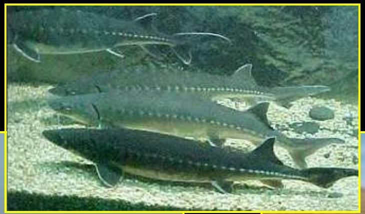
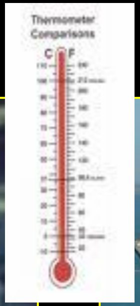
Carbon Sequestration in Tidal Wetlands of New Jersey: from Vulnerability to Opportunity

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Danielle Kreeger
Science Director
Partnership for the Delaware Estuary





To be discussed

Importance of Tidal Wetlands

Carbon Sequestration in Tidal Wetlands

Vulnerable Status of Tidal Wetlands

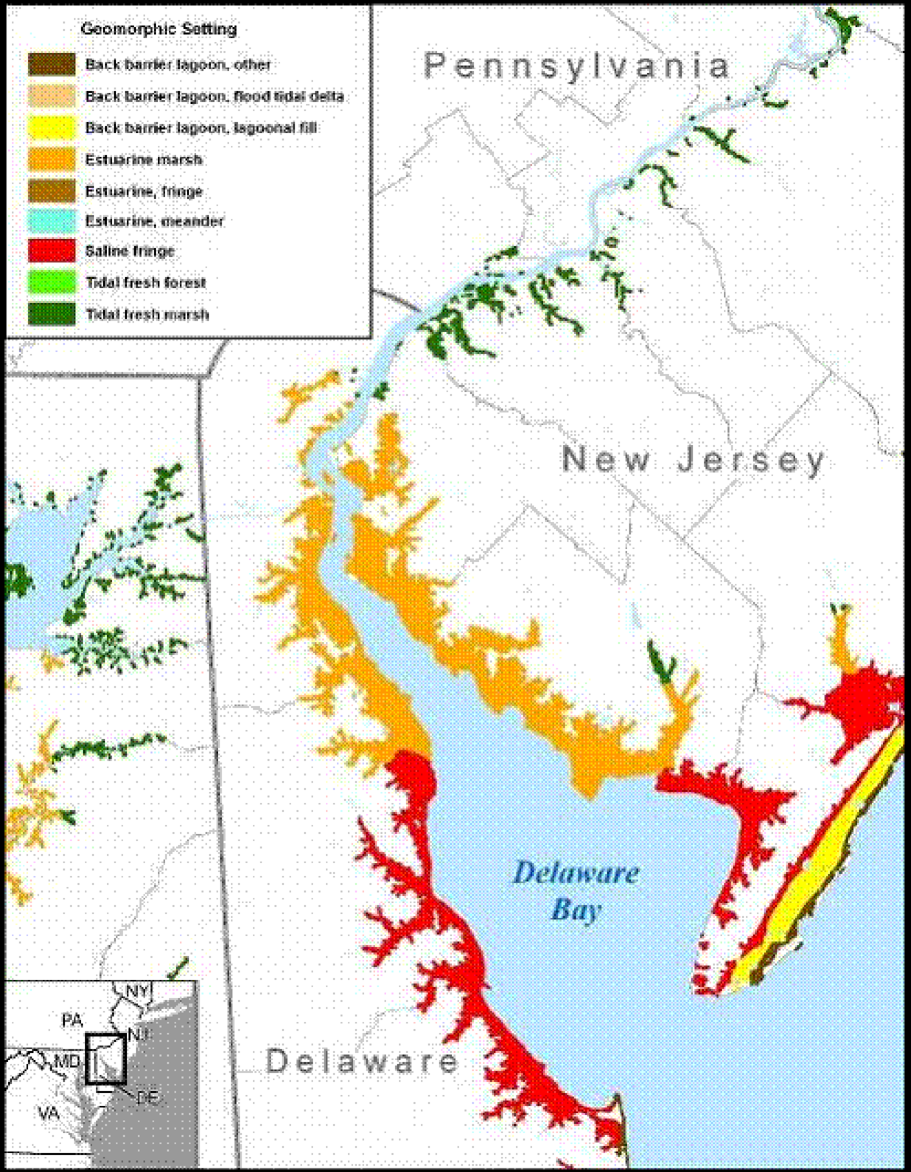
Opportunities for Boosting Tidal Wetland Carbon Sequestration

- ***Protection, Restoration and Enhancement***
- ***Shoreline Protection, Living Shorelines***
- ***Monitoring and Assessment***

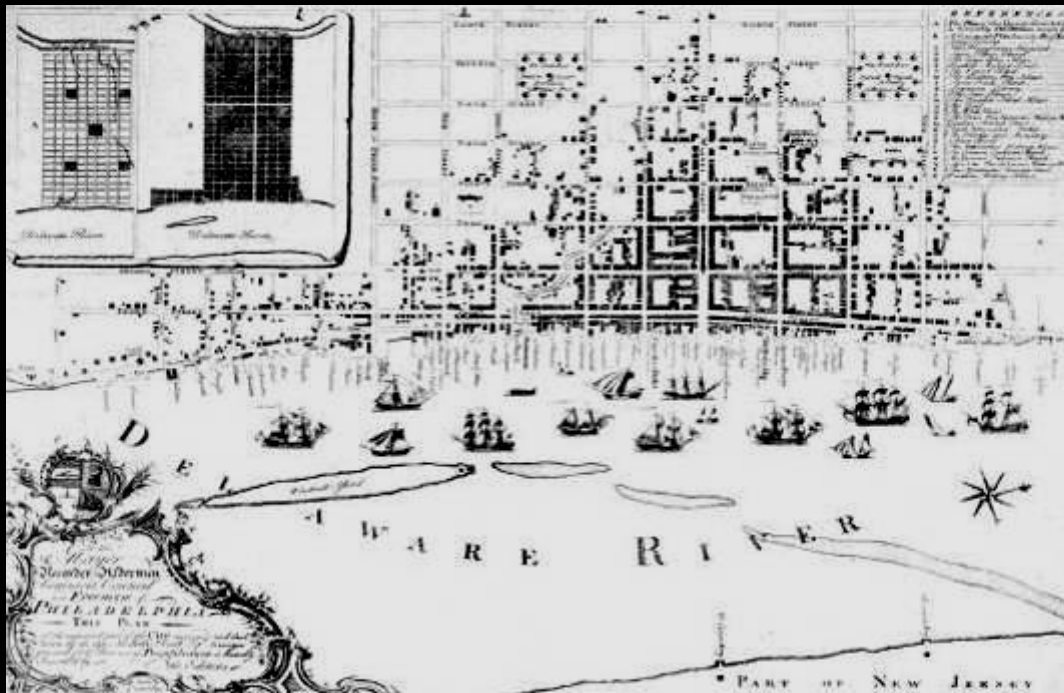
Synergistic Activities

- ***Regional Restoration***
- ***Climate Adaptation***

Delaware Estuary



Rich History as a "Working River"



1762 map showing Philadelphia on the Delaware River

Slide adapted from Jonathan Sharp's

Also a "Living River"

Importance of Tidal Wetlands



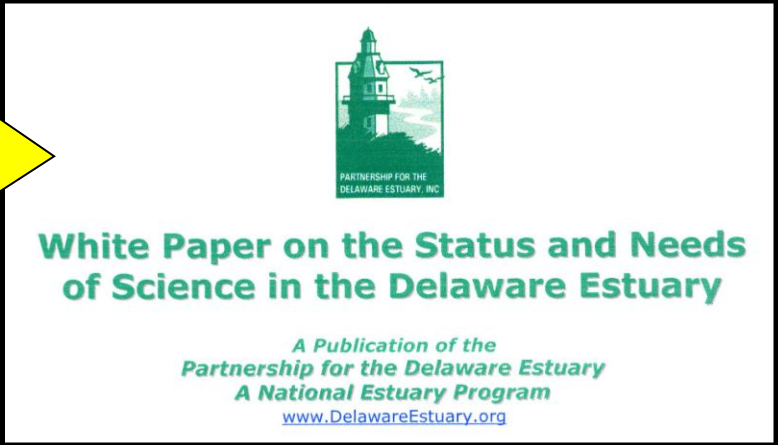

Delaware Estuary Science Conference

Goals:

- Assess knowledge
- Assess science and management needs

Participation:

Hundreds, 10 States
>240 Presentations to date



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White Paper on the Status and Needs of Science in the Delaware Estuary

A Publication of the
Partnership for the Delaware Estuary
A National Estuary Program
www.DelawareEstuary.org

Conceptual Framework

2006

How is our system distinct from other large American estuaries?

The Delaware Estuary

A WATERSHED OF DISTINCTION

What makes the **Delaware Estuary** uniquely valuable? What distinguishes it from other large American estuaries? What are its hallmark animals, plants, and resources? What are the principle environmental challenges it faces? This brochure summarizes answers to these questions by highlighting the "signature" environmental traits and issues within four regions of the Delaware Estuary: Schuylkill Valley, Upper Estuary, Lower Estuary, and Delaware Bay.

The message is clear — the Delaware Estuary is a unique resource that is internationally important for historical, socioeconomic, and environmental reasons. Once home to the first major city in the New World and the initial seat of the United States, the Delaware Estuary was the principle corridor for commerce that sustained the Industrial Revolution in America, and a major strategic port for national defense. This storied legacy of the Delaware as a working river of national strategic importance continues into the 21st century. But unknown to many, coexisting with this commercial backdrop are some of the nation's best environmental treasures not to be found anywhere else in the world.

Inside, the distinguishing land uses, habitat types, animals and plants, and environmental concerns are identified for each of these regions by using a simple graphical depiction based on the most current scientific information. Also highlighted are examples of interesting socioeconomic and environmental facts about the Delaware Estuary's ecosystem. Together, these diagrams and facts provide an ecologically-based conceptual framework that integrates natural features and societal impacts to describe the environmental landscape of the Delaware Estuary.

For more information, visit the Delaware Estuary Information Gateway on the web, our new clearinghouse for environmental information, and links at the Partnership for the Delaware Estuary's website: ***www.DelawareEstuary.org***.

Partnership for the Delaware Estuary: *A National Estuary Program*
One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE 19801
1-800-445-4935 • Tel: 302-655-4990 • Fax: 302-655-4991

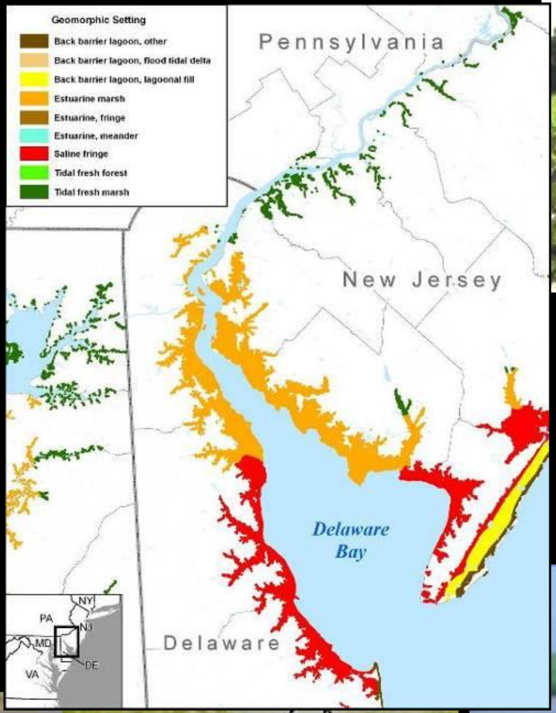
Technical Needs

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)

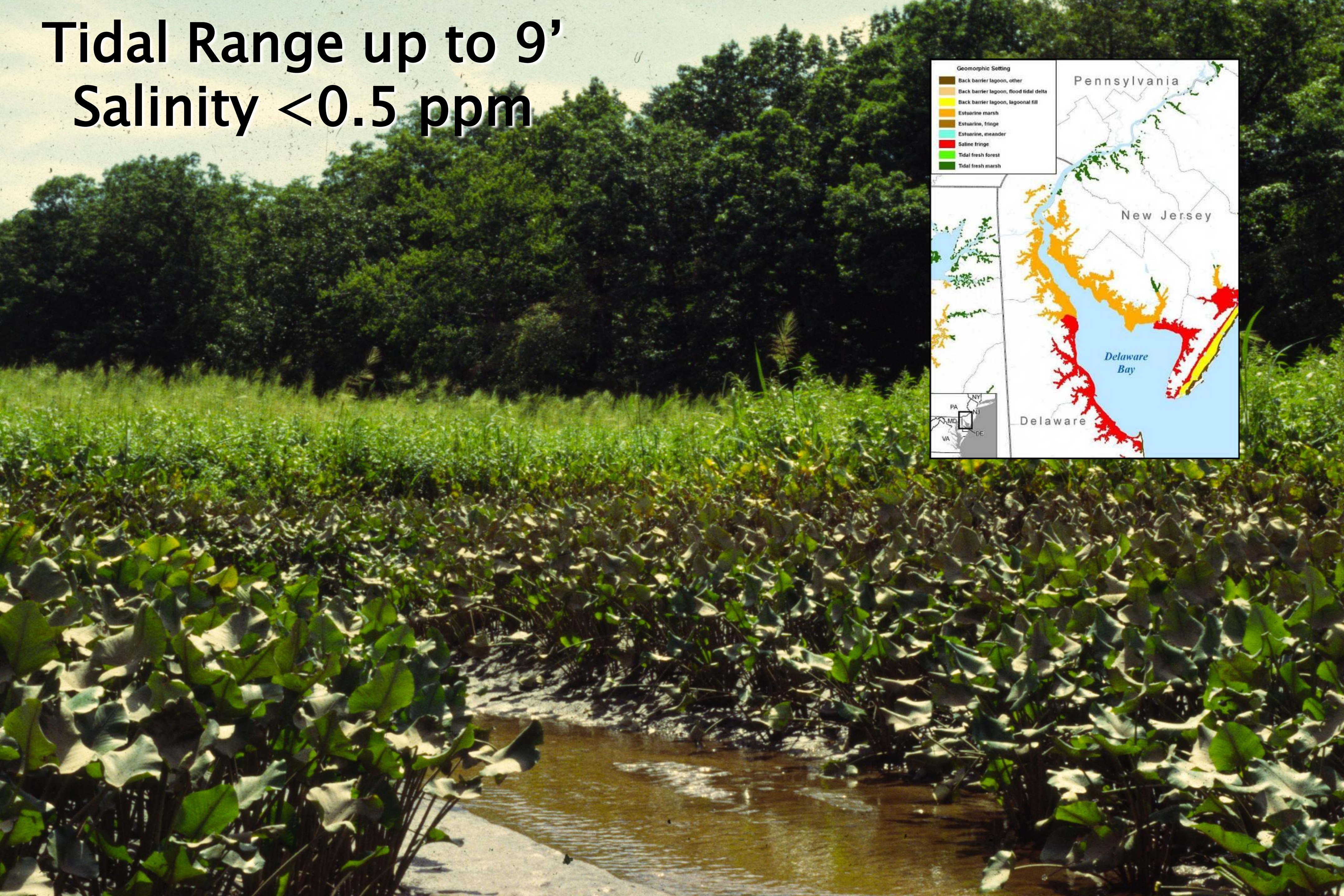
Tidal Wetlands

A Signature Trait of System

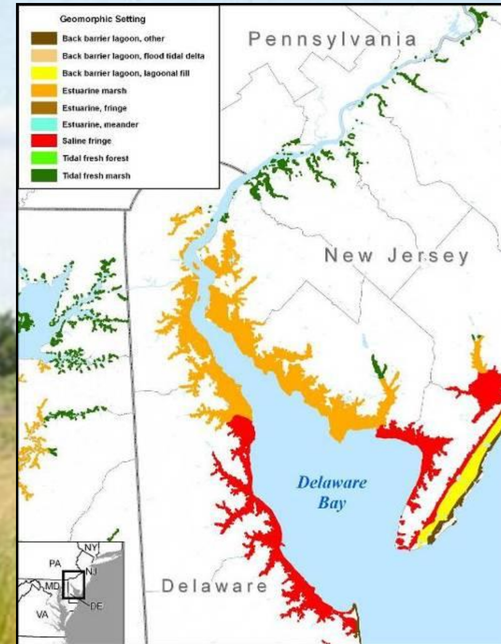
- Near Contiguous Band
- Diverse: *Freshwater Tidal Marshes*
  Brackish Marshes
  Salt Marshes

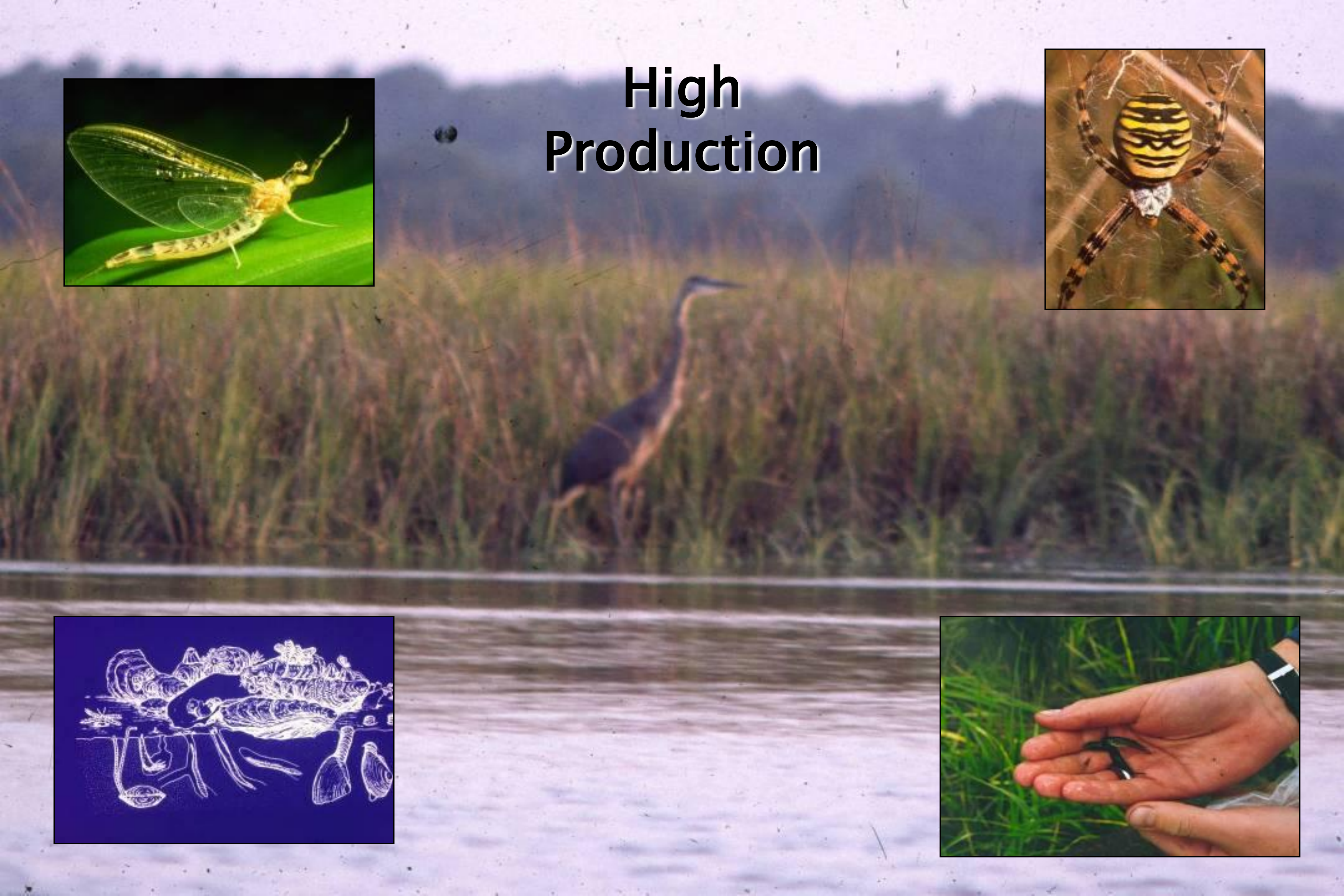


Rutgers University


Tidal Range up to 9’
Salinity <0.5 ppm
Geomorphic Setting
Back barrier lagoon, other
Back barrier lagoon, flood tidal delta
Back barrier lagoon, lagoonal fill
Estuarine marsh
Estuarine, fringe
Estuarine, meander
Saline fringe
Tidal fresh forest
Tidal fresh marsh
Pennsylvania
New Jersey
Delaware Bay
Delaware
PA
NY
NJ
MD
DE
VA

