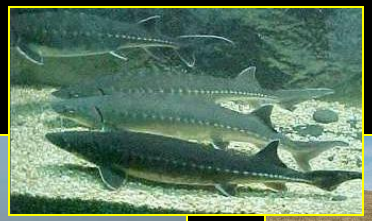
Natural capital and ecosystem service valuation as tools to guide restoration and climate adaptation in the Delaware Estuary

Danielle Kreeger
Science Director
Partnership for the Delaware Estuary





To be discussed

The Delaware Estuary

brief orientation

Making our efforts count:

why are NCV & ESV tools needed?

Example: Regional Restoration

goals & approach
restoration matrices
NCV & ESV framework
case studies

Other Applications

climate adaptation
ecological inventories
on the ground projects

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

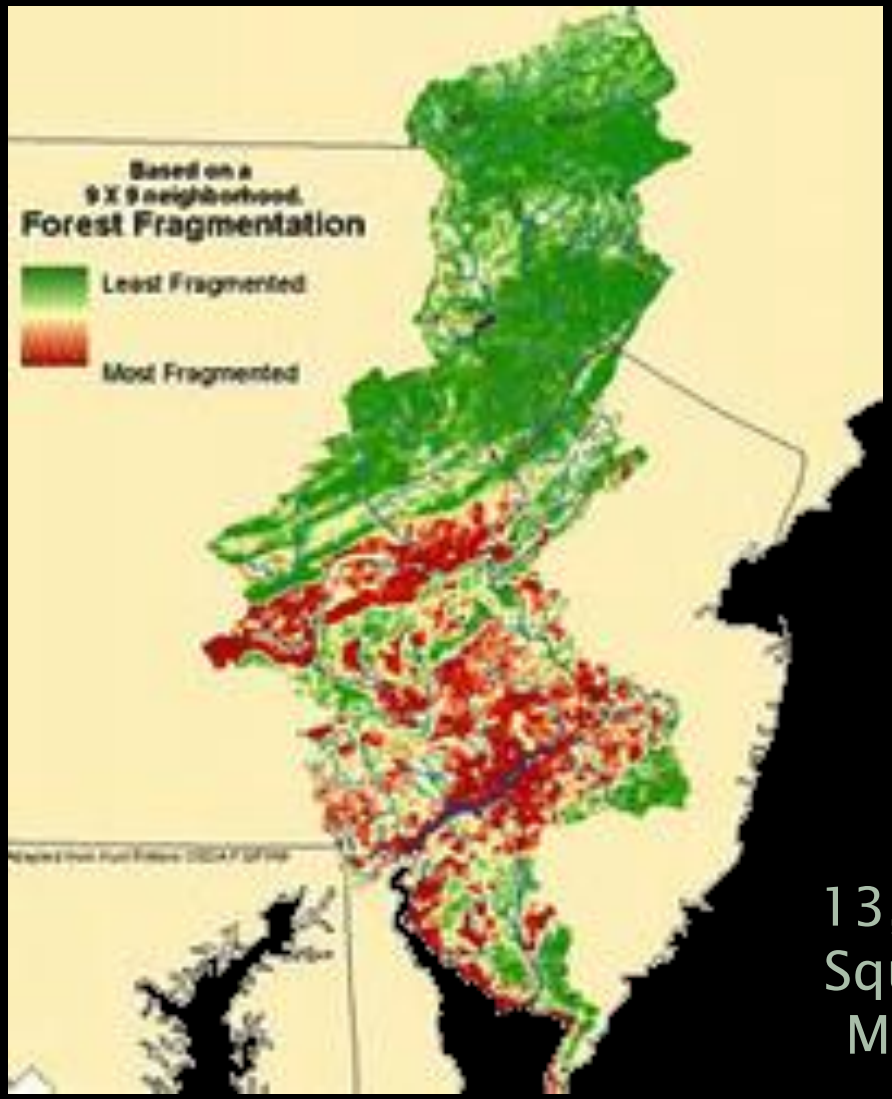
tant to realize, however, that there are small steps each one of us can take in our daily lives that, when multiplied, can make a mean ingful impact.

One of these small steps is the use of compact florescent light bulbs (CFLs). CFLs use up to 75 percent less energy than regular incan descent 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

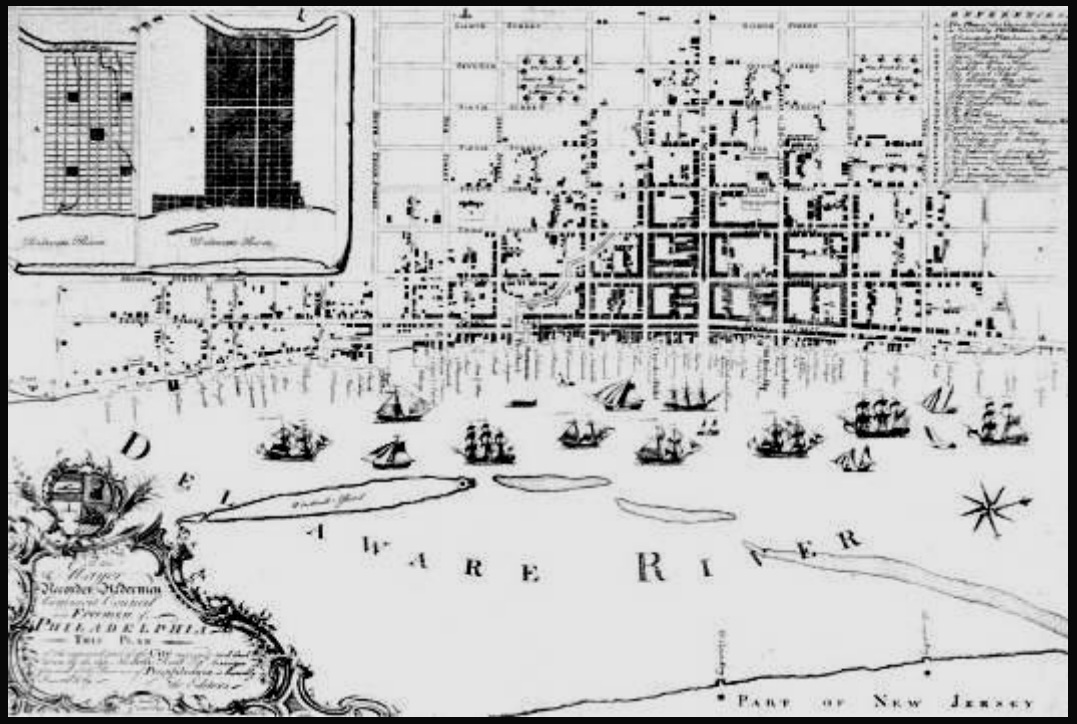
Caveat – An Ecological Manhattan Project?

The Watershed



13,611
Square
Miles

History as a "Working River"

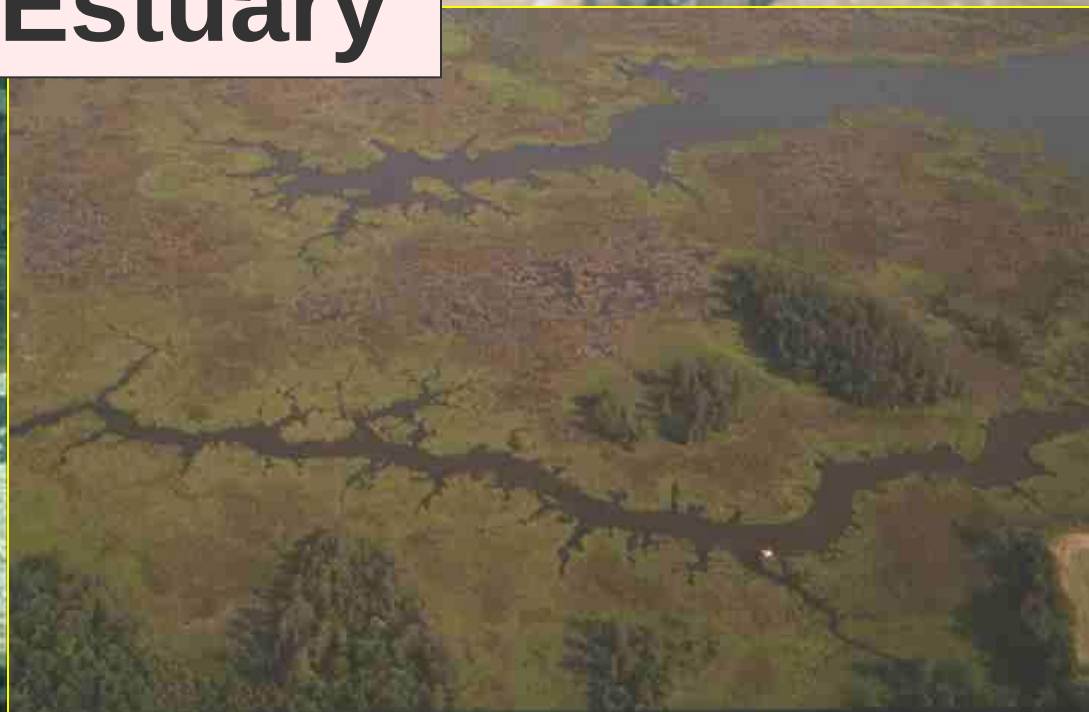


1762 map showing Philadelphia on the Delaware River

Slides adapted from Jonathan Sharp

Also a "Living River"

Delaware Estuary



Making our efforts count

why are NCV & ESV tools needed?

