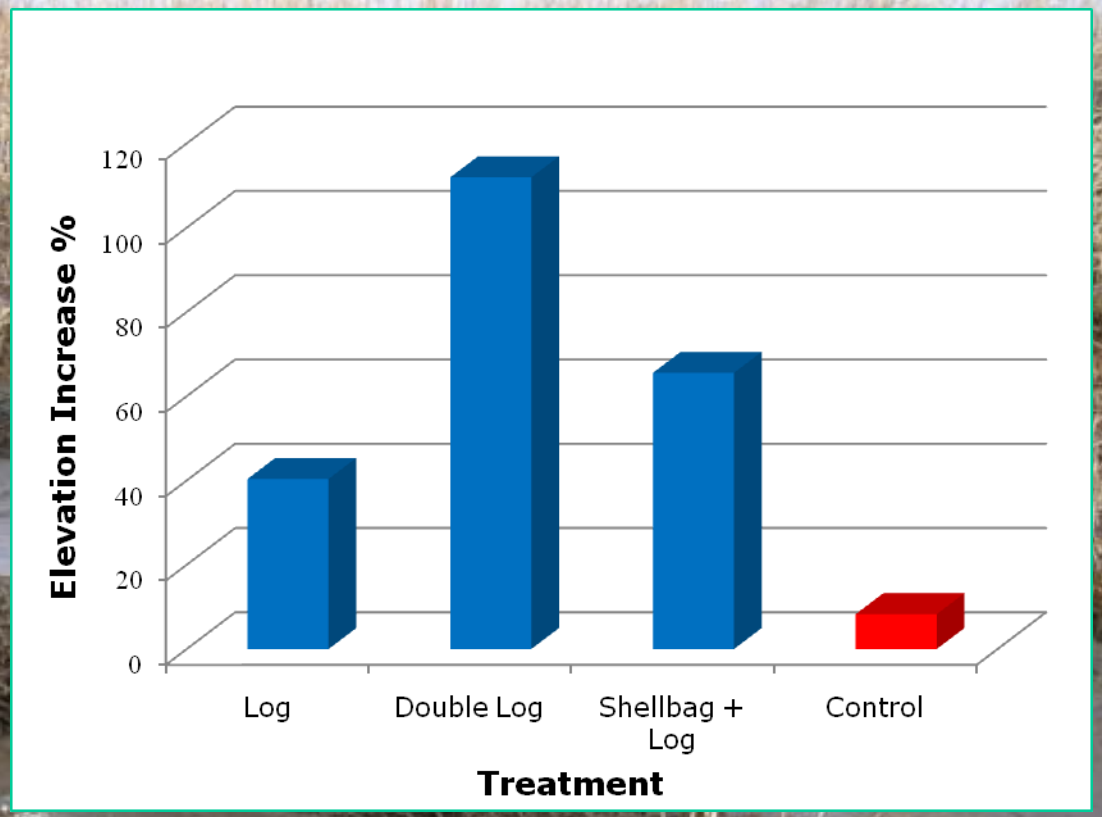


PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Delaware Estuary Living Shoreline Initiative

Shellfish as Natural Breakwaters

- Reduce wave energy
- Trap silt
- Reduce bank erosion
- Protect salt marsh

Slide from Dave Bushek, Rutgers

Delaware Estuary Living Shorelines