Delaware Estuary *Spartina* Marsh




High
Production


Nursery Habitat

Recreation

Tidal Wetlands

A Signature Trait of the Delaware Estuary System

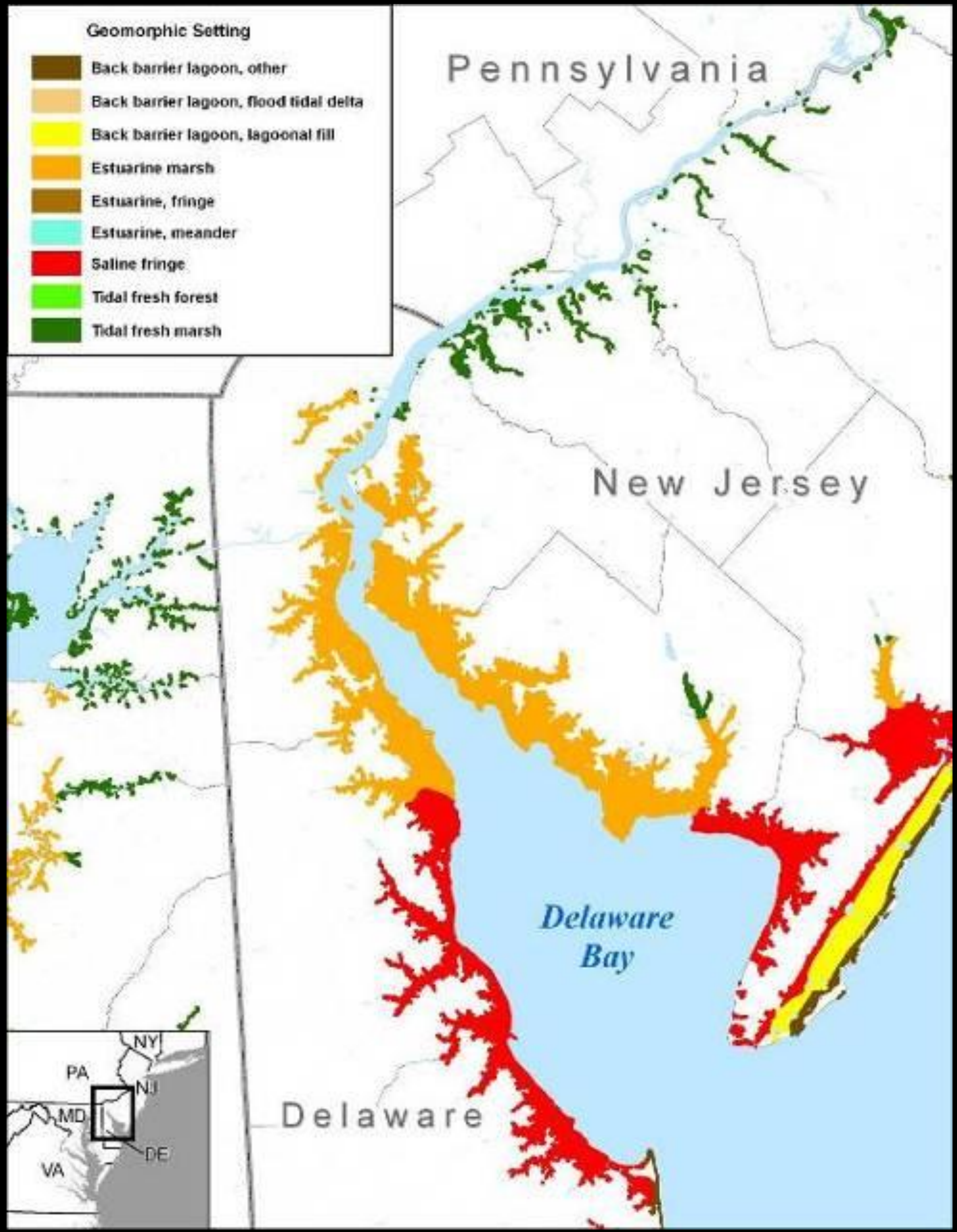
<u>Ecological Values</u>:

Structural

habitat for fish and wildlife
nurseries for imperiled taxa

Functional

food web
water quality
flood protection



Carbon Sequestration

Some Literature

"Temperate wetlands accumulate 1.42 tons C ha^{-1} yr^{-1} " (Bernal and Mitsch 2008)

"Wetlands represent the largest component of the terrestrial biological C pool, and thus play an important role in global carbon cycles." (Chmura et al. 2003).

Denmark : "Wetland soils have the highest average soil organic carbon density (35.6 kg m^{-2}), followed by soils under forests (16.9 kg m^{-2}), agricultural soils (14.0 kg m^{-2}), and soils under natural vegetation (14.4 kg m^{-2})" (Krogh et al 2003).

Since degraded agricultural soils have lower soil organic carbon than forests and wetlands, conversion of agricultural lands to forests and wetlands can enhance SOC stock through C sequestration, and vice versa

Variability in sediment accumulation rates within marshes is a major control of carbon sequestration rates, thus sediment deprivation may lower CS

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

Carbon Sequestration

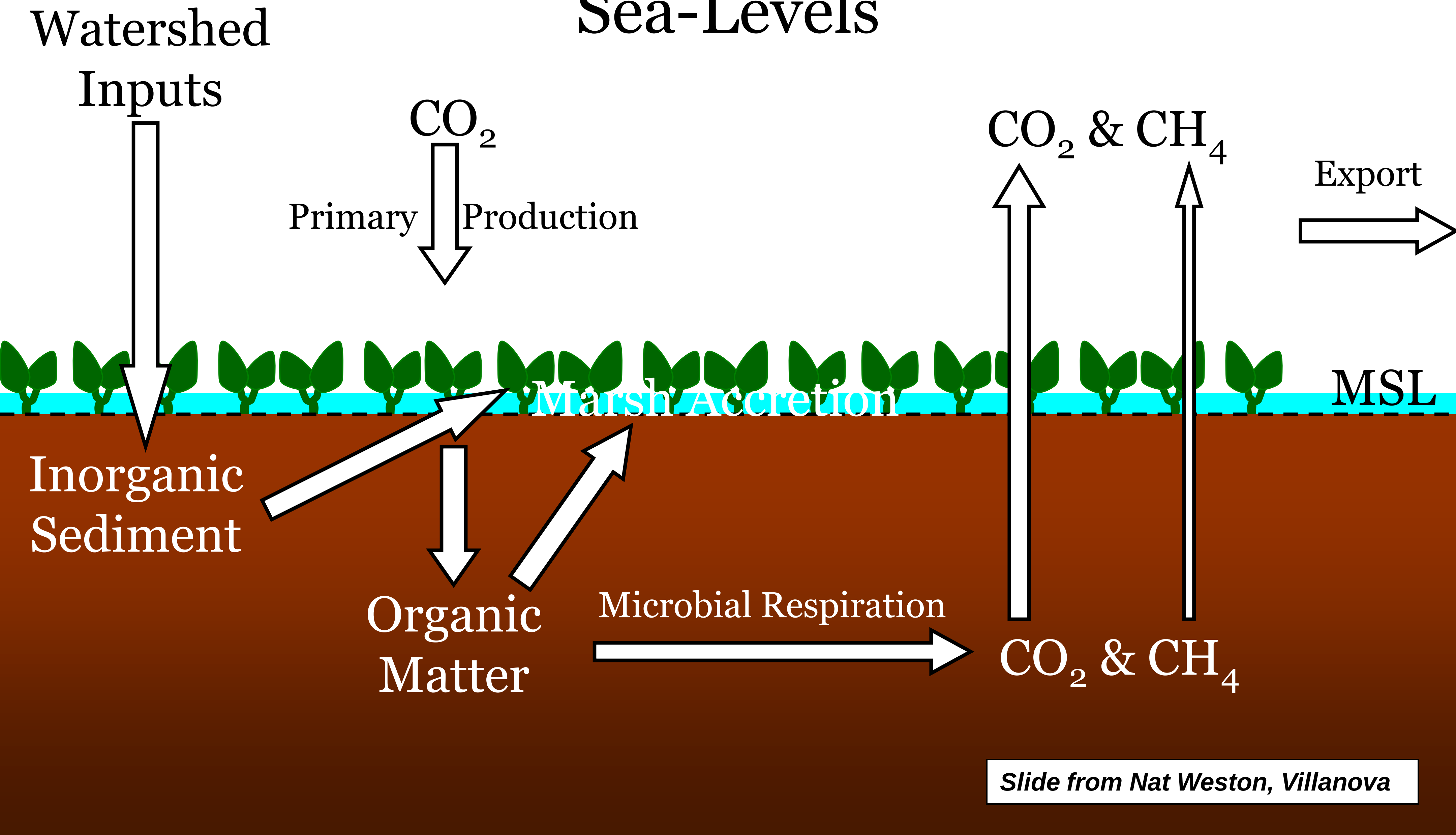
Uncertainties and Variability

Variation in Soil/Substrate Storage of C?
Difference CS between fw tidal and salt marshes?
Methane Release, C loss term (15% of fixation)??
Interspecific Variation in CS?
Aboveground vs. Belowground CS?
CS variation along stressor gradients?
Climate change effects on CS?
as per Craft's work on N sequestration

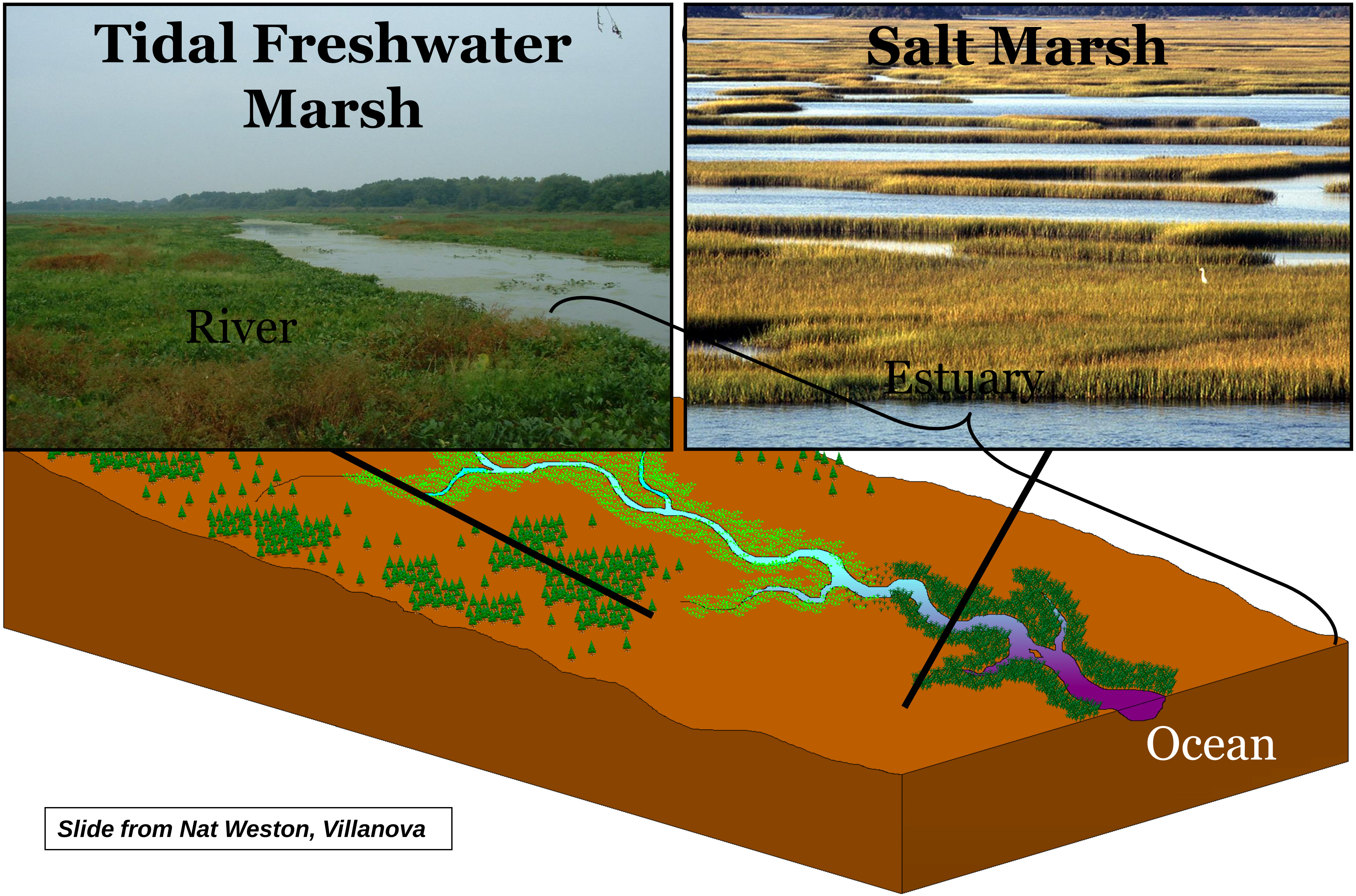
Same Uncertainties for Forests and Other Habitats

Marshes Must Accrete to Keep Pace With Rising Sea-Levels

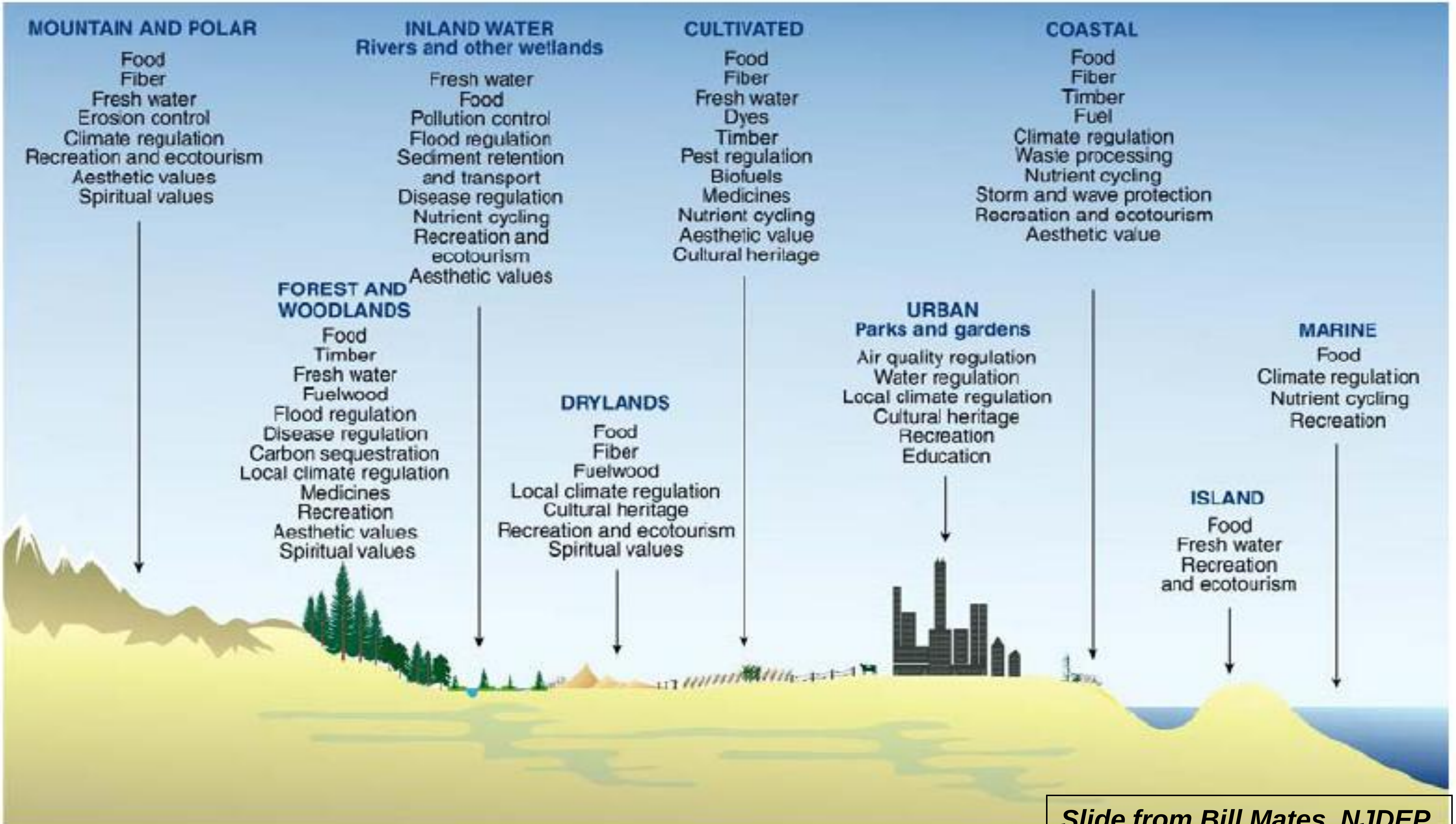
Mass Balance in Tidal Marshes



Slide from Nat Weston, Villanova


Tidal Freshwater Marsh
Salt Marsh
River
Estuary
Ocean
Slide from Nat Weston, Villanova