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

Complex System→

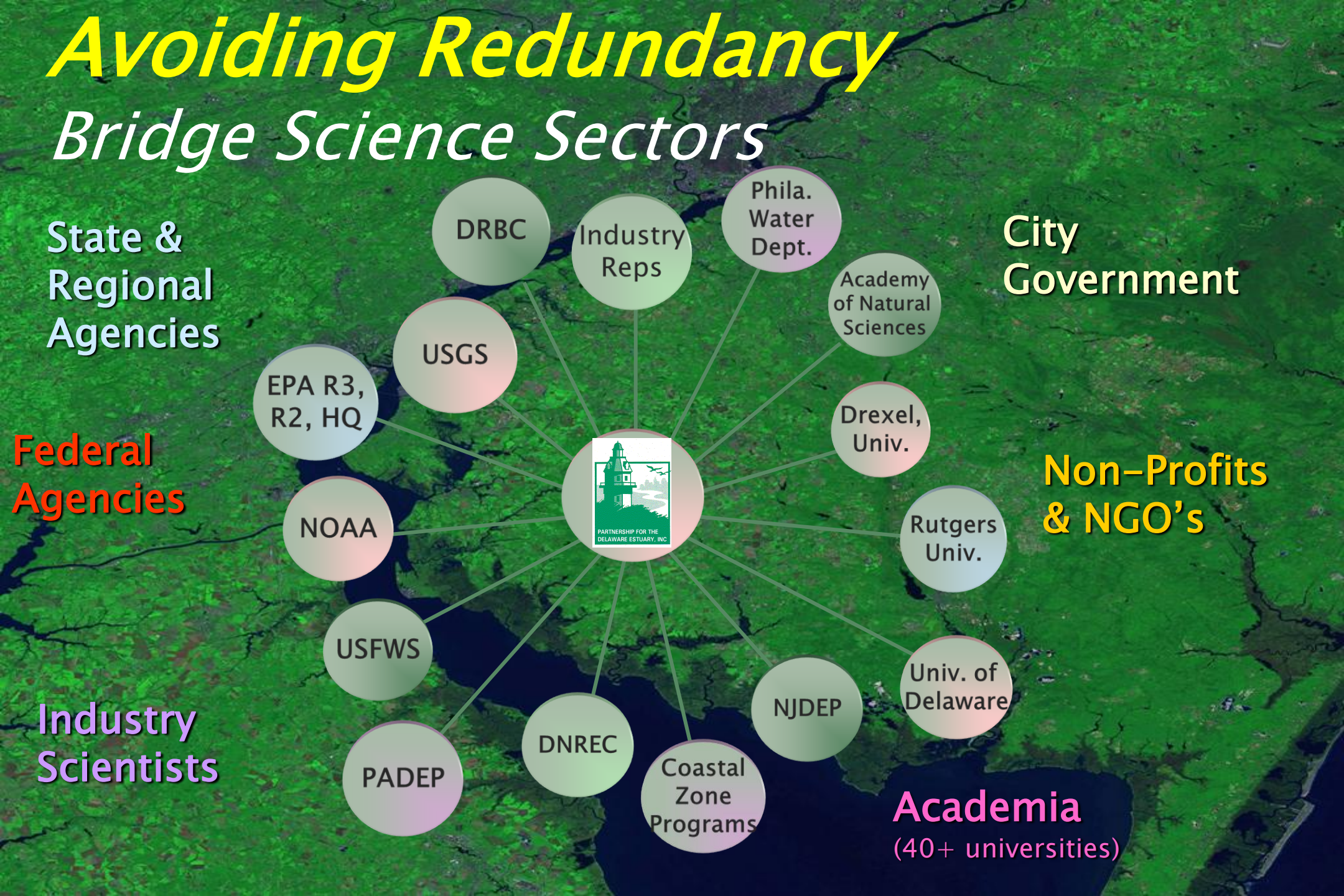
$

To have Highest Impact, must avoid redundancy, invest strategically

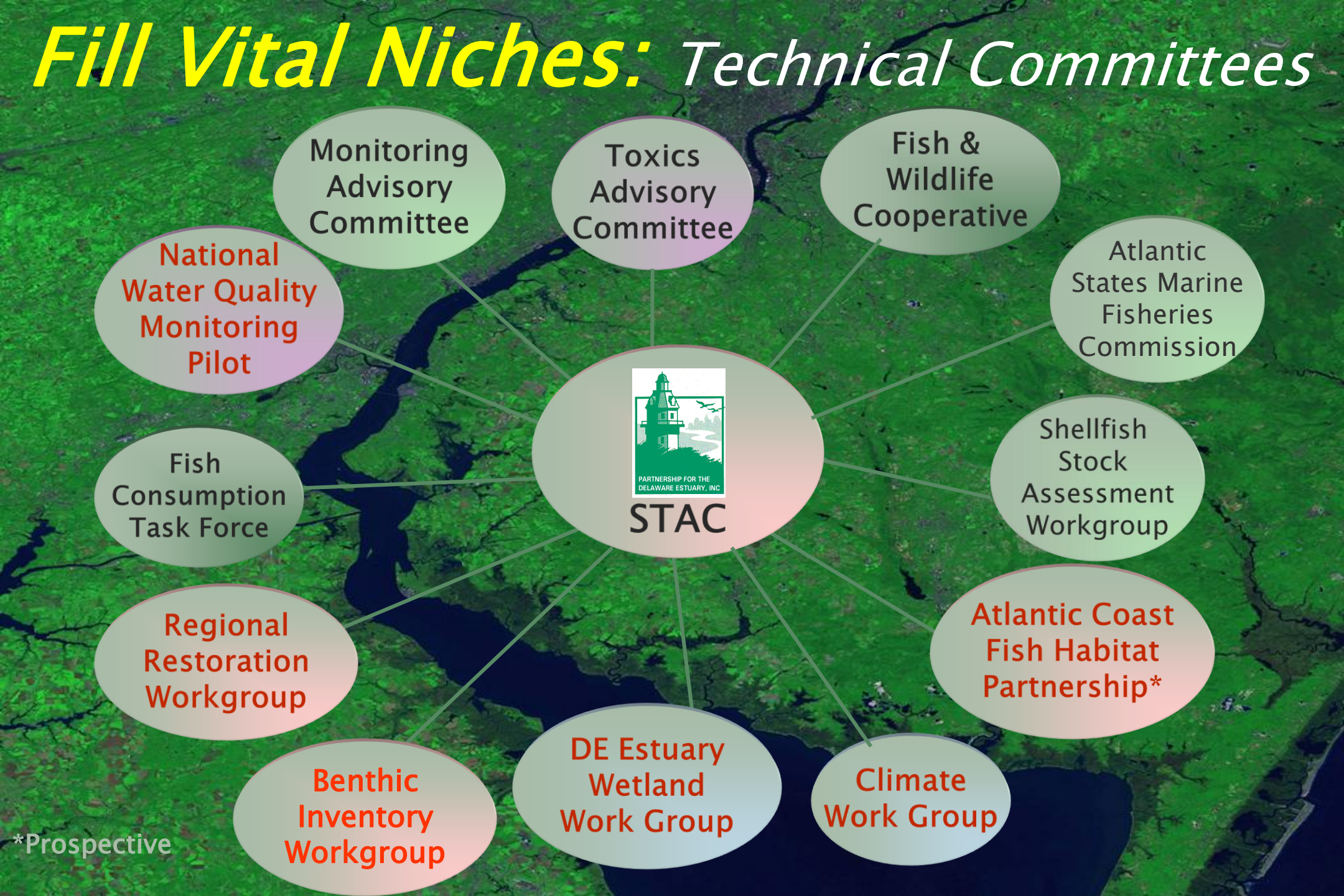
ESV is broadly applicable as an organizing framework for prioritization