Different Ecosystems→Different Benefits

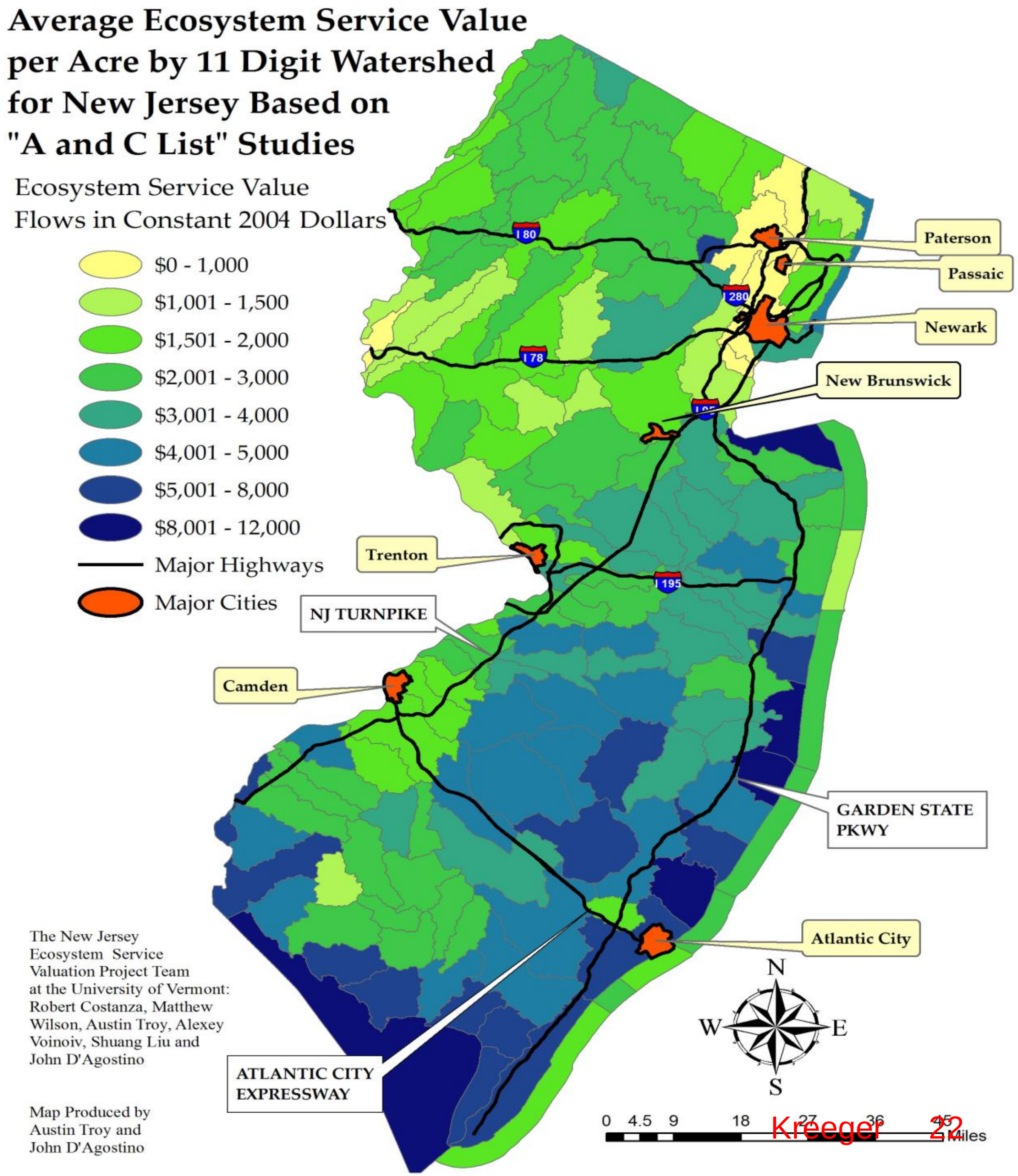


Source: Philippe Rekacewicz, Millennium Ecosystem Assessment (2005)

Slide from Bill Mates, NJDEP

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

New Jersey Department of Environmental Protection



Slide from Bill Mates, NJDEP

Vulnerability and Status

Slide from Chris Bason (Center for Inland Bays, DE)

Tidal Wetlands

A Signature Trait of the Delaware Estuary System

<u>Ecological Values</u>:

Structural

habitat for fish and wildlife
nurseries for imperiled taxa

Functional

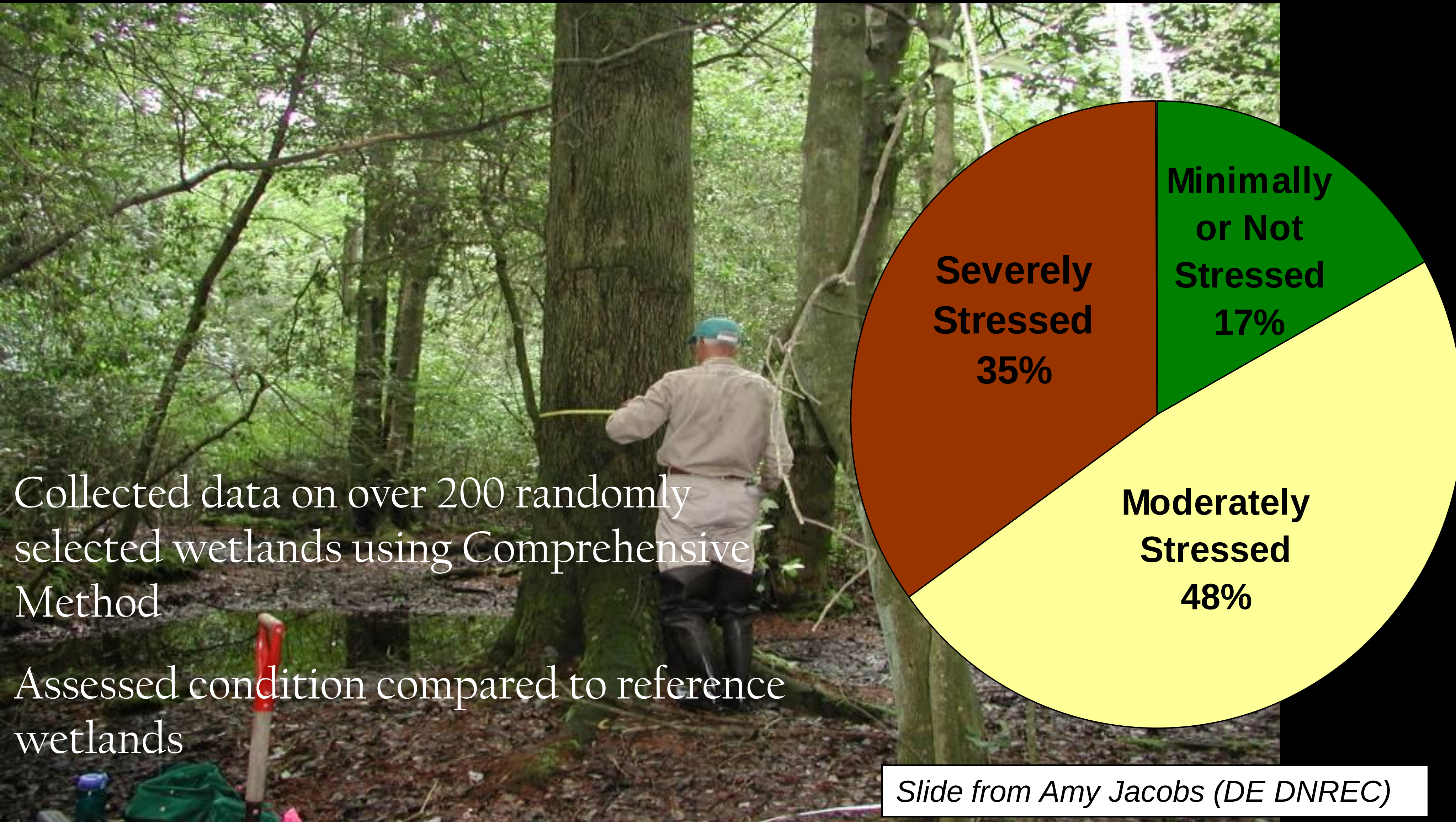
food web
water quality
flood protection

<u>Concerns:</u>

Degradation


Degradation

Condition of non tidal wetlands in the Nanticoke River watershed

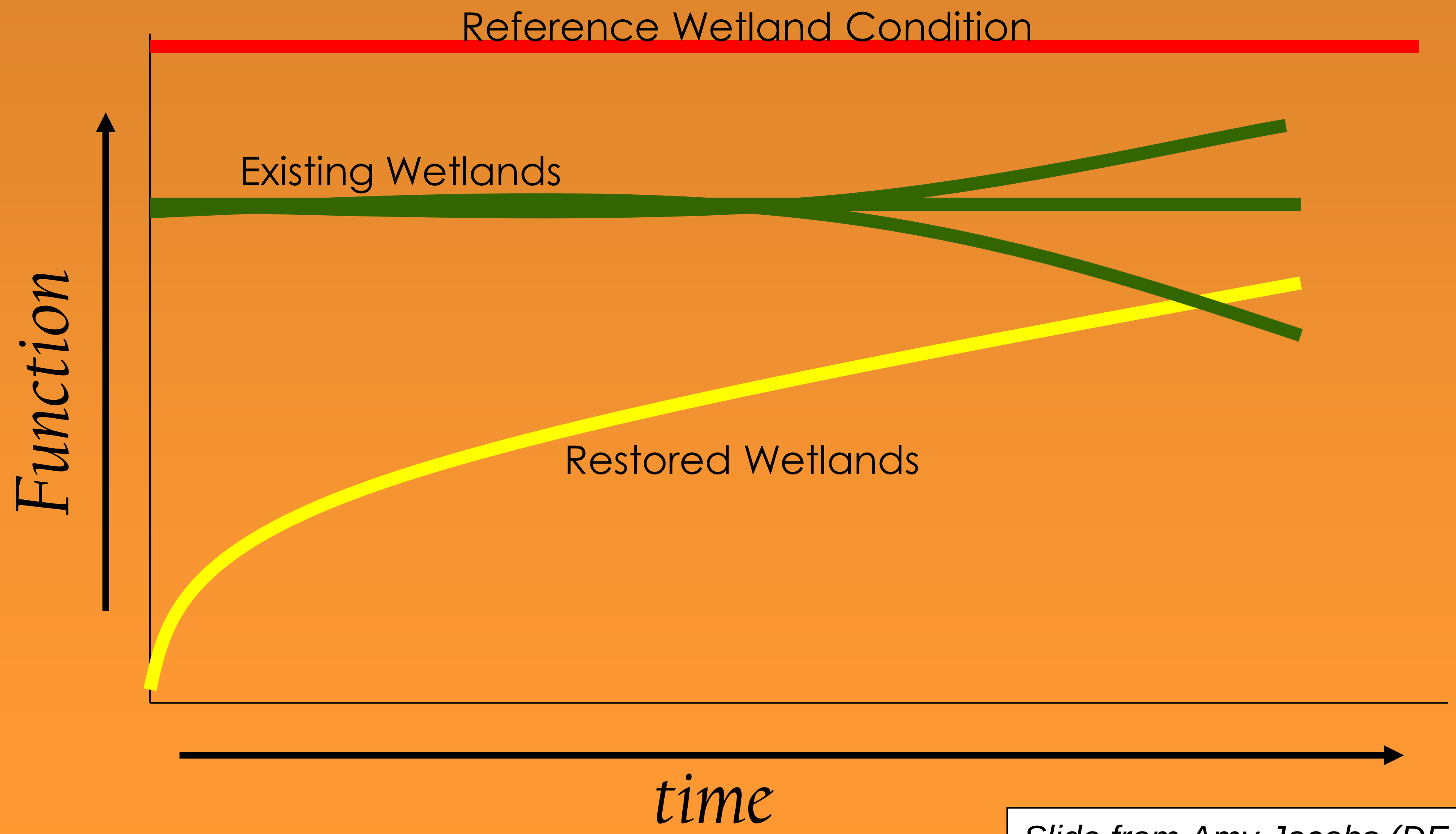


Collected data on over 200 randomly selected wetlands using Comprehensive Method

Assessed condition compared to reference wetlands

Slide from Amy Jacobs (DE DNREC)

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

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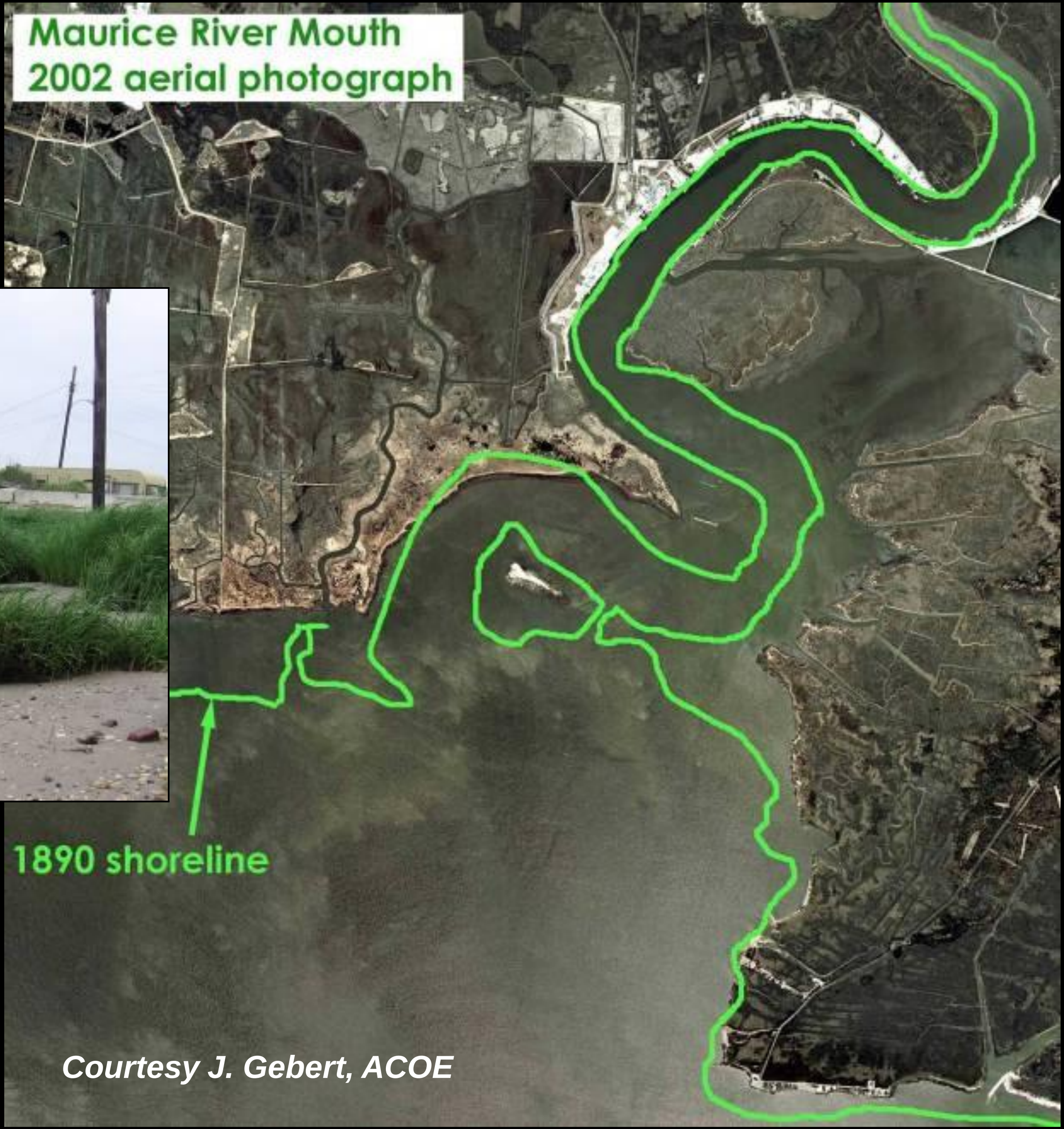
Shoreline Erosion

Courtesy D. Bushek, Rutgers



Courtesy J. Gebert, ACOE

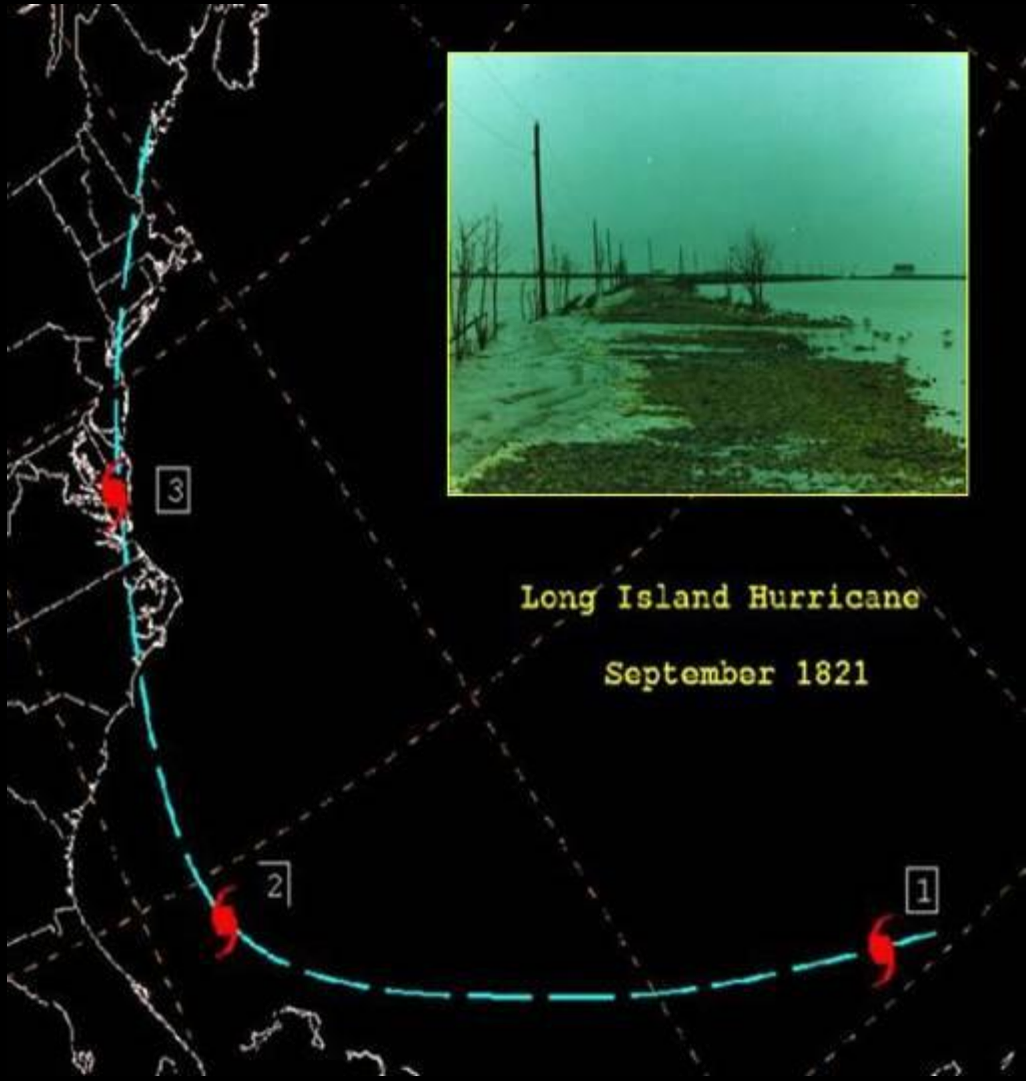
Tidal Wetlands

Ecological Values:

Structural
habitat
Functional
food web
water quality
flood protection

Concerns:
Degradation
Conversion & Loss
Sea Level Rise

Storms



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Tidal Wetlands

Ecological Values:

Structural
habitat
Functional
food web
water quality
flood protection

Concerns:
Degradation
Conversion and Loss
Sea Level Rise
Storms

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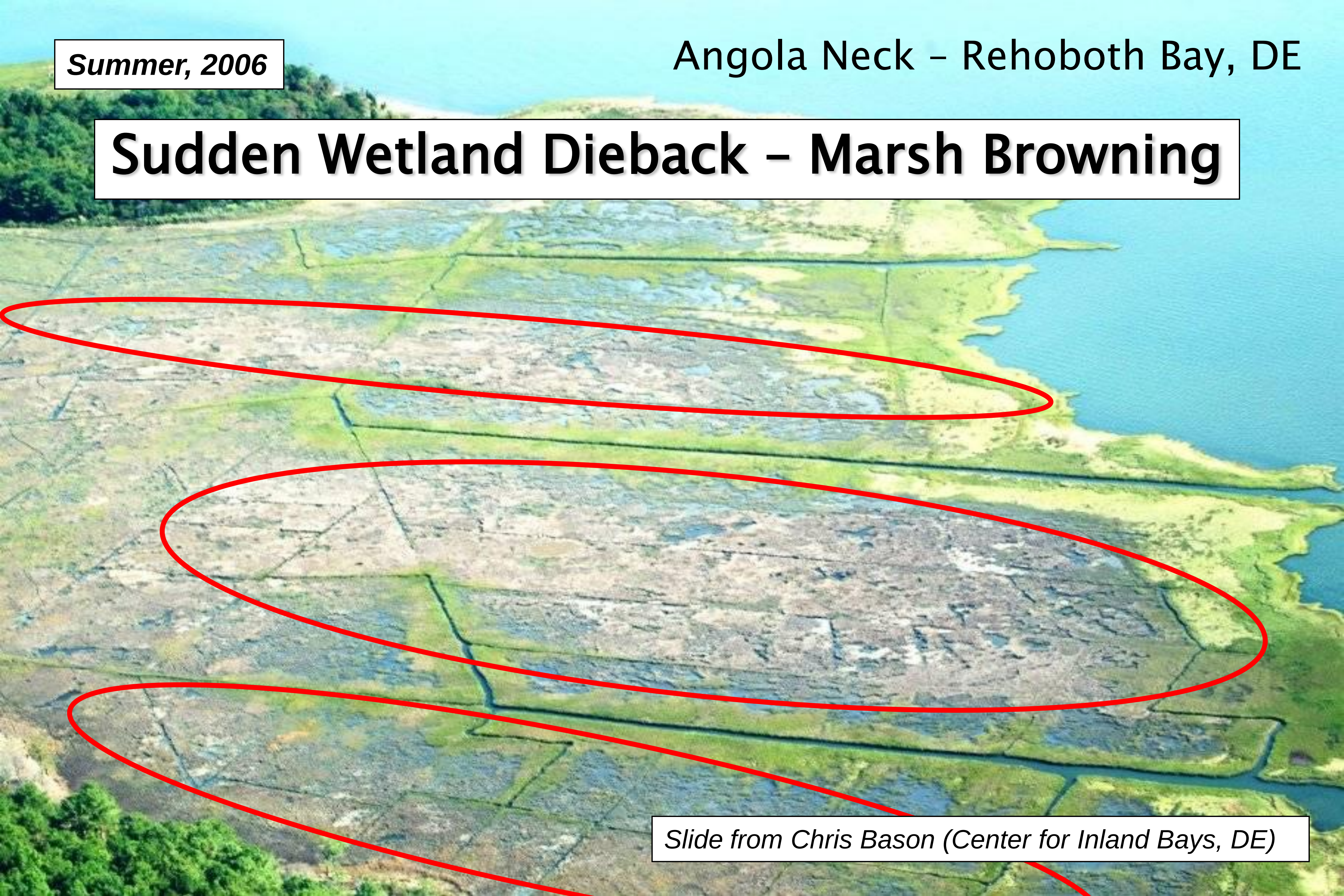
Sediment budget


Summer, 2006
Angola Neck – Rehoboth Bay, DE
Sudden Wetland Dieback – Marsh Browning
Slide from Chris Bason (Center for Inland Bays, DE)

VOLUME 17 • ISSUE 2 • WINTER 2007

ESTUARY NEWS

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

Climate Change Hits Home

By Kathy Klein, Executive Director, Partnership for the Delaware Estuary

As I was driving to work one recent morning, thinking about writing this article and listening to National Public Radio, I learned that the Bulletin of Atomic Scientists has concluded that the threat posed by climate change is second only to that posed by nuclear weapons. Although I am actually relieved that climate change is finally getting the attention it deserves, I am also keenly aware that time continues to tick away as world leaders and other policymakers explore ways to address global warming and its environmental impacts.

Being the visual person that I am, I can't seem to forget the recent image in the media of a lone polar bear floating on a piece of ice that had broken off the Arctic icecap as a result of melting. What most people do not realize, however, is you do not have to go to the Arctic to see the results of global warming. For many years, scientists in the Delaware Estuary have noted the dieback of upland

tant to realize, however, that there are small steps each one of us can take in our daily lives that, when multiplied, can make a meaningful impact.

One of these small steps is the use of compact florescent light bulbs (CFLs). CFLs use up to 75 percent less energy than regular incandescent light bulbs while lasting approximately eight times longer, and this results in less production of greenhouse gas emissions, air pollution, and toxic waste. The average CFL will save its owner at least $55 in energy costs over its lifetime. If every U.S. household replaced one bulb with a CFL, it would have the same impact as removing 1.3 million cars from the road.

I love a challenge and I hope you do too. Therefore, I would like to challenge the readers of "Estuary News" to make the switch at home, in at least one light fixture, from an incandescent light bulb to a CFL. If you already use CFLs in your home, why not make the


So What Can We Do?

Opportunities for Boosting Carbon Sequestration

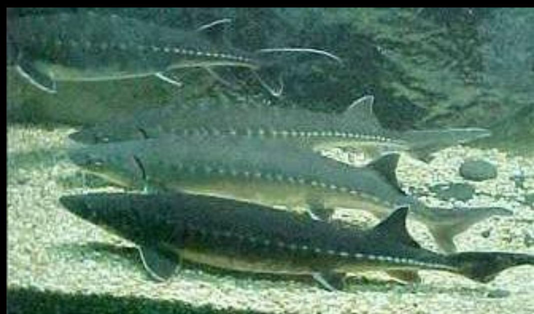
Protection, Restoration and Enhancement

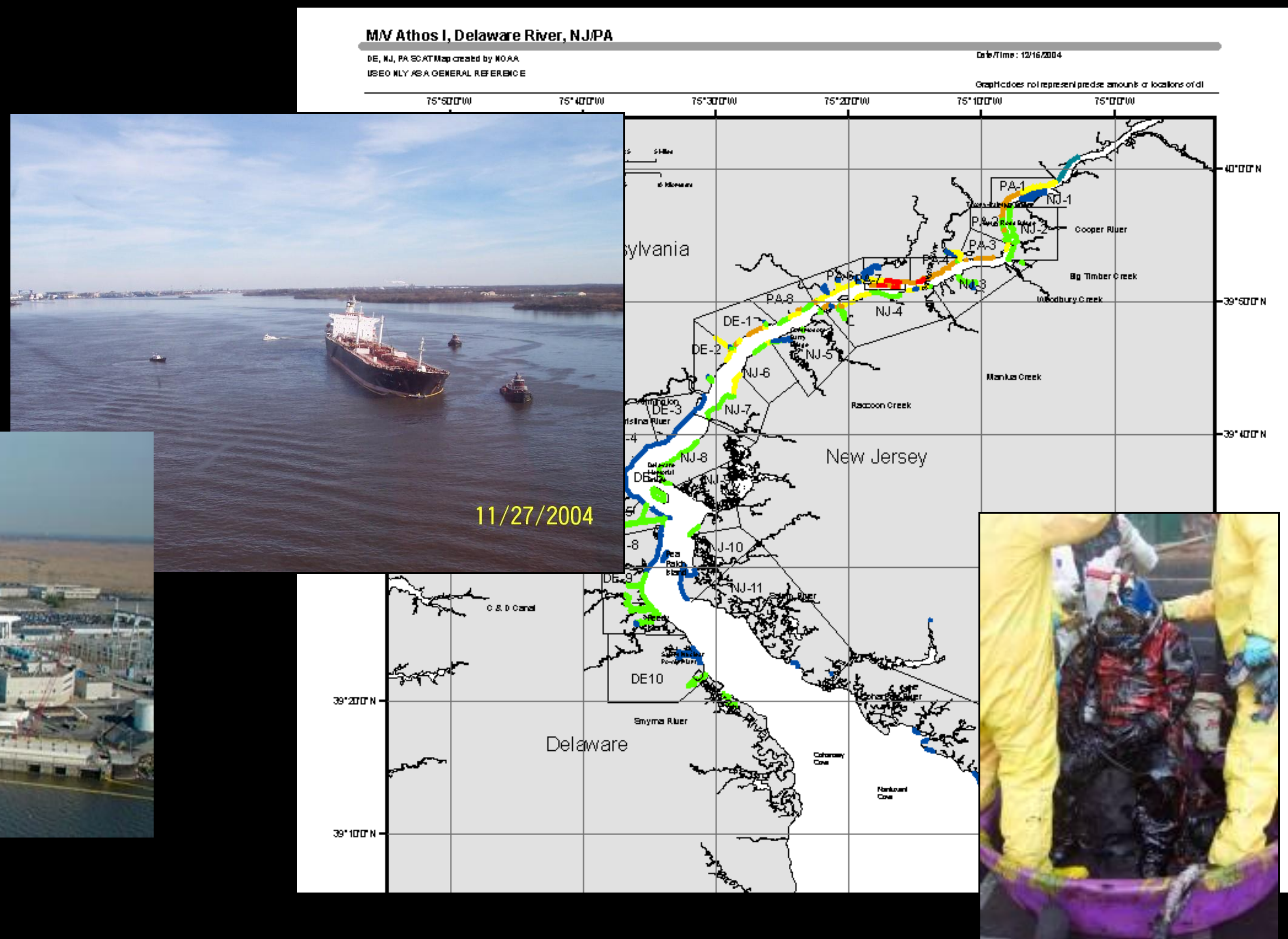
Shoreline Protection, Living Shorelines

Monitoring, Assessment and Science

What Can We Do?

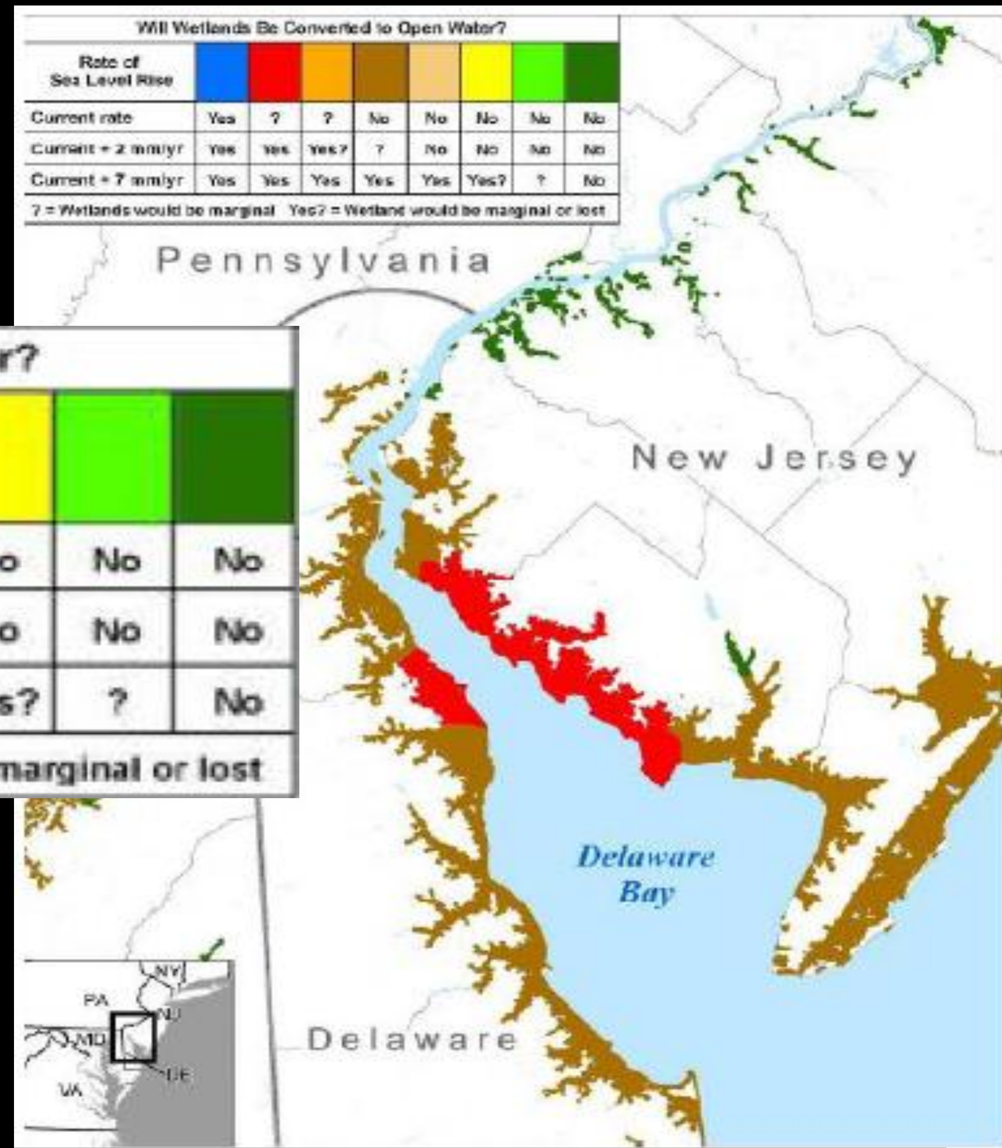
1. Build Resiliency
Protect and Conserve





Vulnerability: will wetlands be converted to open water?

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								



Reed et al., unpublished draft as of Feb. 2008

Slide adapted from Michael Craghan, Rutgers

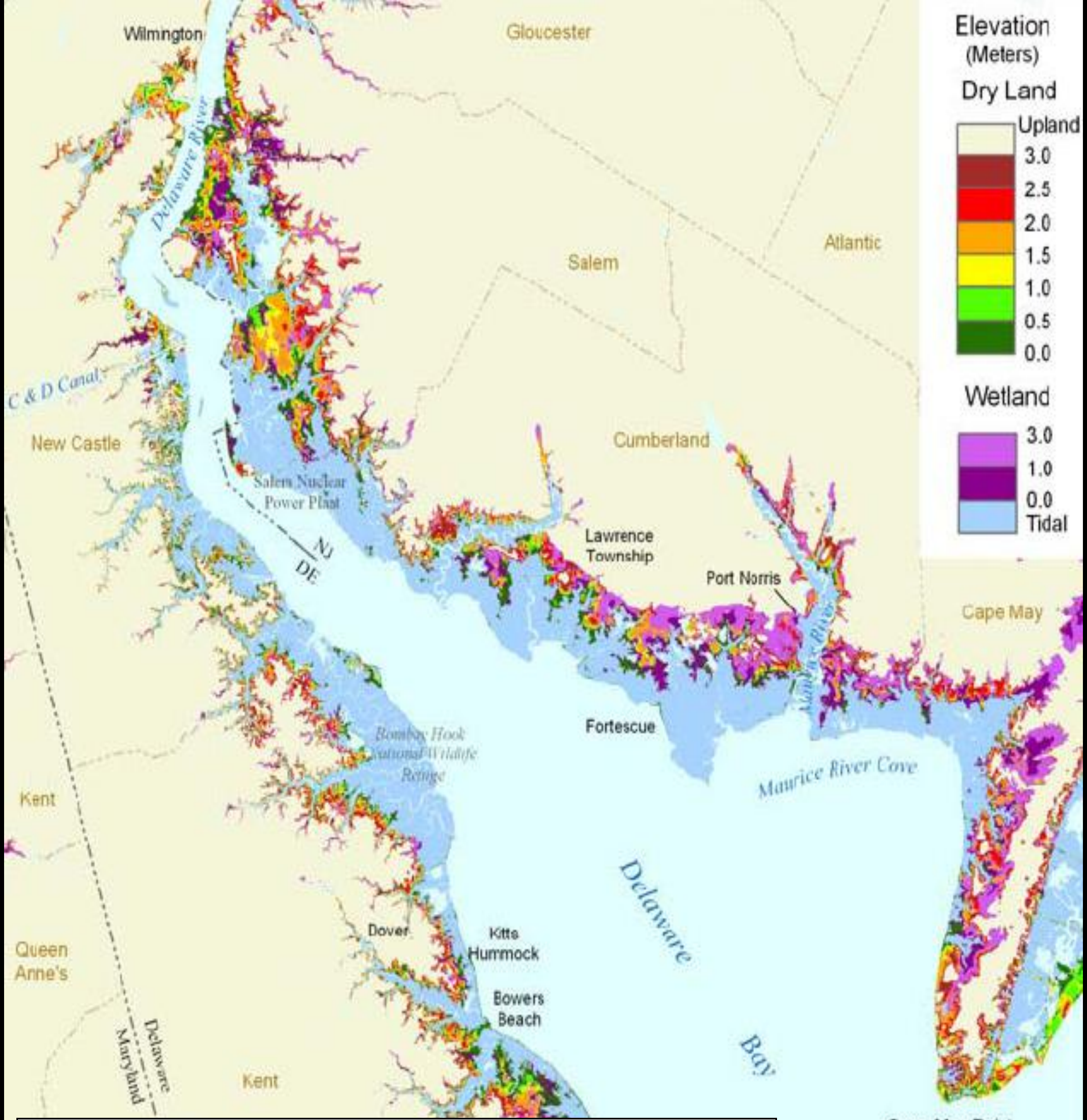
Tidal marshes need to move:

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

and/or

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

Can they do it?