Avoiding Redundancy

Bridge Science Sectors



Fill Vital Niches: Technical Committees



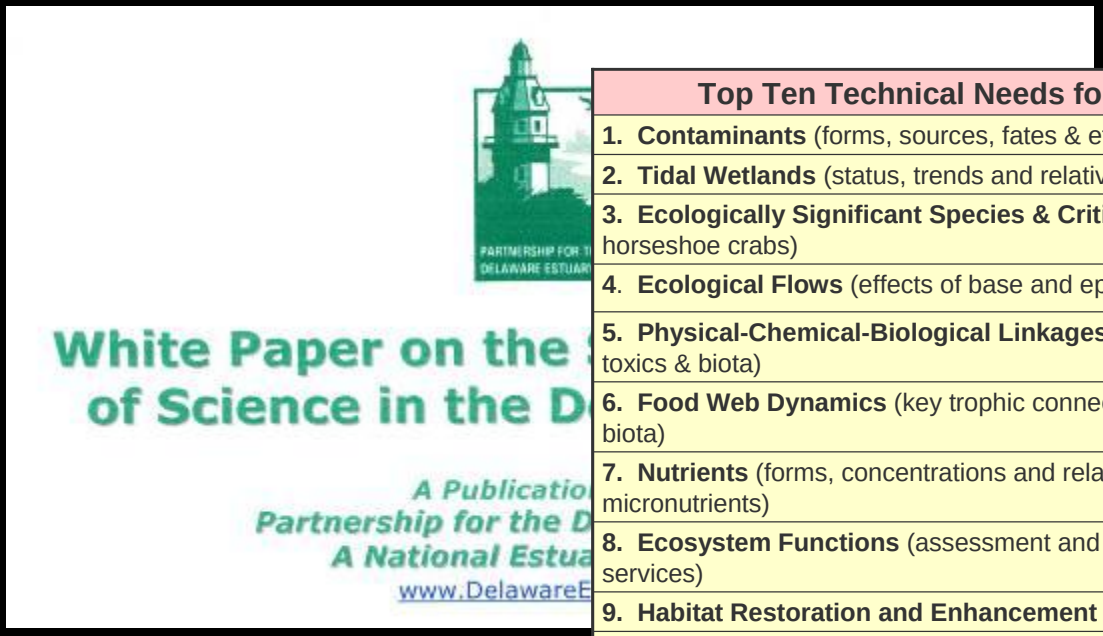
Working Together

1. Conferences & Workshops

- Delaware Estuary Science Conference (every 2 years)

Prioritization

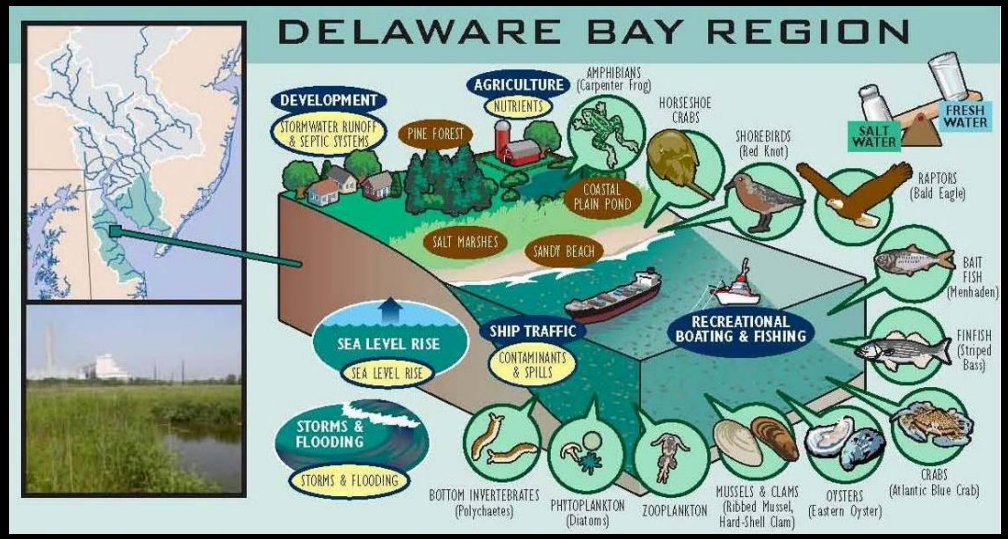
1. Conferences & Workshops
2. Science and Technical Committees
3. Watershed-Level Initiatives
   - Science Priority Setting (White Paper)



Top Ten Technical Needs for the Delaware Estuary
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, reefs, horseshoe crabs)
4. **Ecological Flows** (effects of base and episodic flows on salt balance & biota
5. **Physical-Chemical-Biological Linkages** (e.g., sediment budget effects on toxics & biota)
6. **Food Web Dynamics** (key trophic connections among functional dominant biota)
7. **Nutrients** (forms, concentrations and relative balance of macro- and micronutrients)
8. **Ecosystem Functions** (assessment and economic valuation of ecosystem services)
9. **Habitat Restoration and Enhancement** (science & policy)

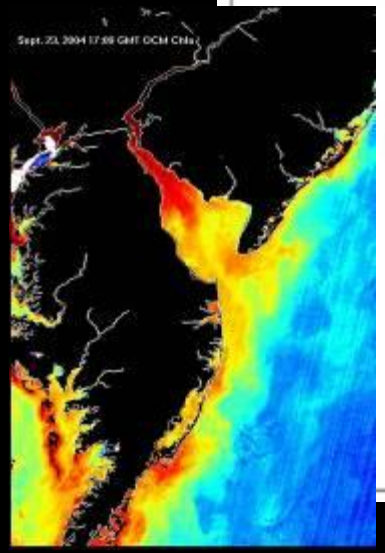
Prioritization

1. Conferences & Workshops
2. Science and Technical Committees
3. Watershed-Level Initiatives
   - Science Priority Setting (White Paper)
   - Conceptual Framework for System Traits



Prioritization

1. Conferences & Workshops
2. Science and Technical Committees
3. Watershed-Level Initiatives
   - Science Priority Setting (White Paper)
   - Conceptual Framework
   - Monitoring (e.g. NWQMN Pilot)



The Delaware Estuary Watershed to Ocean Observing System (DEWOOS)

Prioritization

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

Restoration

Restore, conserve or otherwise enhance ecosystem structure and function

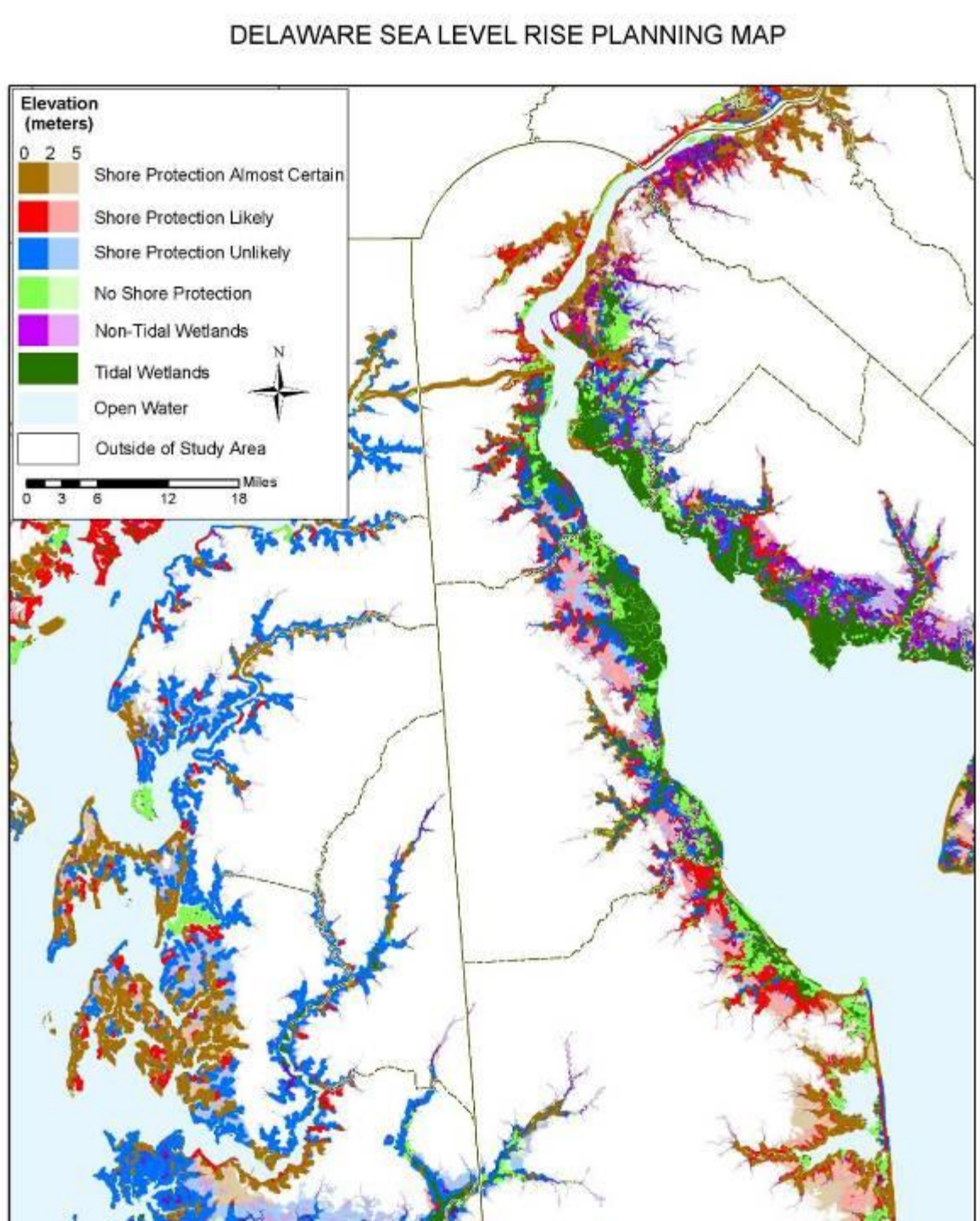
PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

...But Smartly

Regional Restoration Initiative

Includes:

- Protection
- Conservation
- Enhancement
- Restoration



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 and work to fill gaps

Principles:

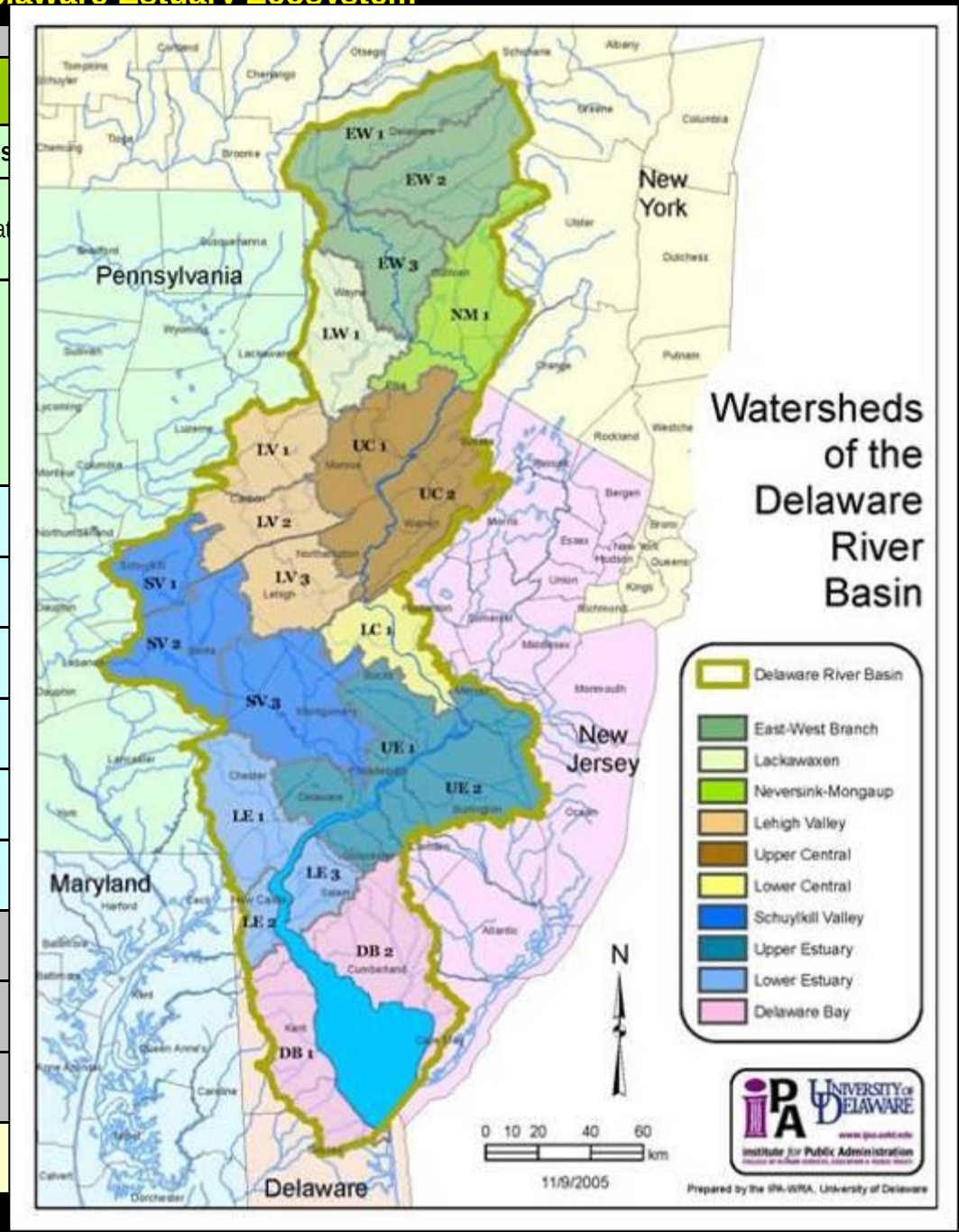
- science-based
- proactive
- timely, responsive
- comprehensive
- multi-jurisdictional

Project Registry

Conceptual Matrix for the Delaware Estuary Ecosystem

Number of Cells = 141

		Nontidal Watershed						
		Freshwater					Fres	
		Delaware River (above River Mile 133)		Other Rivers and Streams (below River Mile 133)			Approximat	
		Main Channel	Tributaries to Delaware River (e.g., Lehigh)	Schuylkill River & Its Tributaries	Christina River & Its Tributaries	Other Tributaries	Main Channel	
Aquatic	Pelagic							
	Benthic							
Terrestrial	Tida							
	Riparia							
	Watersh							
Socioeconic								



SCHUYLKILL VALLEY REGION

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

DELAWARE BAY REGION

DEVELOPMENT

STORMWATER RUNOFF & SEPTIC SYSTEMS

AGRICULTURE

NUTRIENTS

PINE FOREST

AMPHIBIANS (Carpenter Frog)

HORSESHOE CRABS

SHOREBIRDS (Red Knot)

SALT WATER

FRESH WATER

RAPTORS (Bald Eagle)

COASTAL PLAIN POND

SALT MARSHES

SANDY BEACH

BAIT FISH (Menhaden)

SEA LEVEL RISE

SEA LEVEL RISE

SHIP TRAFFIC

CONTAMINANTS & SPILLS

RECREATIONAL BOATING & FISHING

FINFISH (Striped Bass)

STORMS & FLOODING

STORMS & FLOODING

BOTTOM INVERTEBRATES (Polychaetes)

PHYTOPLANKTON (Diatoms)

ZOOPLANKTON

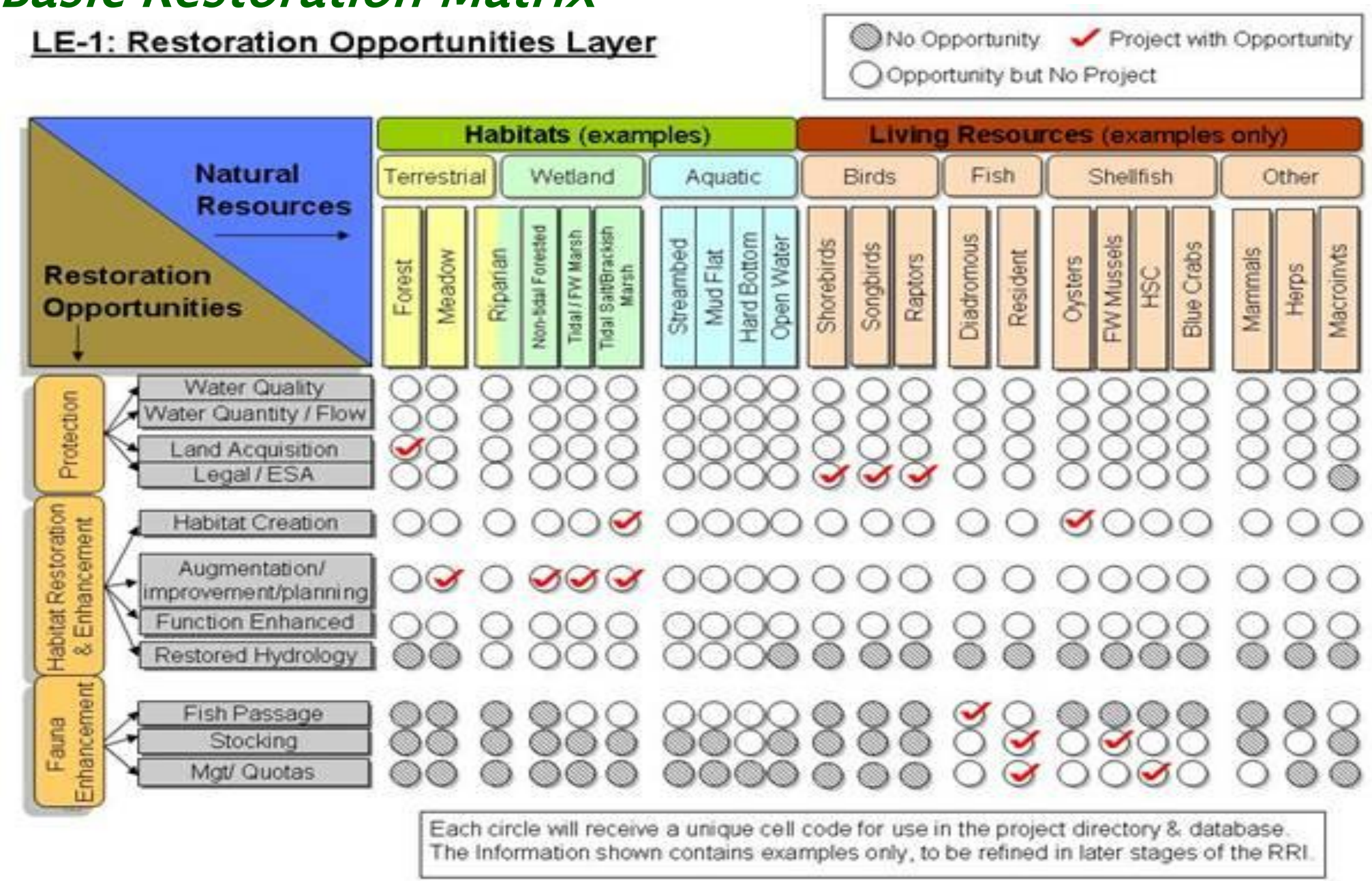
MUSSELS & CLAMS (Ribbed Mussel, Hard-Shell Clam)