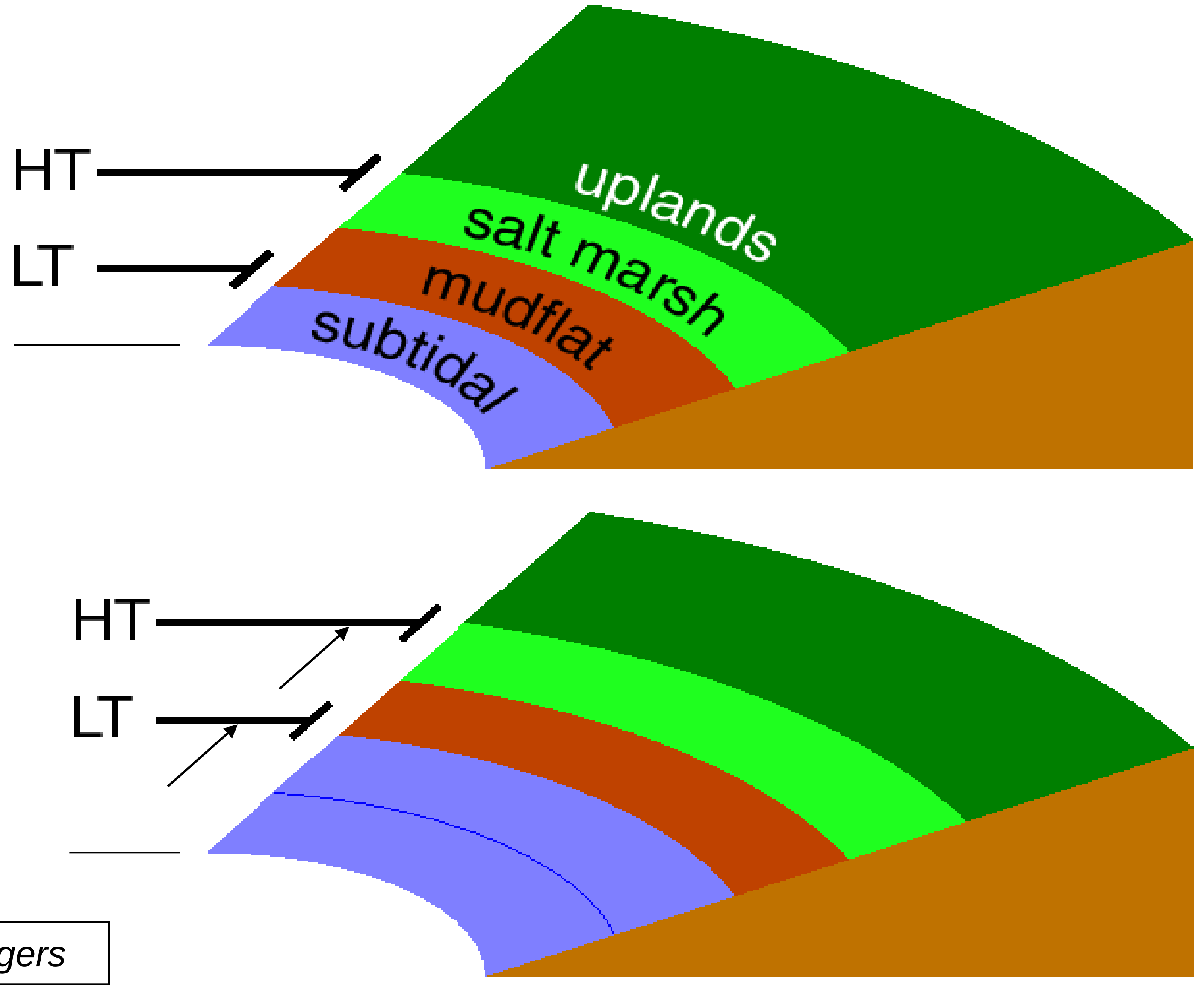


Slide adapted from Michael Craghan, Rutgers

SLR and transgression

Env'l types are controlled by the frequency, depth, and salinity of tidal flooding.

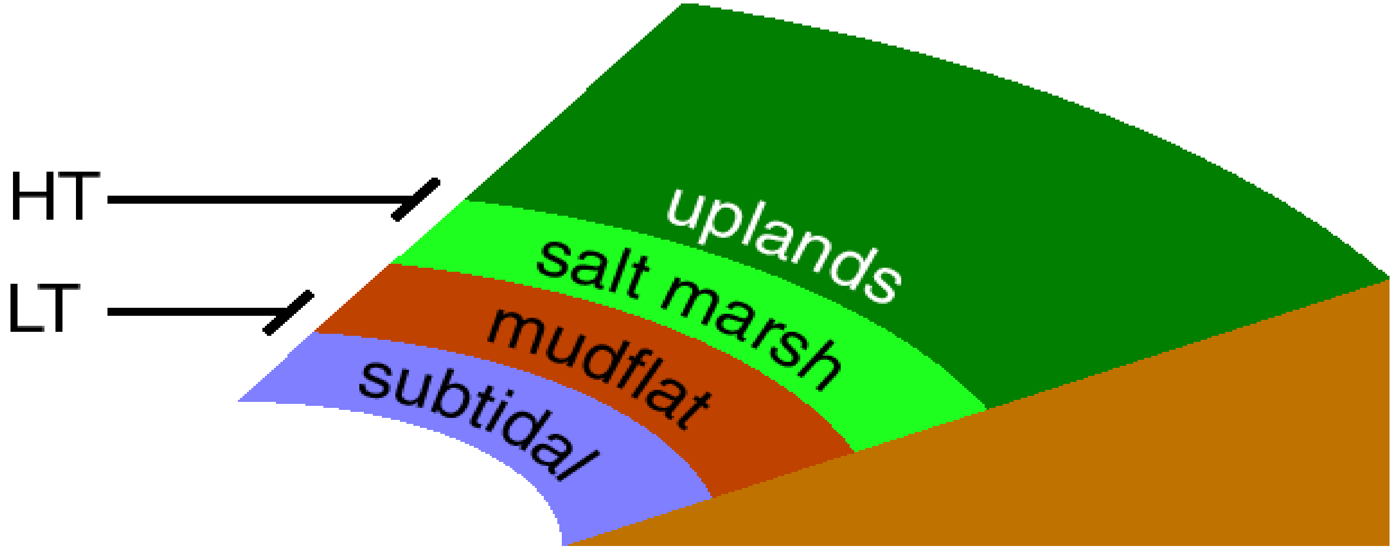
As sea-level rises, the environments shift with the changing flood conditions.



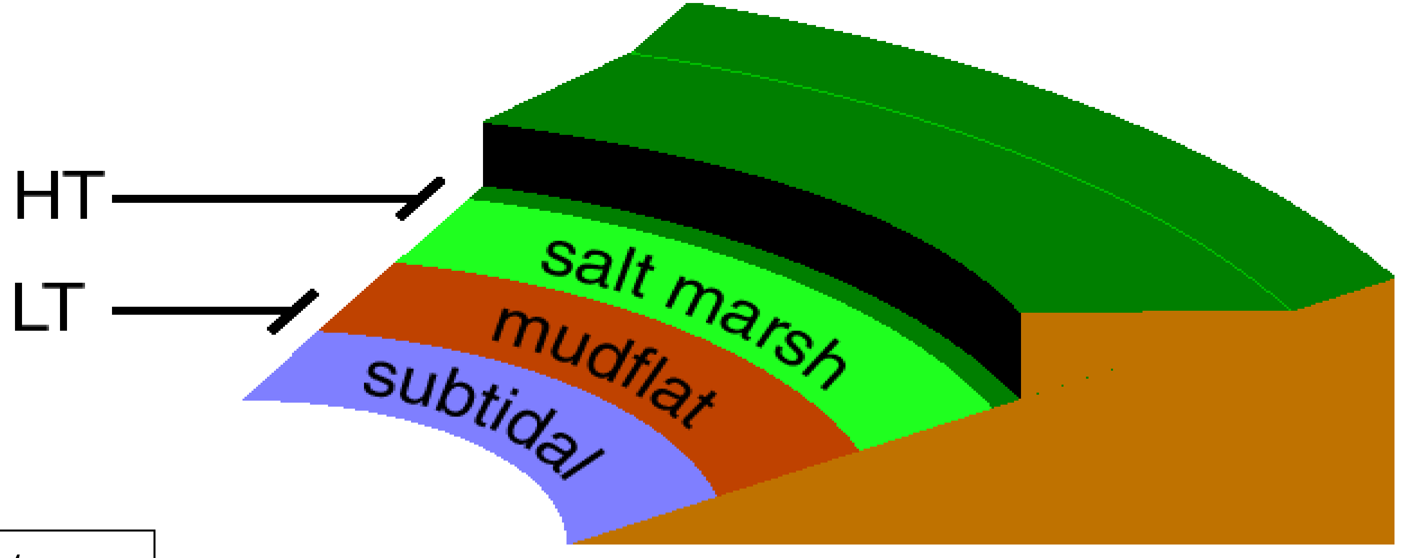
Slide from Michael Craghan, Rutgers

Stepped terrain

The terrain is not always as orderly as shown in block diagrams.



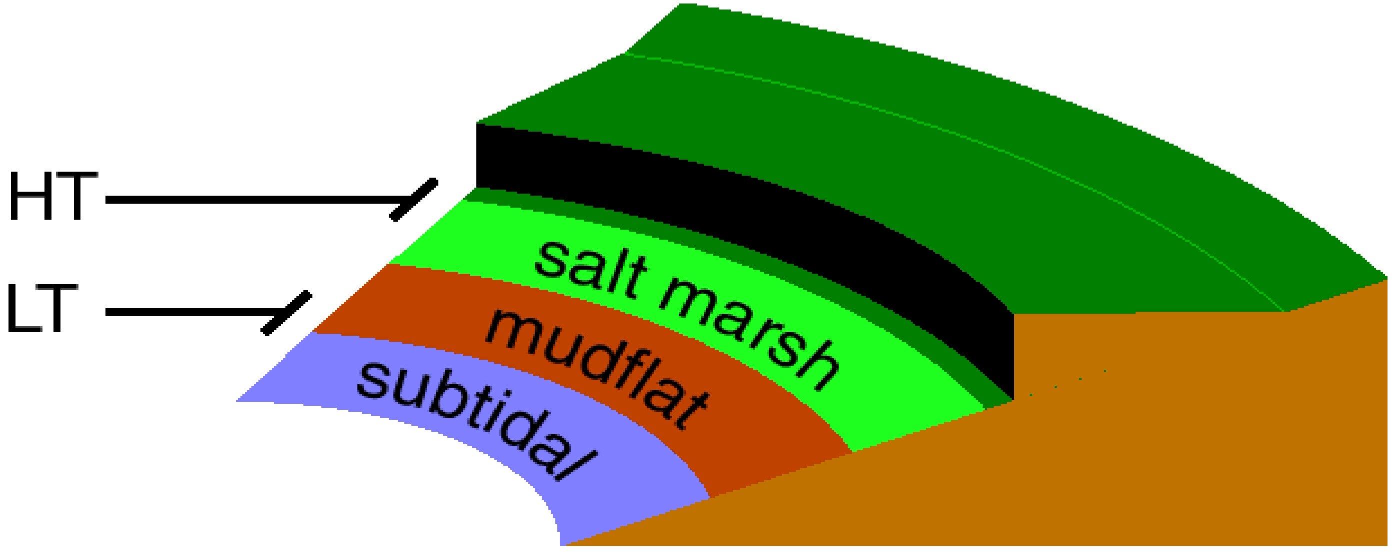
Elevation steps (which could be bluffs, roads, bulkheads, etc.) are often part of the landscape.



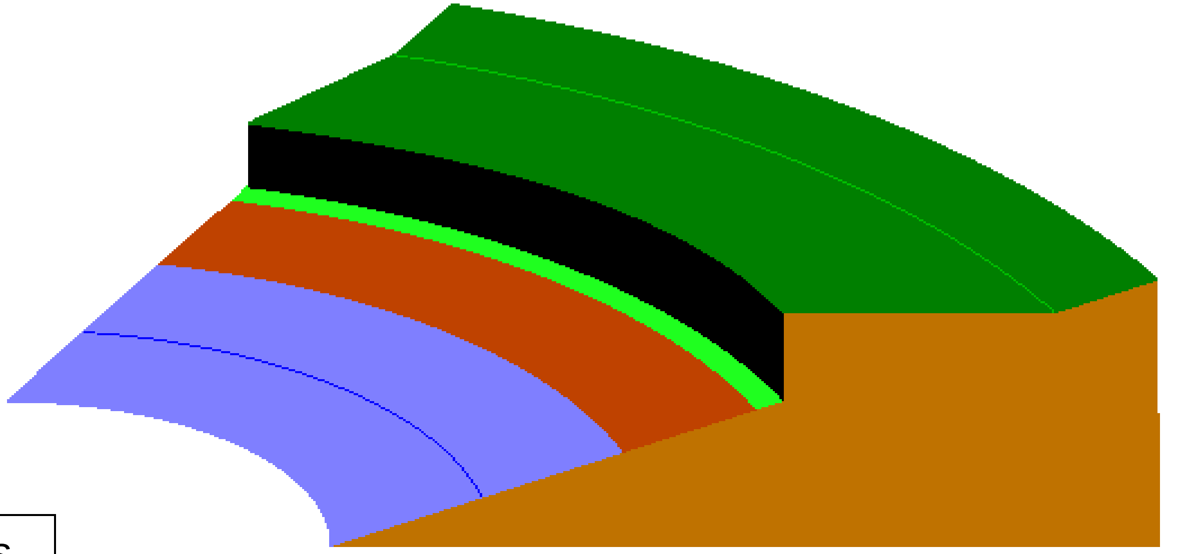
Slide from Michael Craghan, Rutgers

The “coastal squeeze”

Irregular terrain keeps SLR from producing a neat, orderly shoreline transgression.



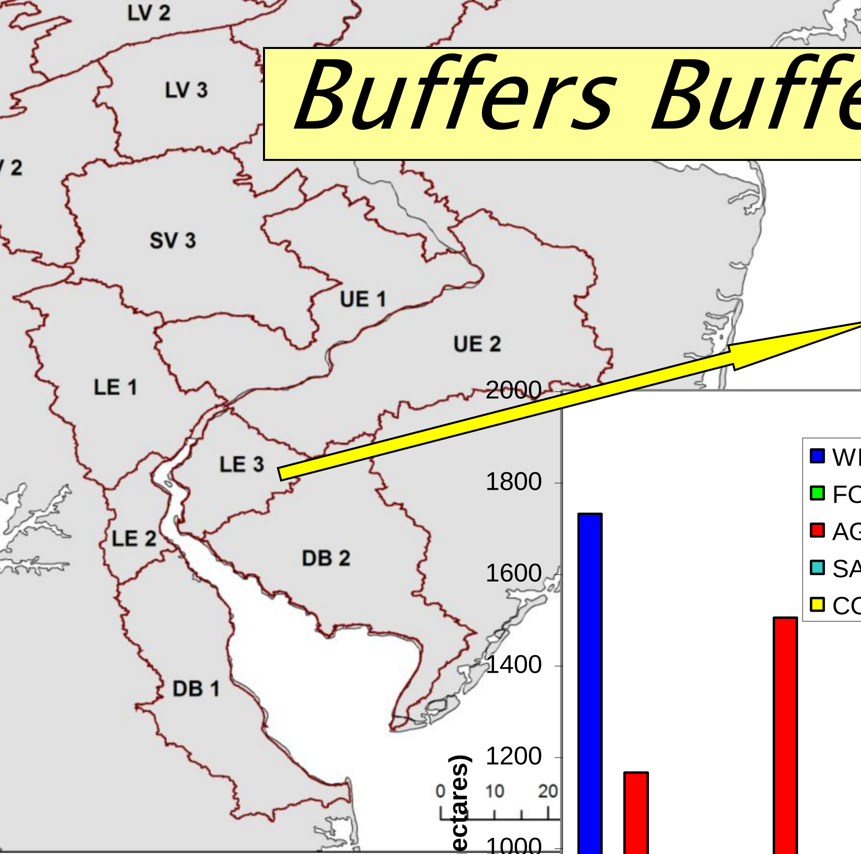
Instead, habitats such as tidal marshes get squeezed between rising waters and barriers, and are progressively lost.

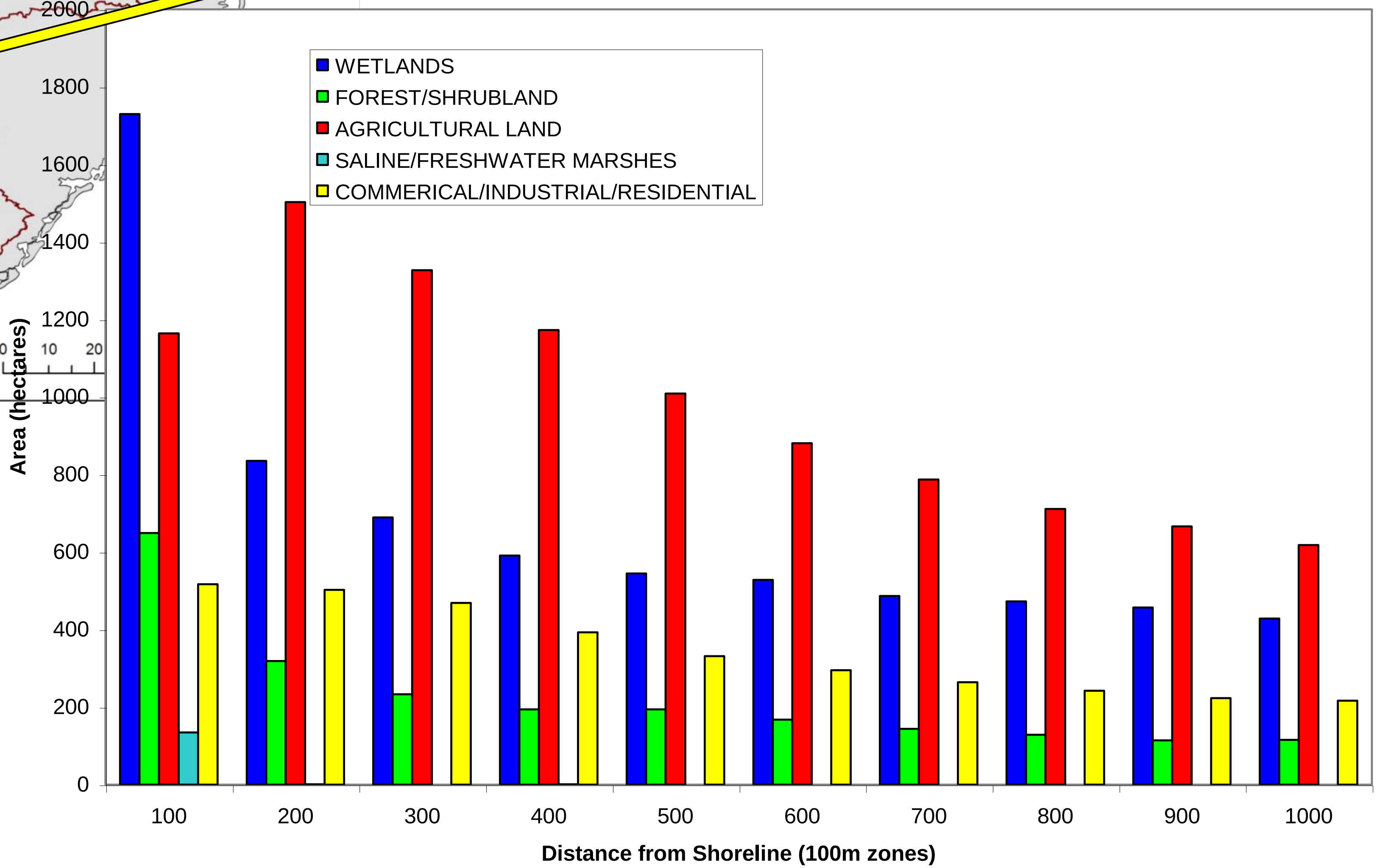


Slide adapted from Michael Craghan, Rutgers

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..

Shovel Ready Projects !!

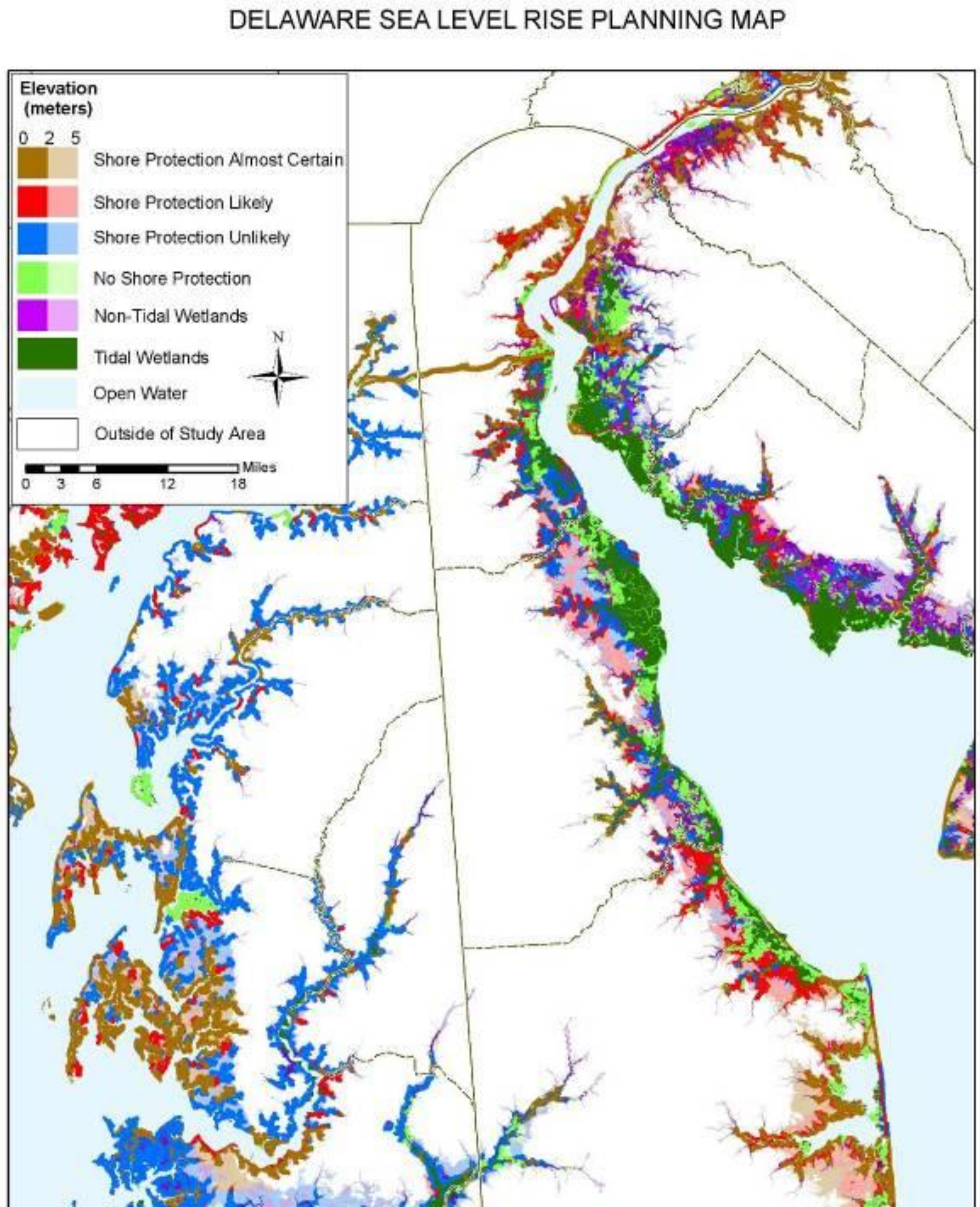
...But Smartly

Regional Restoration Coordination

US Climate Change Science Program
Draft Prospectus Section 4.1

Coastal Elevations and Sensitivity to Sea Level Rise

http://www.climatescience.gov/



Added Complexity

- Ecological Flows
- Land Use Change
- LNG Terminal
- Spills, NRDA
- Dredging
- Withdrawals
- Inundation, SLR
- Horseshoe Crabs, Red Knots
- Emerging Pollutants

Restoration for the Future

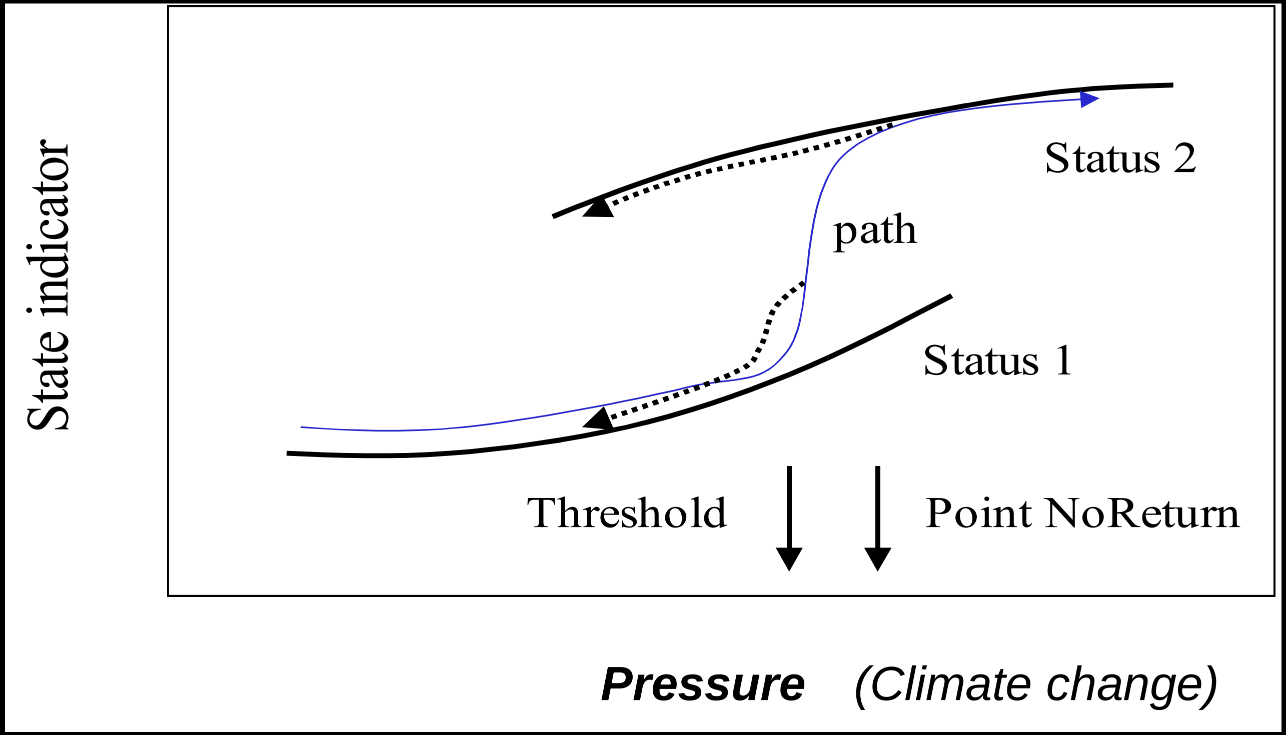
Restore, conserve or otherwise enhance ecosystem structure and function

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Slide from Carlos Duarte

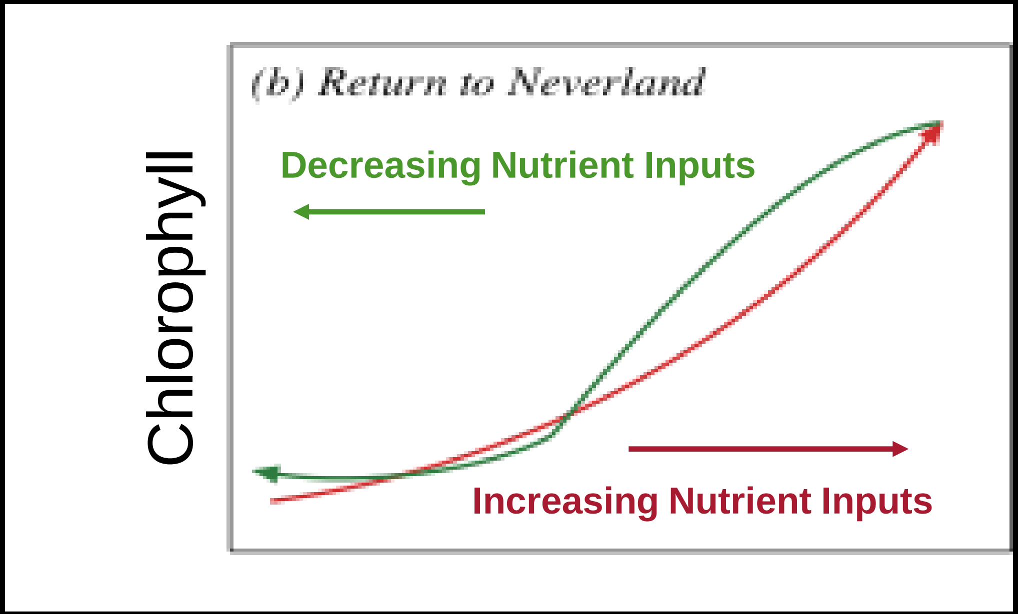
What are Ecological Thresholds?

- Non linear behavior, representing shifts in ecosystem status
- Characterized by thresholds or ”tipping points” that represent breaking points of the system
- Once breached, ”recovery” may be slow or unlikely

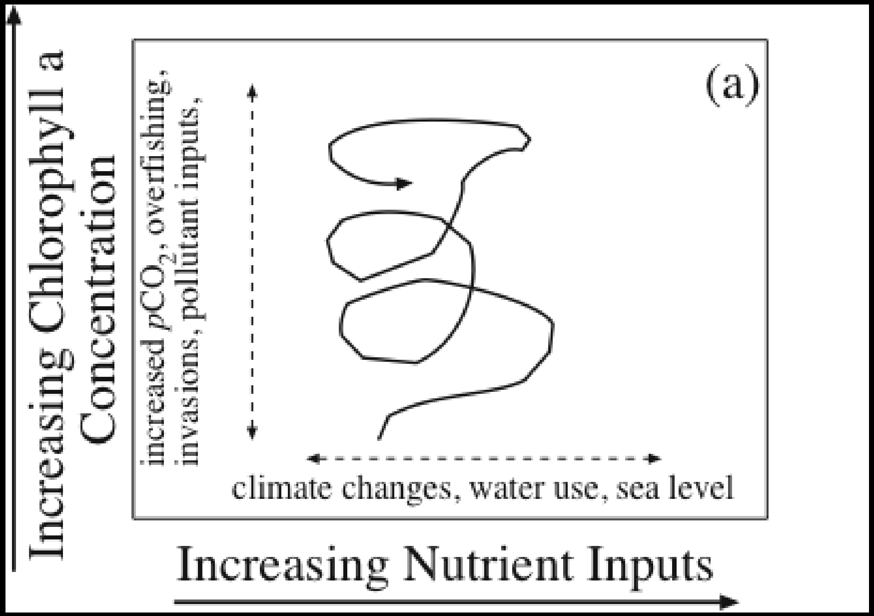


Knowing where these tipping points are will be extremely valuable to set policy targets (Climate-driven Thresholds)

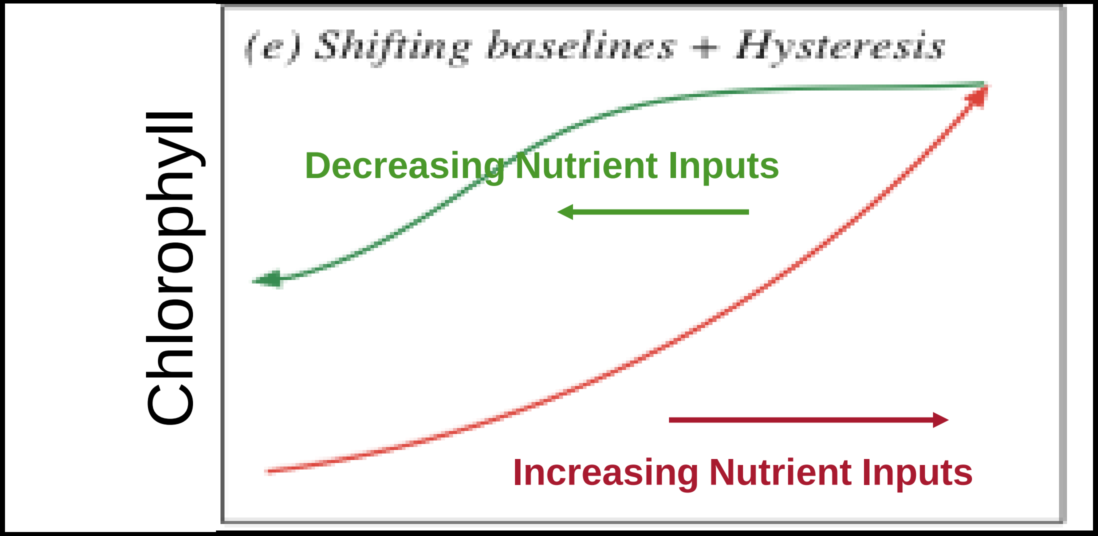
The Expectation



Slide and principles, Duarte et al. (submitted)



The Reality



Ecosystem Trajectories Rarely Reverse Course

"Reference Values" are Dynamic

New Buffers Become Established to Reinforce New Steady States

So, "Restore" for the Future by Building ESV (e.g. Carbon Seq.)

On-the-Ground Projects
"Living Shorelines"

Slide adapted from R. Brumbaugh's, and Courtesy L. Coen, SCORE South Carolina

Delaware Estuary Living Shoreline Initiative

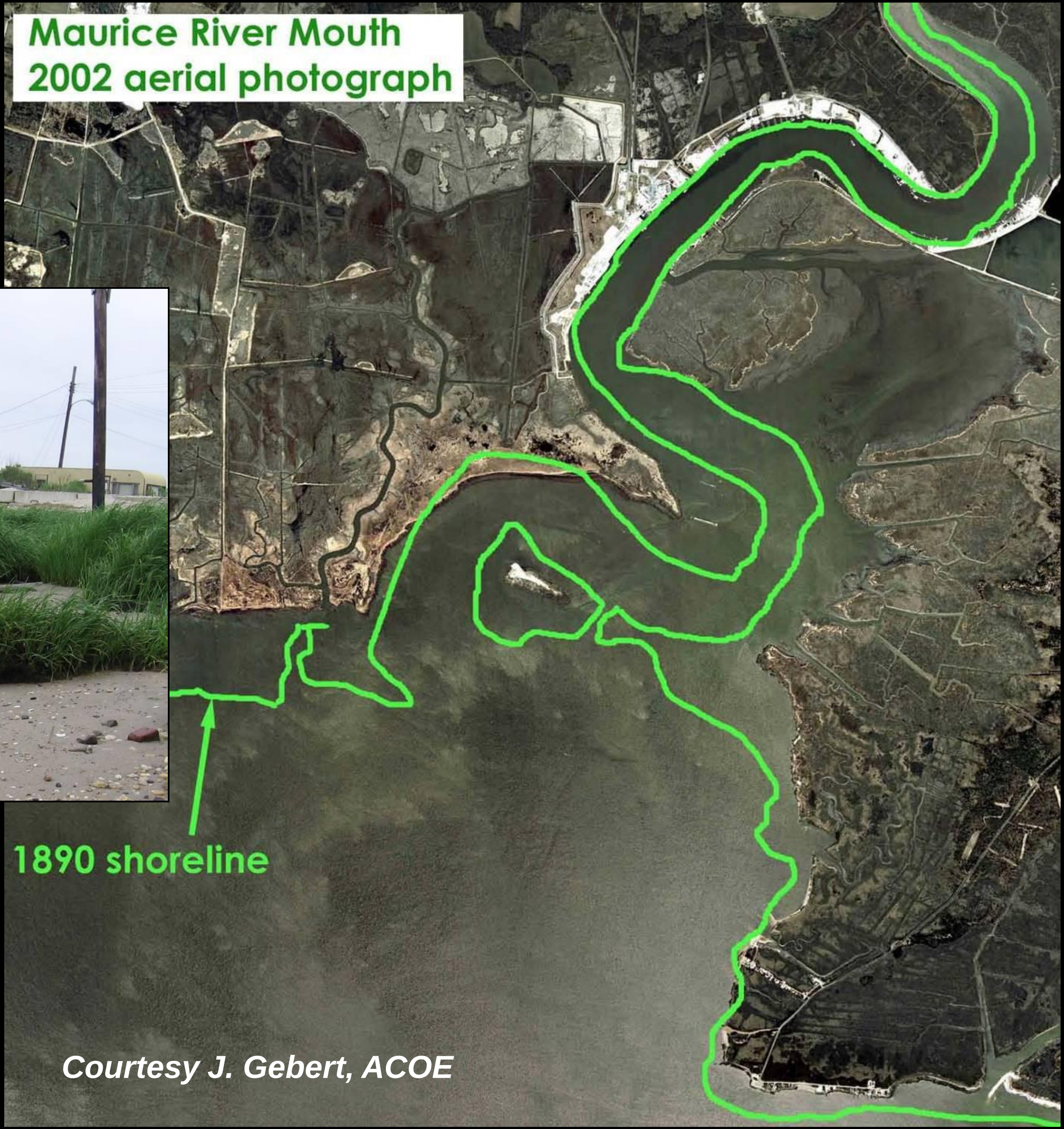
Shellfish as Natural Breakwaters

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

Slide from Dave Bushek, Rutgers

Shoreline Erosion

Courtesy D. Bushek, Rutgers



Courtesy J. Gebert, ACOE

Fringing intertidal oysters not common in Delaware Bay – Mussels to the rescue?


Ecosystem Engineers

Shoreline Stabilization

Coir Biologs and Mats: a strategy to reduce erosion while encouraging mussel recruitment or enabling seeding of mussels

Coconut fibers (coir) are spun or woven to create mats or bound into logs to create biodegradable ‘soft’ armor for stream bank and shoreline protection.

Designed to stabilize sediments to allow colonization by plants.

Fibrous structure also enables mussel colonization.

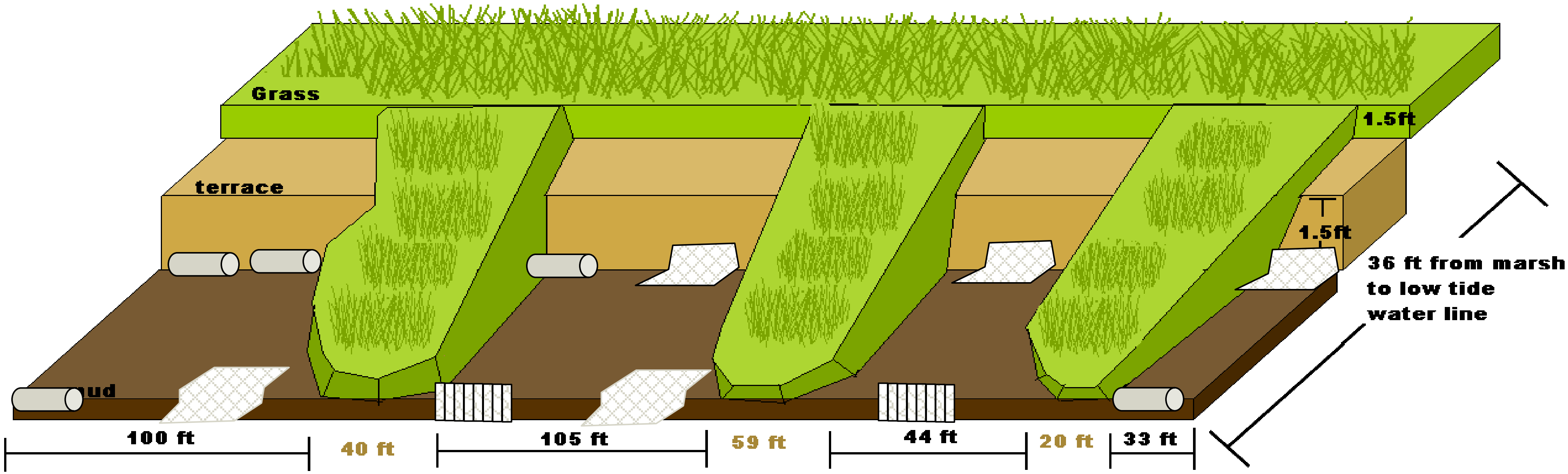
Mussels can recruit naturally or be seeded directly from wild populations, hatcheries or shellfish gardeners.