OYSTERS (Eastern Oyster)

CRABS (Atlantic Blue Crab)

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Basic Restoration Matrix



Value-Added Restoration Matrix (VARM)

Watershed Sub-Region: Lower Estuary 1 (LE1)

Natural Resourc

Habitats (examples)

Conservation/ Enhancement/ Restoration Activity			Scale	Key	Terrestrial			Wetland					Aquatic				
					hab 1	*hab 2*	*hab 3*	*hab 4*	*hab5*	*hab6*	*hab 7*	*hab 8*	*hab 9*	*hab 10*	*hab 11*	*hab 12*	*hab 13*
					Forest	Meadow	Other	Non-tidal Forested Wetland	Non-tidal Herbaceous Wetland	Tidal Freshwater Wetland	Tidal Brackish and Salt Marsh	Other Wetlands	Streambed	Shoreline	Oyster Reef		Open Water
Protection	Water Quality																
						Notes:											
	Water Quantity/Flow					***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											
	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)																	
				NOTES:													
				Extra Credit for RUF, Buffer value, single large over several small													
				Have way to flag high need areas with no projects													
Habitat Creation																	
				** Conecting													
				** contiguousness, special circumstances													

See Figure 7b

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

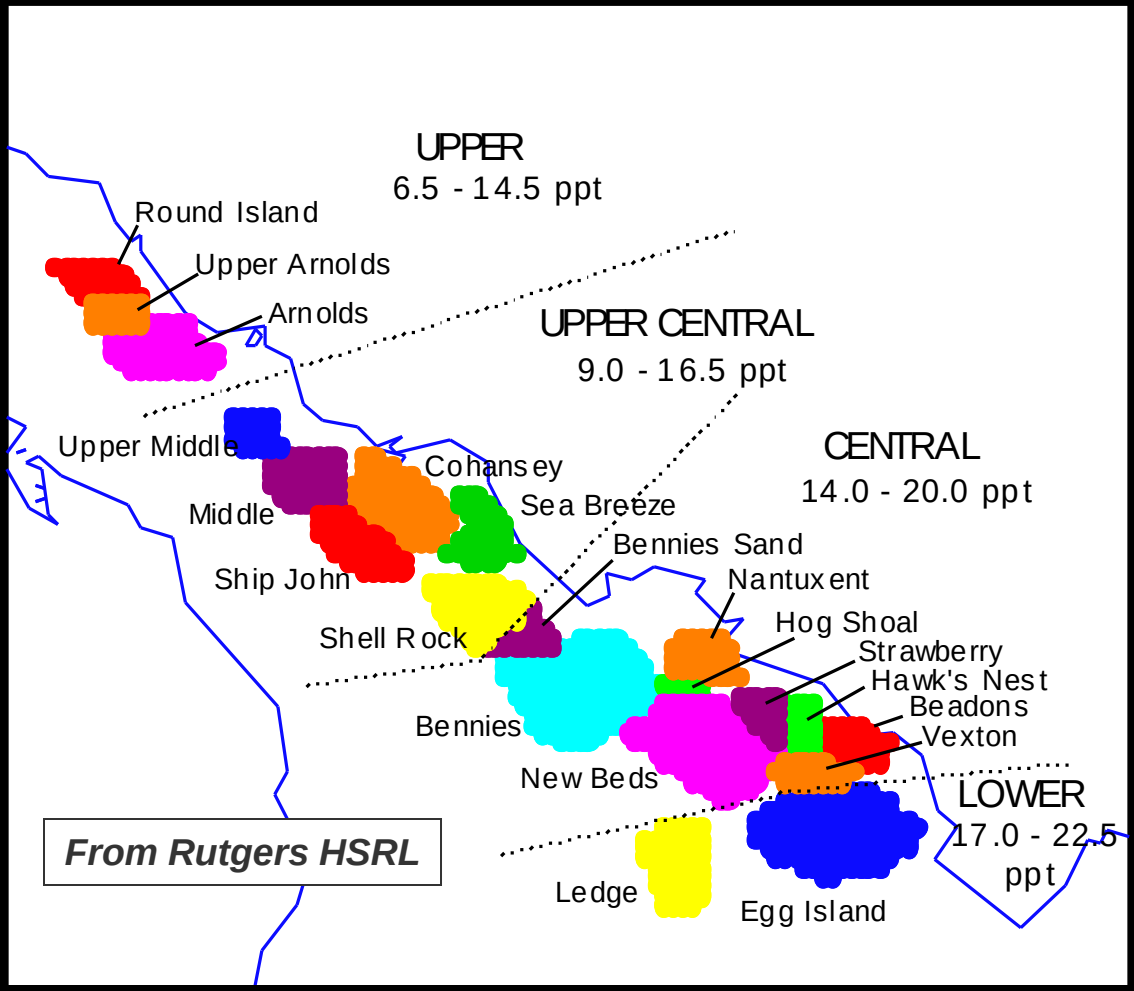
Tidal Marshes

Bivalve Shellfish

Headwater Streams

Urban Waterfront

Oysters and Other Bivalve Shellfish



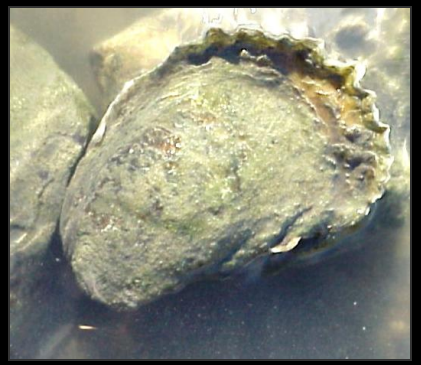
PARTNERSHIP FOR THE DELAWARE ESTUARY, INC


PARTNERSHIP FOR THE
DELAWARE ESTUARY, INC

Others?

Elliptio complanata

Geukensia demissa



Crassostrea virginica

11 Other Species of Freshwater Unionid Mussels

Corbicula fluminea

Rangia cuneata

Mya arenaria

Mytilus edulis

Ensis directus

Mercena mercena

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

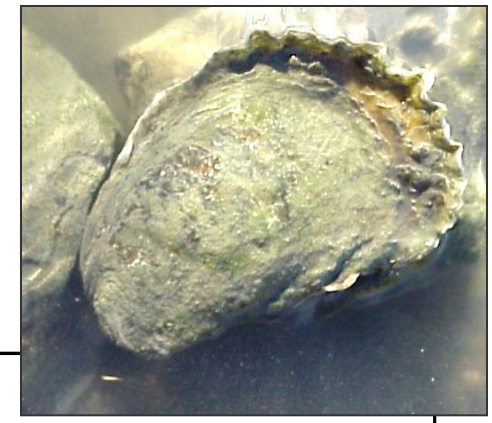
Freshwater Mussels

Marsh Mussels

CTUIR Freshwater Mussel Project

DE Living Shorelines 2008

Oyster Landing Data



Millions of Pounds

0
5
10
15
20
25
30
35

1860 1880 1900 1920 1940 1960 1980 2000

Year

Loss of Biodiversity & Population Abundance

PDE Study Area

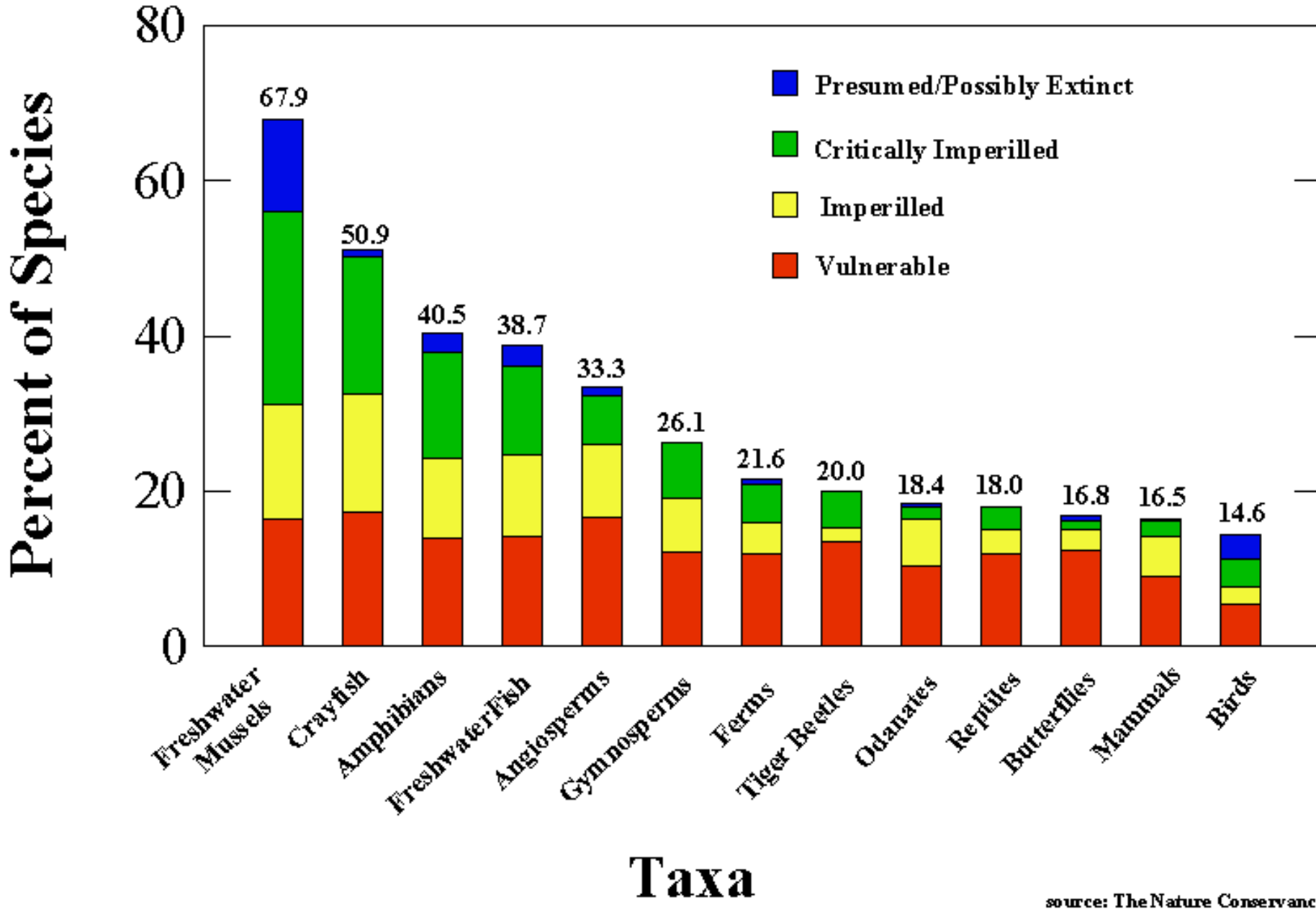
Patchy, Impaired

Rare

Extirpated

		State Conservation Status		
Scientific Name	**Scientific Name**	**DE**	**NJ**	**PA**
ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	Endangered	Endangered	Critically Imperiled
ALASMIDONTA UNDULATA	TRIANGLE FLOATER	Extirpated ?	Threatened	Vulnerable
ALASMIDONTA VARICOSA	BROOK FLOATER	Endangered	Endangered	Imperiled
ANODONTA IMPLICATA	ALEWIFE FLOATER	Extremely Rare	no data	Extirpated ?
ELLIPTIO COMPLANATA	EASTERN ELLIPTIO	common	common	Secure
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	Endangered	Threatened	Vulnerable
LAMPSILIS RADIATA	EASTERN LAMPMUSSEL	Endangered	Threatened	Imperiled
LASMIGONA SUBVIRIDIS	GREEN FLOATER	no data	Endangered	Imperiled
LEPTODEA OCHRACEA	TIDEWATER MUCKET	Endangered	Threatened	Extirpated ?
LIGUMIA NASUTA	EASTERN PONDMUSSEL	Endangered	Threatened	Critically Imperiled
MARGARITIFERA MARGARITIFERA	EASTERN PEARLSHELL	no data	no data	Imperiled
PYGANODON CATARACTA	EASTERN FLOATER	no data	no data	Vulnerable
STROPHITUS UNDULATUS	SQUAWFOOT	Extremely Rare	Species of Concern	Apparently Secure