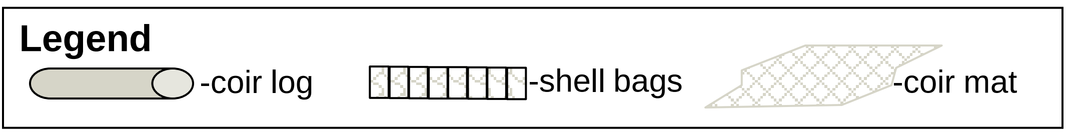
Living Shorelines

Maurice River sites

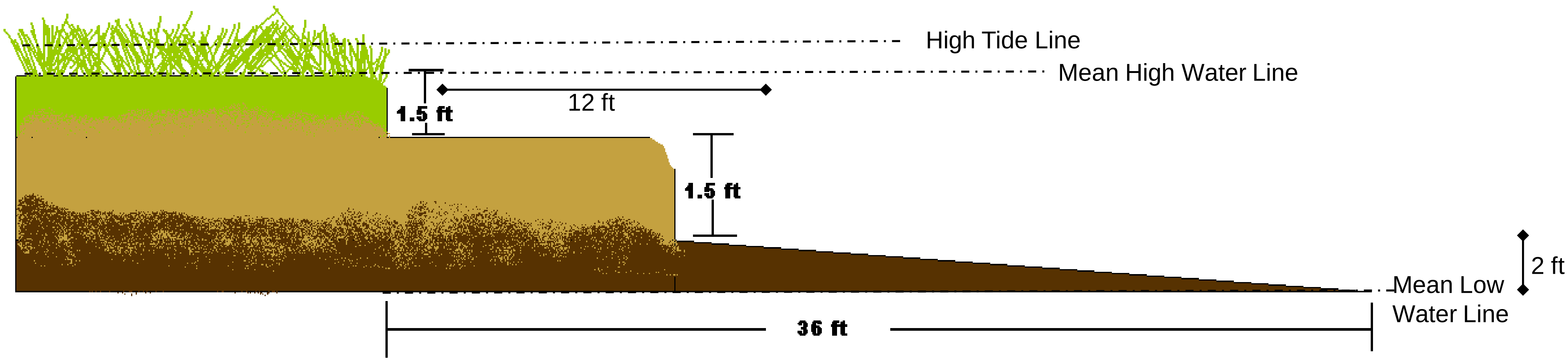
Energy and erosion decreases from A to D.

Within each site, a portion of the marsh edge is modified and portions are left unaltered as controls





Schematic of site C. Smaller distance to water creates steeper slope



Examples

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HASKIN SHELLFISH RESEARCH LABORATORY

ENHANCING THE FISHERIES OF NEW JERSEY

www.DelawareEstuary.org

Potential Initiative Study Sites

Watershed	NJ Wildlife Management Area (WMA)
Cohansey River	Dix WMA
Back Creek	New Sweden WMA
Nantuxent River	Nantuxent WMA
Fortescue Creek	Fortescue WMA
Dividing Creek	Berrytown WMA
Dividing Creek	Egg Island WMA
Maurice River	Heislerville WMA
Dennis Creek	Dennis Creek WMA
Pond Creek	Higbee Beach WMA

What Can We Do?

3. Monitor & Study

Although it is not drawn to scale, this graphic depicts the monitoring components that could someday be incorporated into DEWOOS. Red items are monitoring activities and hardware, the green areas are natural resources, and the black symbols represents system attributes and issues.

Development of a Estuary-Wide Strategy for Tidal Wetland Monitoring & Assessment:

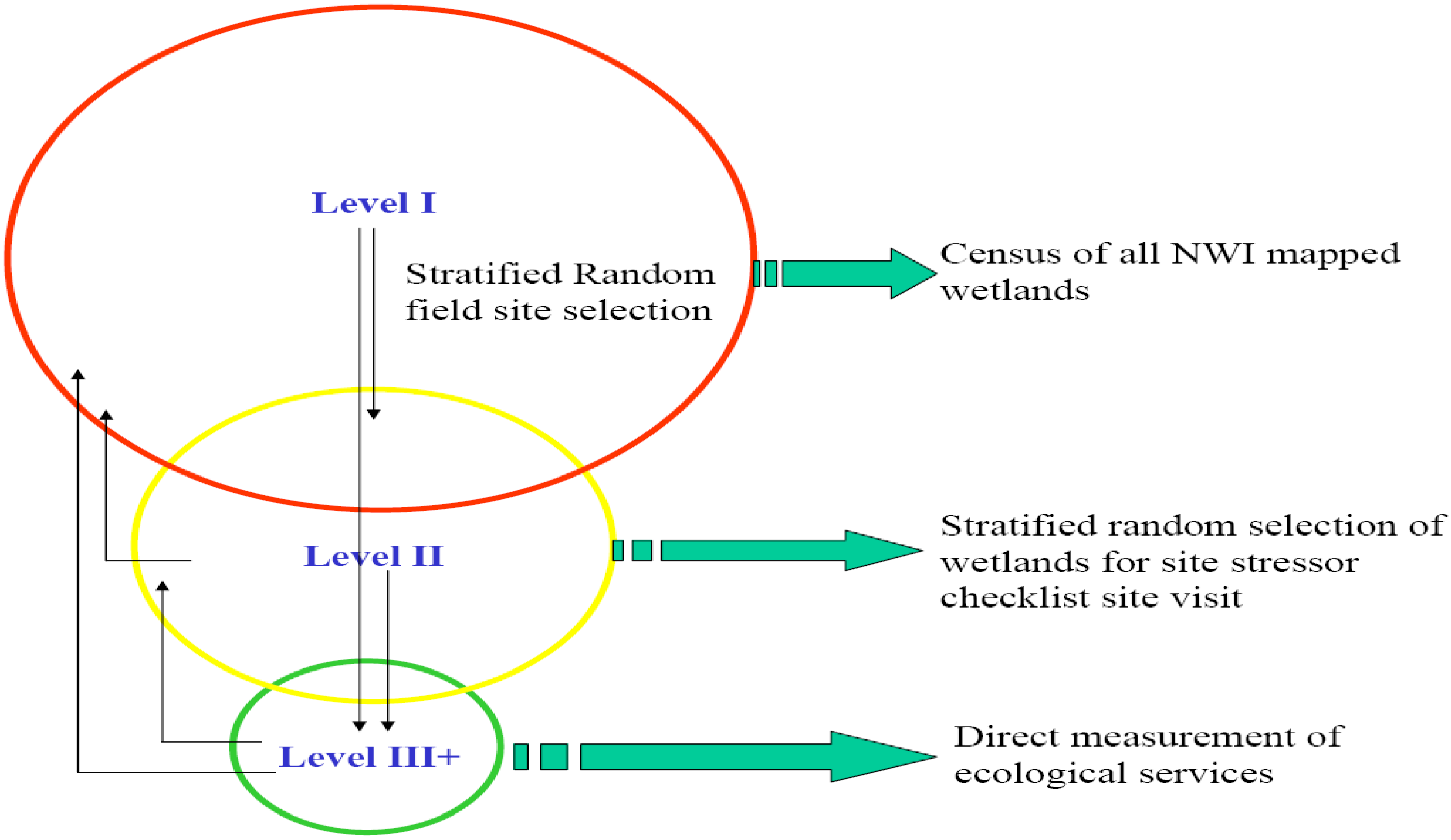
What parameters to monitor?

How to measure spatial extent?

How to detect precursors of wetland decline?

How to set up a meaningful sampling strategy?

Guidance from EPA



Slide from Regina Poeske (EPA Region III)

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

- Sample Frame
  all tidal wetlands in the Delaware Estuary

- Subpopulations
  wetland type (oligohaline, mesohaline, polyhaline)
  state (DE, NJ, PA)

DEWMAP Design:

Tier 1

Tier 2

Tier 3

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

Tier 3 Example Metrics

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

Tier 3 Fixed Stations:

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

Total DEWMAP Cost:

Tier	Year 1	Year 2	Year 3	Year 4	Year 5	Total
1	$25,000	$125,000	$30,000	-	-	$180,000
2	$25,000	$140,000	$60,000	-	-	$225,000
3	$100,000	$95,000	111,250	$111,250	$111,250	$528,750
Total	$150,000	$360,000	$201,250	$111,250	$111,250	**$933,750**

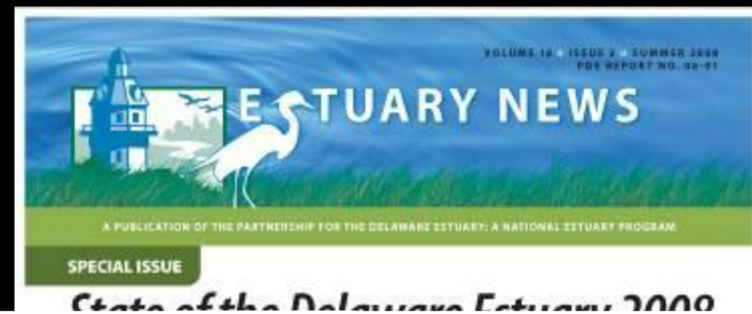
Synergistic Activities

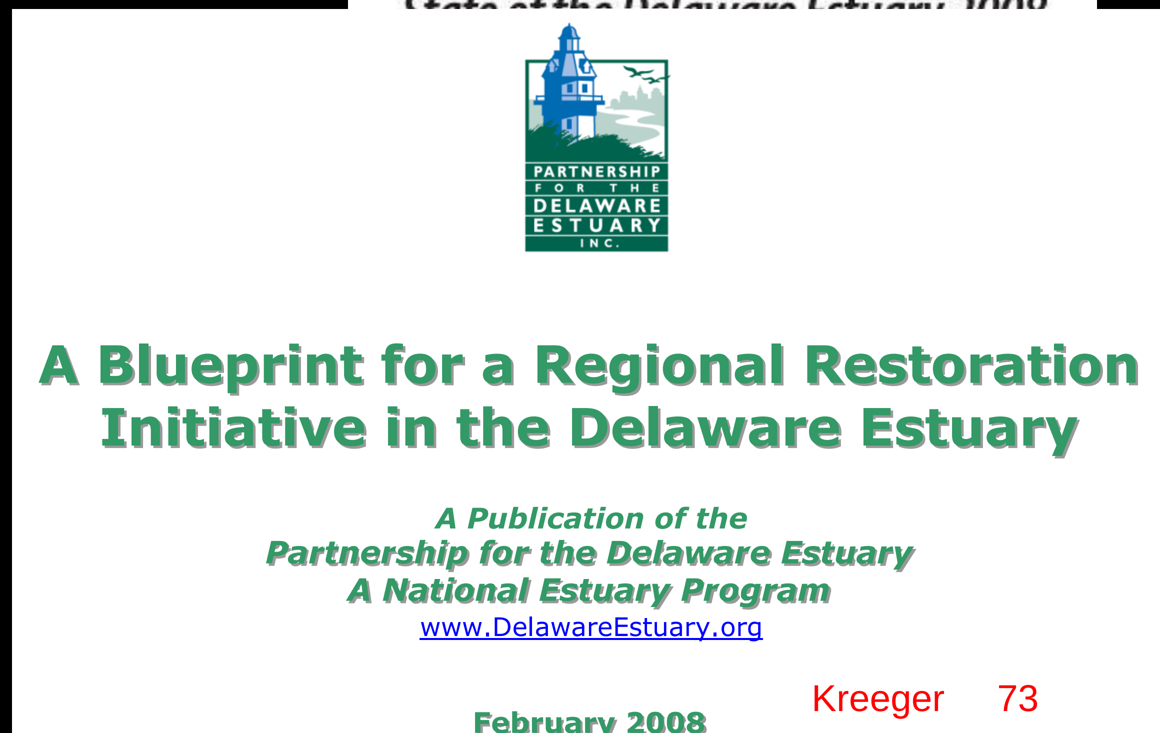
Regional Restoration

Climate Adaptation

Science Activities

1. Conferences & Workshops
2. Science and Technical Committees
3. Watershed-Level Initiatives
   - Science Priority Setting
   - Conceptual Framework
   - Monitoring
   - State of the Estuary
   - Restoration




PARTNERSHIP FOR THE DELAWARE ESTUARY INC.

A Blueprint for a Regional Restoration Initiative in the Delaware Estuary

A Publication of the
Partnership for the Delaware Estuary
A National Estuary Program
www.DelawareEstuary.org

February 2008

Regional Restoration Initiative

Making our efforts count

- Large and complex system
- Limited resources
- Broad CCMP
- Urgency

Complex System→

$

To have Highest Impact, must invest strategically in highest value projects that yield maximum benefits to ecosystem goods and services, including CS

Regional restoration considers which activities are best across time and space at both the watershed and sub-watershed scale

Climate Adaptation Planning

High Need
Escalating Interest
New Programs
Still.. Little On-the-Ground Action

Recent CSO Survey:

- 80% of coastal states plan to develop sea level rise adaptation plans
- only 3 have made any progress
- no standard approach
- little federal coordination

CLIMATE READY ESTUARIES
EPA

Adaptation Needs *(in addition to mitigation)*

- **Vulnerability** – forecast and assess risks, using best judgment at any point in time
- **Opportunity** – identify management and policy options that can help us adapt and maximize natural resource outcomes
- **Obstacles** – identify potential barriers to action (e.g., interstate cooperation, data comparability, etc.)
- **Adaptation** – recommend actions to fill crucial information needs (e.g., monitoring), directly address risks, and iteratively strengthen plans

Climate Ready Pilot

CLIMATE READY ESTUARIES EPA

- **Goal** – perform a vulnerability assessment and draft adaptation plan for one or more case studies: tidal wetlands, shellfish, drinking water, headwater streams
- **Tasks**
  - Vulnerability/Risk Assessment - inventory threats to natural resources under various management response scenarios
  - Valuation - Assess the natural goods and services associated with the possible impacts using a natural capital framework
  - Identify and prioritize adaptation options to protect or enhance at risk resources, and maximize ecosystem services such as CS
  - Provide management and policy recommendations that are likely to yield the greatest natural resource outcomes

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Climate Ready Project Tasks

Climate Workgroup → Case Study Subgroups

	Vulnerability Assessment	Natural Capital Valuation	Management & Adaptation Options
Drinking Water			
Tidal Wetlands			
Bivalve Shellfish			

Adaptation Report

Management and Policy

Outreach, Education, Messaging

Climate Adaptation Planning

Strategic adjustments for climate change to maximize long-term ecosystem health and resiliency, as well as lives and livelihoods

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

Where will wetlands be converted to open water, where can we save them?

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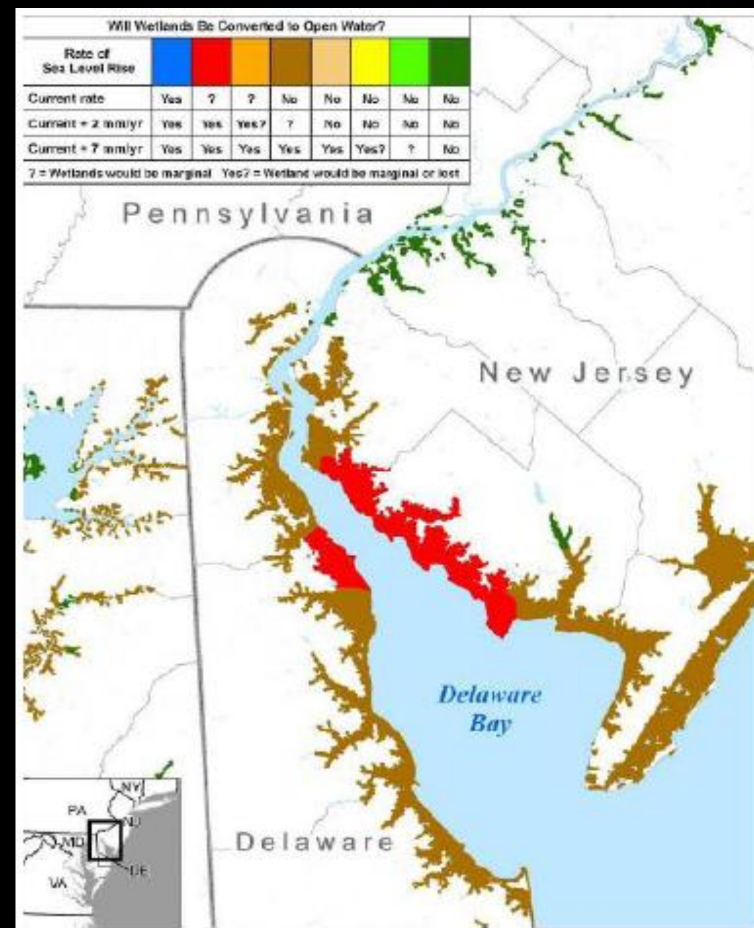
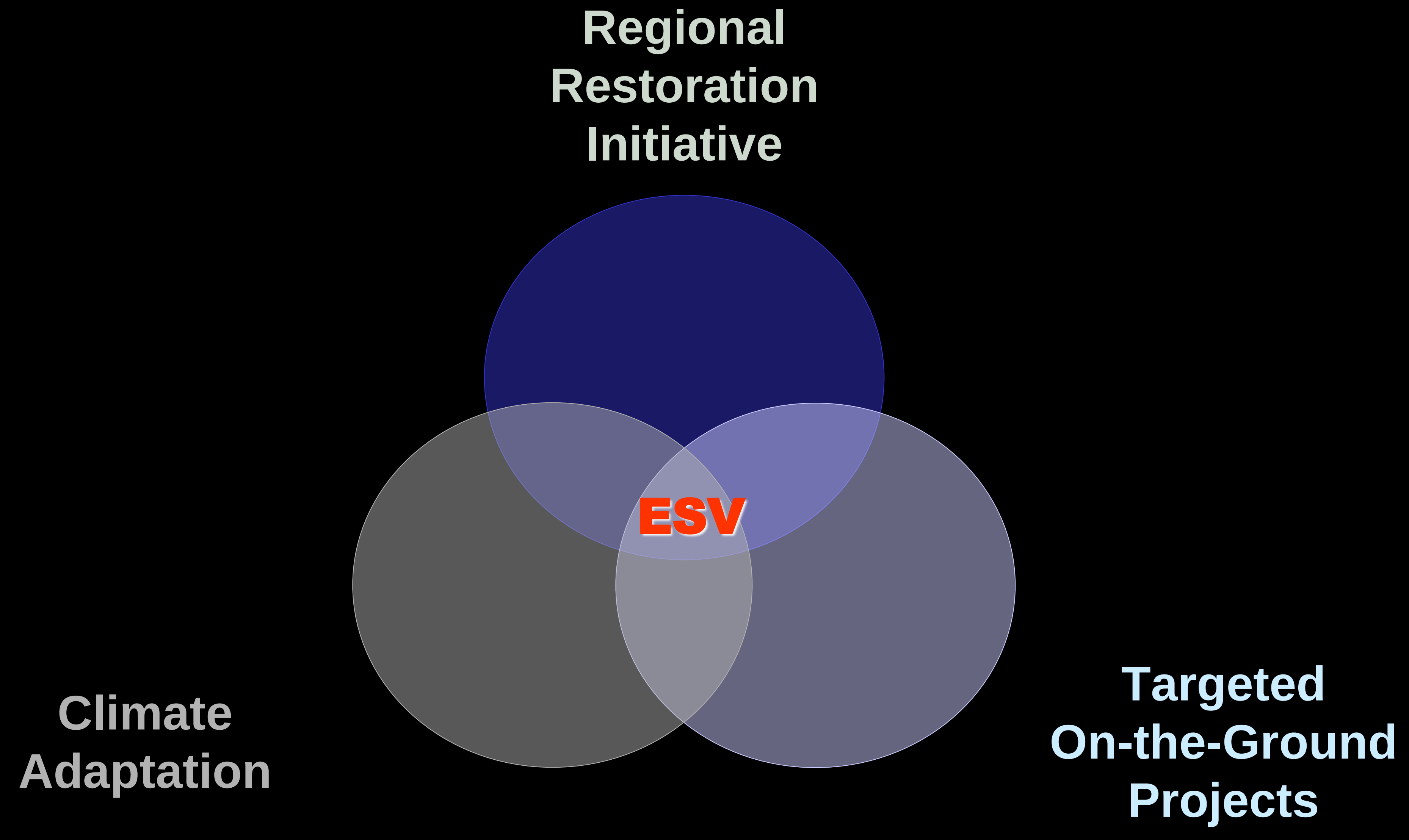
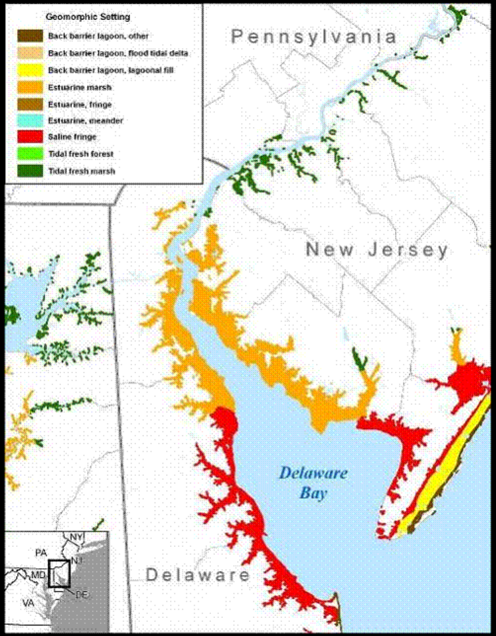