Conservation Status of United States Taxa



source: The Nature Conservancy, 1997

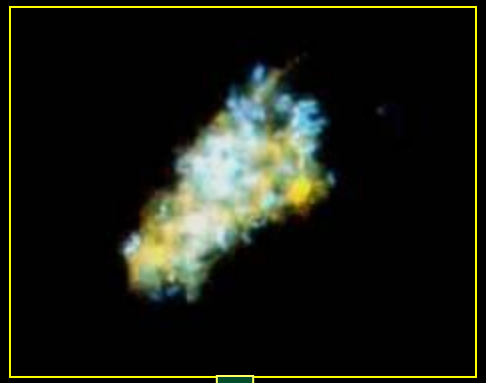
Ecosystem Services

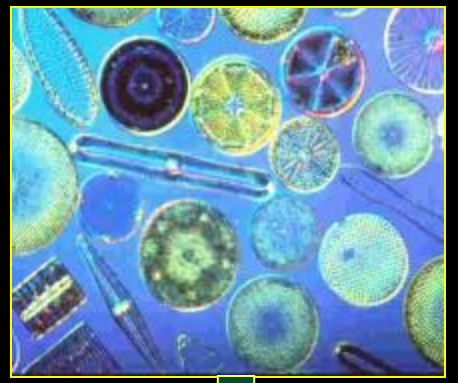
1. Structure

↑ Habitat Complexity

↑ Binding of Bottom

↑ Bottom Turbulence





2. Function

↓ Suspended Particulates

↓ Particulate N, P

↑ Light

↑ Sediment Enrichment

Recycle Dissolved Nutrients

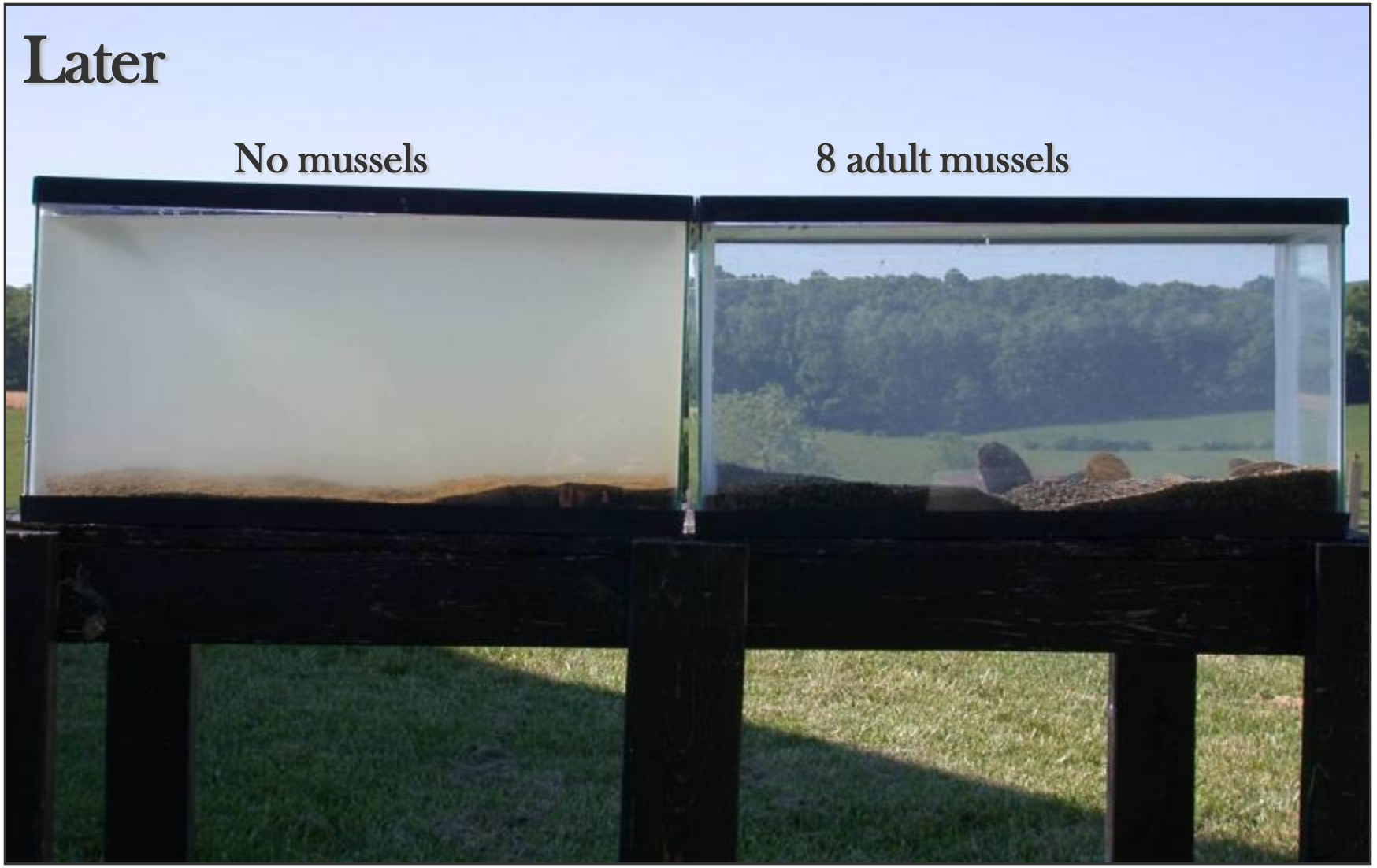
Mussels Are Habitat
INITIATIVE
Restoring Our Nation's Water Quality

Clean Water

Slide from Catherine Gatenby, USFWS

Mussels Are Habitat
INITIATIVE
Restoring Our Nation's Water Quality

Biofiltration Potential



Slide from Catherine Gatenby, USFWS

Elliptio complanata

Geukensia demissa

Crassostrea virginica

Estimate of Water Processing Potential

4.3 Billion *Elliptio*

= 2.9 Million Kilos Dry Tissue Weight

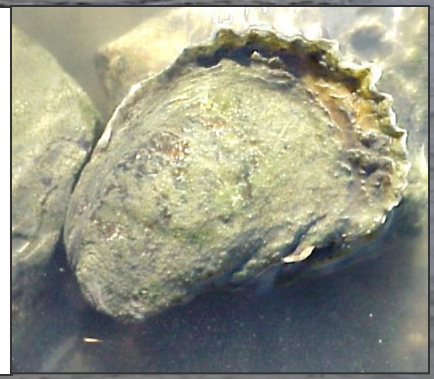
= 9.8 Billion Liters per Hour

208,000 per hectare on average
10.5 Billion *Geukensia*
Clearance Rate = 5.1 L h-1 g-1 *(DK data)*
11.7 Million Kilos Dry Tissue Weight