Ecosystem Services in PDE Science



Summary

- Tidal wetlands are a hallmark feature of New Jersey, especially in the Delaware Estuary
- These marshes are excellent sources of carbon sequestration. More study is needed to better understand the marsh types and conditions where maximum CS is attained and vulnerable
- Monitoring and assessment of marsh condition and stressor relationships would facilitate management, planning for climate change, and prioritizing activities to maximize ecosystem services
- Tidal marshes in southern NJ provide an excellent laboratory for testing new monitoring, protection and restoration tactics that boost future carbon sequestration



– End –

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Regional Restoration Initiative

Goals:

- Characterize the most ecologically significant natural resources in different watershed regions
- Assess ecological goods and services flowing from these resources
- Use a natural capital valuation approach to identify highest value activities that maximize goods and services from these resources
- Identify, inventory and rank specific projects that conserve, enhance or restore these resources
- Identify high value activities for which we still need projects in different watershed regions, and work to fill project gaps

Principles:

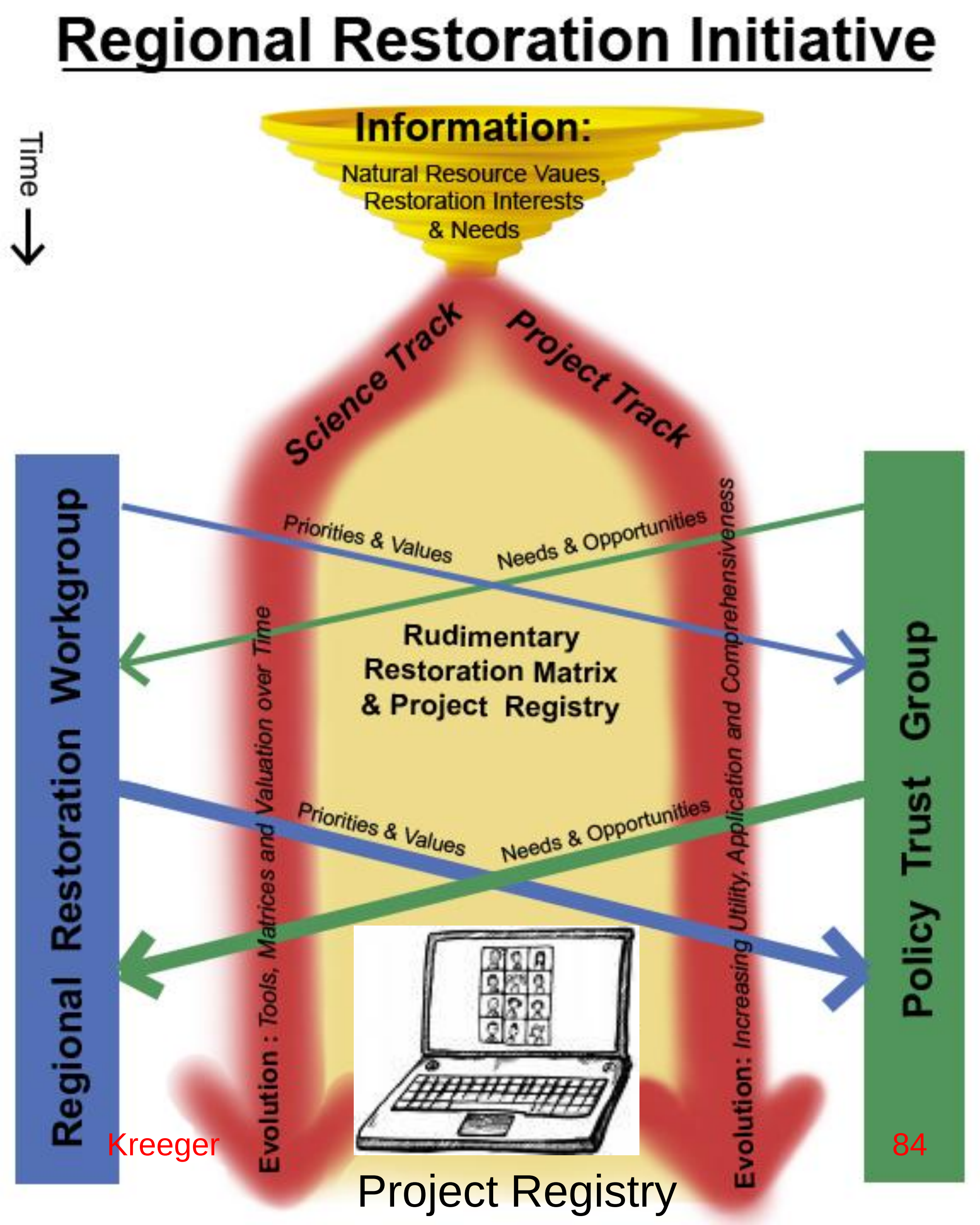
- science-based
- proactive
- timely, responsive
- comprehensive
- multi-jurisdictional

Project Registry

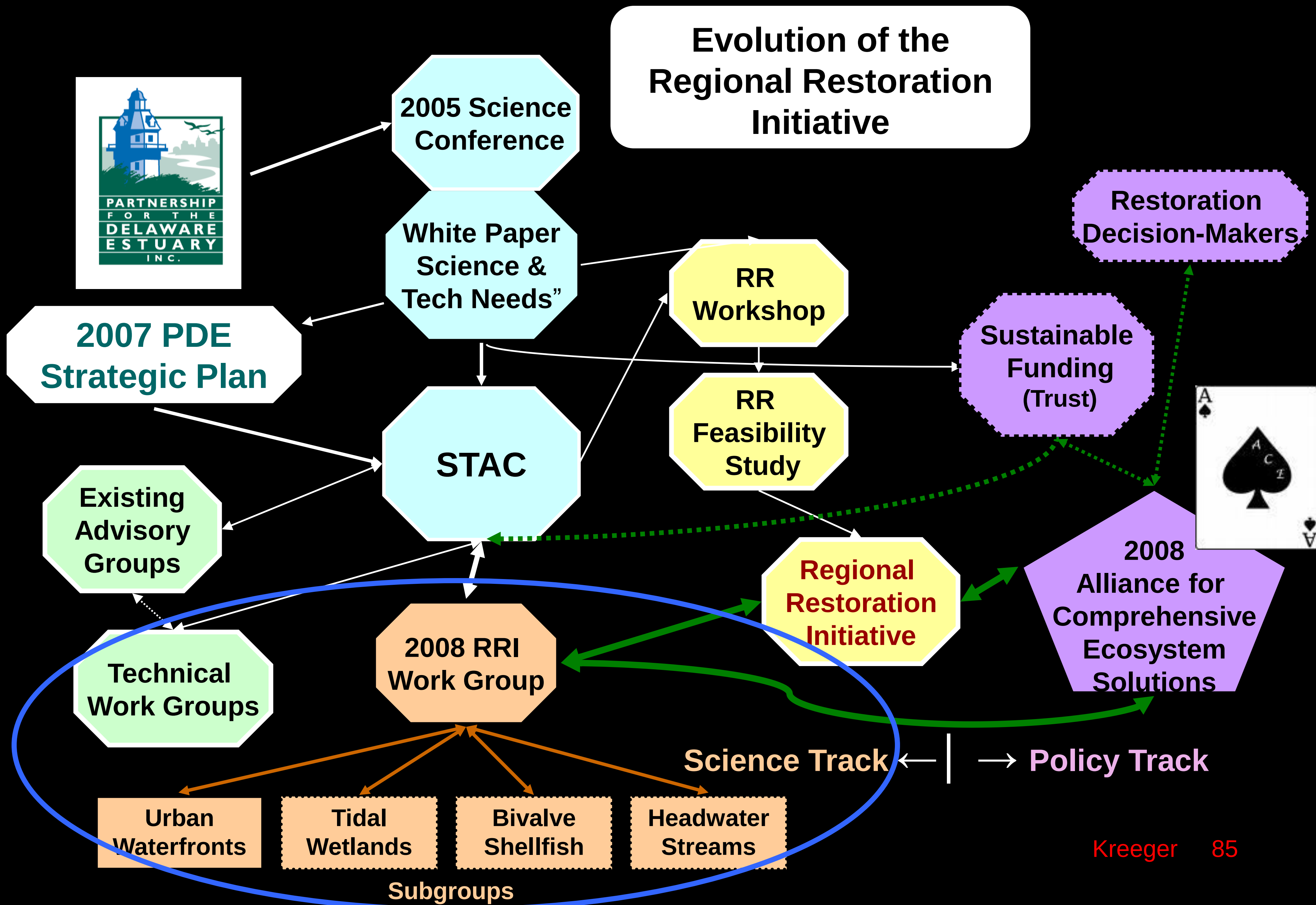
Kreeger

Schematic of operational groups and activities

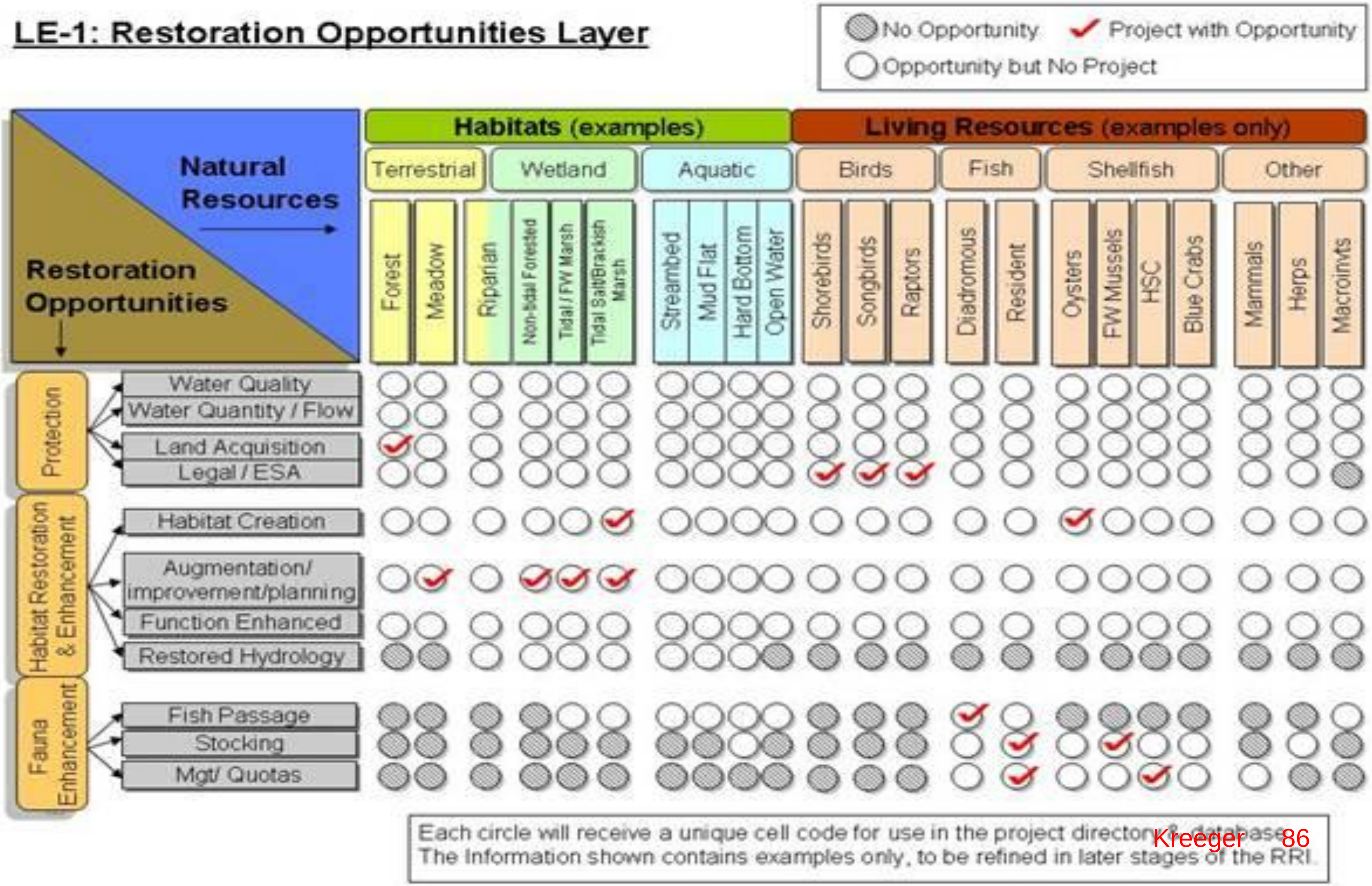
- *Science Track*
- *Policy Track*
- *Project Registry*



Kreeger


Evolution of the Regional Restoration Initiative
PARTNERSHIP FOR THE DELAWARE ESTUARY INC.
2005 Science Conference
White Paper Science & Tech Needs"
2007 PDE Strategic Plan
STAC
RR Workshop
RR Feasibility Study
Restoration Decision-Makers
Sustainable Funding (Trust)
Existing Advisory Groups
Regional Restoration Initiative
2008 Alliance for Comprehensive Ecosystem Solutions
Technical Work Groups
2008 RRI Work Group
Science Track
Policy Track
Urban Waterfronts
Tidal Wetlands
Bivalve Shellfish
Headwater Streams
Subgroups

Basic Restoration Matrix



Value-Added Restoration Matrix (VARM)

Watershed Sub-Region: Lower Estuary 1 (LE1)

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Natural Resourc

Habitats (examples)

Conservation/ Enhancement/ Restoration Activity			Scale	Key	Terrestrial: hab 1 Forest	hab 2 Meadow	hab 3 Other	Wetland: hab 4 Non-tidal Forested Wetland	hab5 Non-tidal Herbaceous Wetland	hab6 Tidal Freshwater Wetland	hab 7 Tidal Brackish and Salt Marsh	hab 8 Other Wetlands	Aquatic: hab 9 Streambed	hab 10 Shoreline	hab 11 Oyster Reef	hab 12	hab 13 Open Water
Protection	Water Quality																
	Water Quantity/Flow																
	Land Acquisition																
	Legal																
Habitat Restoration		Cell Code	-	**2a**		**2a**	**3a**	**4a**	**5a**								
		Projects Exist?	-				GAP		high need								
	Natural Capital Values	Ecoservice Value	0-10	lo / med / hi			2	8	9								
		Extractive Value (Trust)	0-10				2	4	1								
		Functional Dominance	0-5	lo / med / hi			1	4	5								
		Critical Imperiled	0-5	lo / med / hi			0	4	4								
	Other Values	Signature Type	0-3	lo / med / hi			0	1	5								
		Lack of Opportunity	0-3	lo / med / hi			1	0	0								
		Other Considerations**	0-3	lo / med / hi			1	0	1								
		Importance Score				na	7	**21**	**25**								
Habitat Enhancement (incl/ condition improvement of same acreage)																	
Habitat Creation																	

Notes:

Cells are shaded grey if not appropriate for subregion or other factors

Everything in this spreadsheet is a prototype example to provide framework for considering struct

See Figure 7b

NOTES:

Extra Credit for RUF, Buffer value, single large over several small

Have way to flag high need areas with no projects

** Conecting

** continguousness, special circumstances

Value-Added Restoration Matrix

Restoration Activity							Terrestrial			Wetland	
							hab 1	hab 2	hab 3	hab 4	hab5
			Scale	Key			Forest	Meadow	Other	Non-tidal Forested Wetland	Tidal Freshwater Wetland
Habitat Restoration		Cell Code	-	2a				2a	3a	4a	5a
		Projects Exist?							GAP		high need
	Natural Capital Values	Ecoservice Value	0-10	lo	med	hi			2	8	9
		Extractive Value (Trust)	0-10						2	4	1
		Functional Dominance	0-5	lo	med	hi			1	4	5
		Critical Imperiled	0-5	lo	med	hi			0	4	4
	Other Values	Signature Type	0-3	lo	med	hi			0	1	5
		Lack of Opportunity	0-3	lo	med	hi			1	0	0
		Other Considerations**	0-3	lo	med	hi			1	0	1
		Importance Score						na	7	21	25

Regional Restoration Initiative

ID Key Resources

Ecological Valuation

N.C. Outcomes from Activities

Project Registry & Gaps

Case Studies

Tidal Marshes

Bivalve Shellfish

Headwater Streams

Urban Waterfront