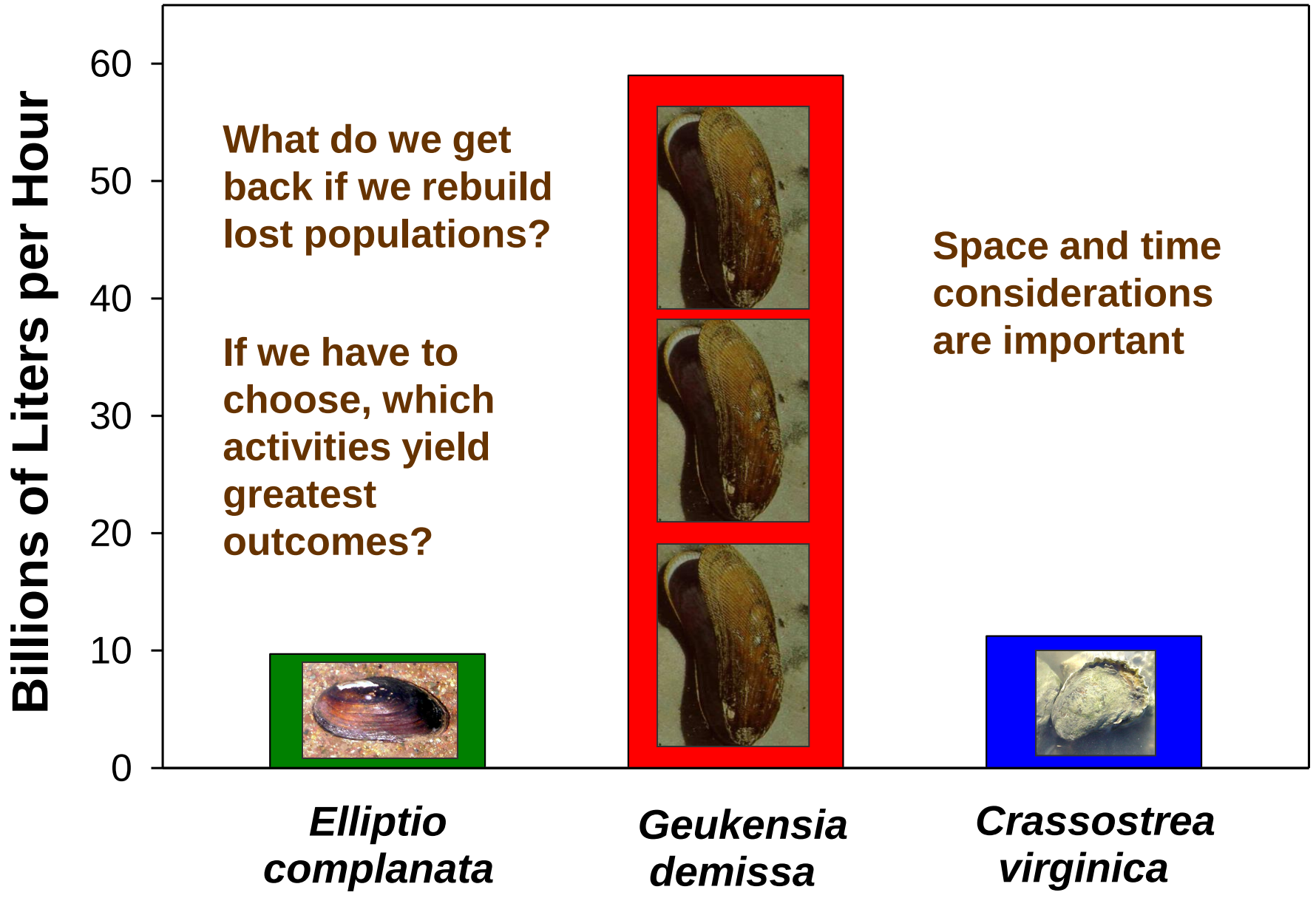
= 59.0 Billion Liters per Hour

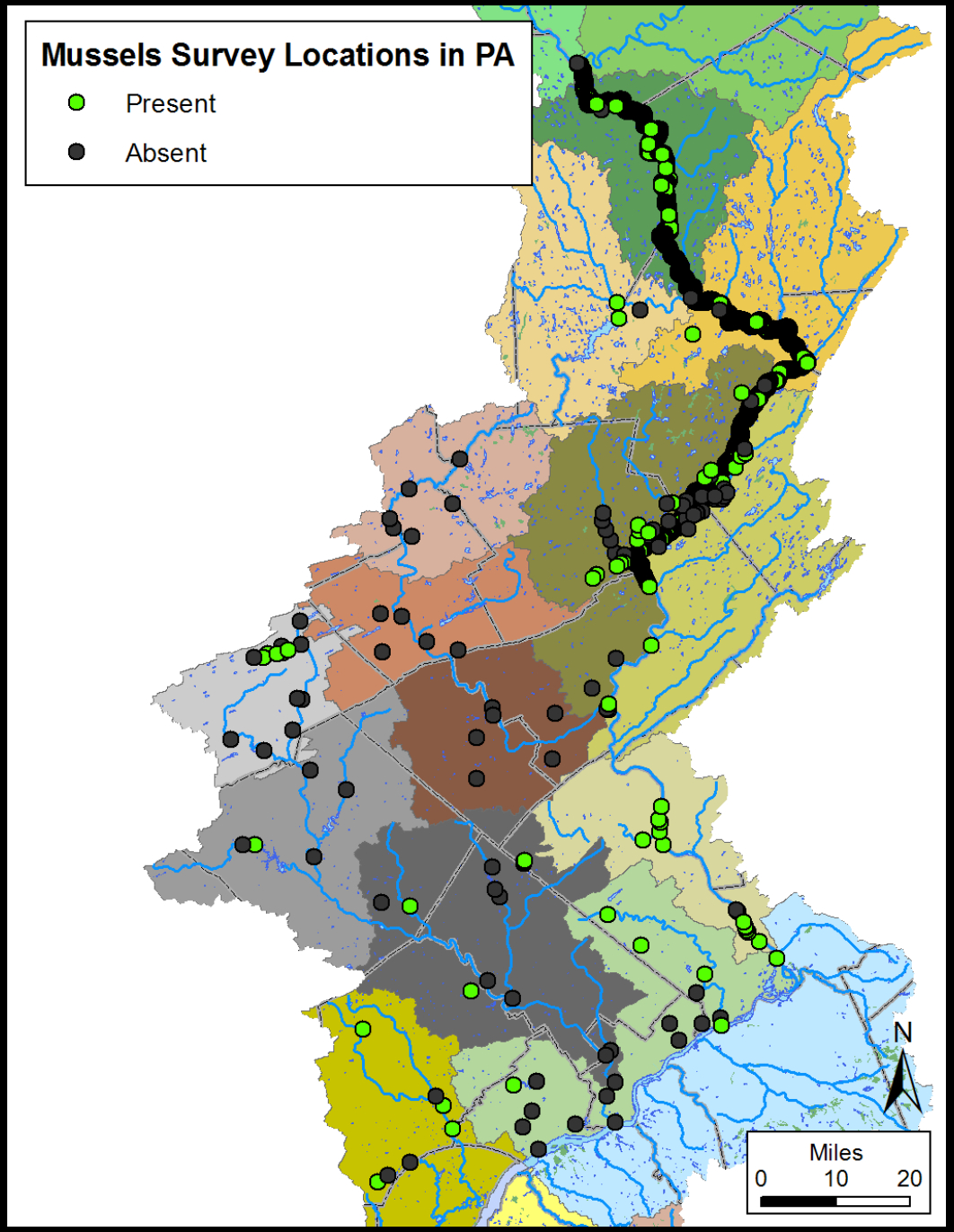
Oysters on Seed Bed Reefs

2.0 Billion *Crassostrea* *(Powell, 2003 data)*
Mean size = 0.87 g dry tissue weight *(DK data)*
Clearance Rate = 6.5 L h−1 g−1 *(Newell et al 2005)*
= 11.2 Billion Liters per Hour



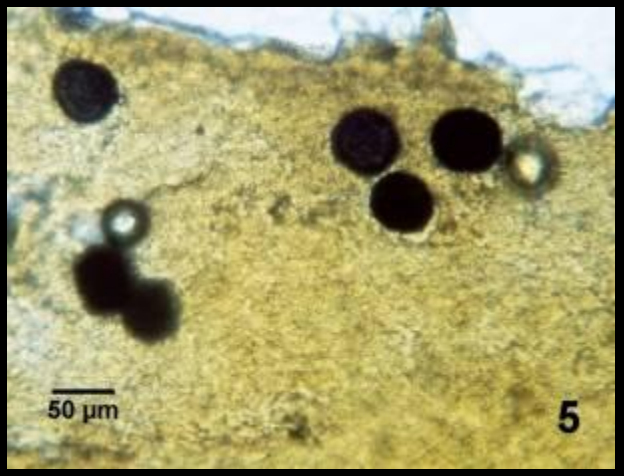
Population-Level Water Processing



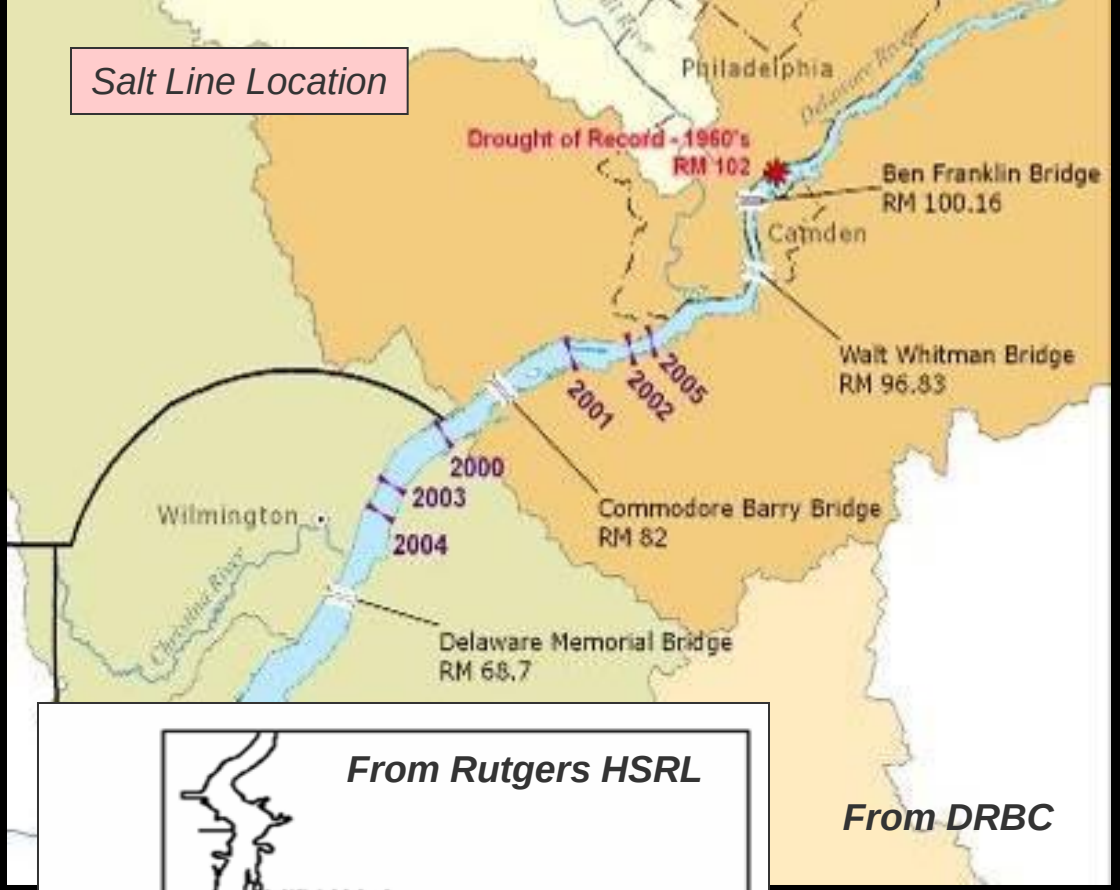

Mussels Survey Locations in PA
Present
Absent
N
Miles
0
10
20

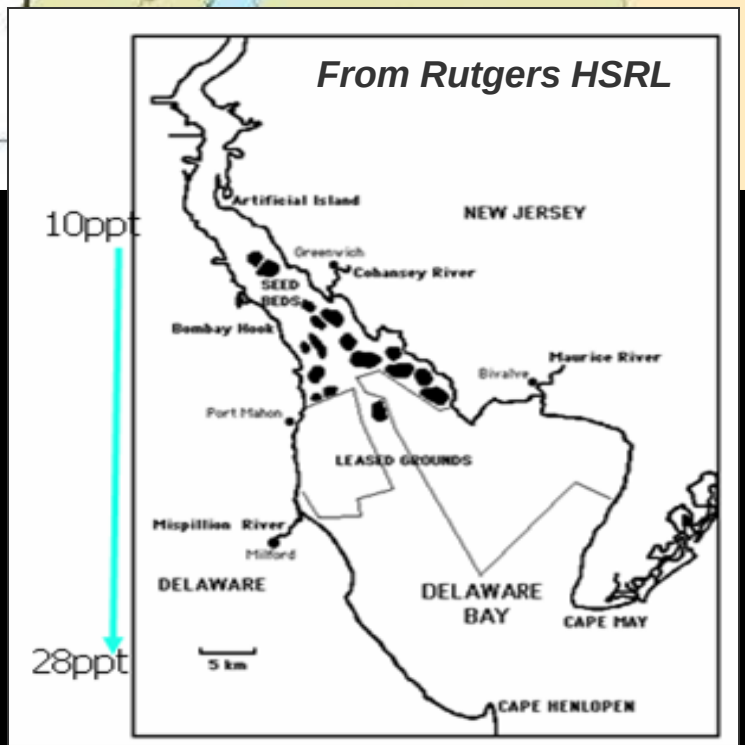
Oyster Disease and Salinity

www.livingclassrooms.org/lbo/dermo/oyster2.jpg



http://www.pac.dfo-mpo.gc.ca/sci/shelldis/images/pmdoy5.jpg



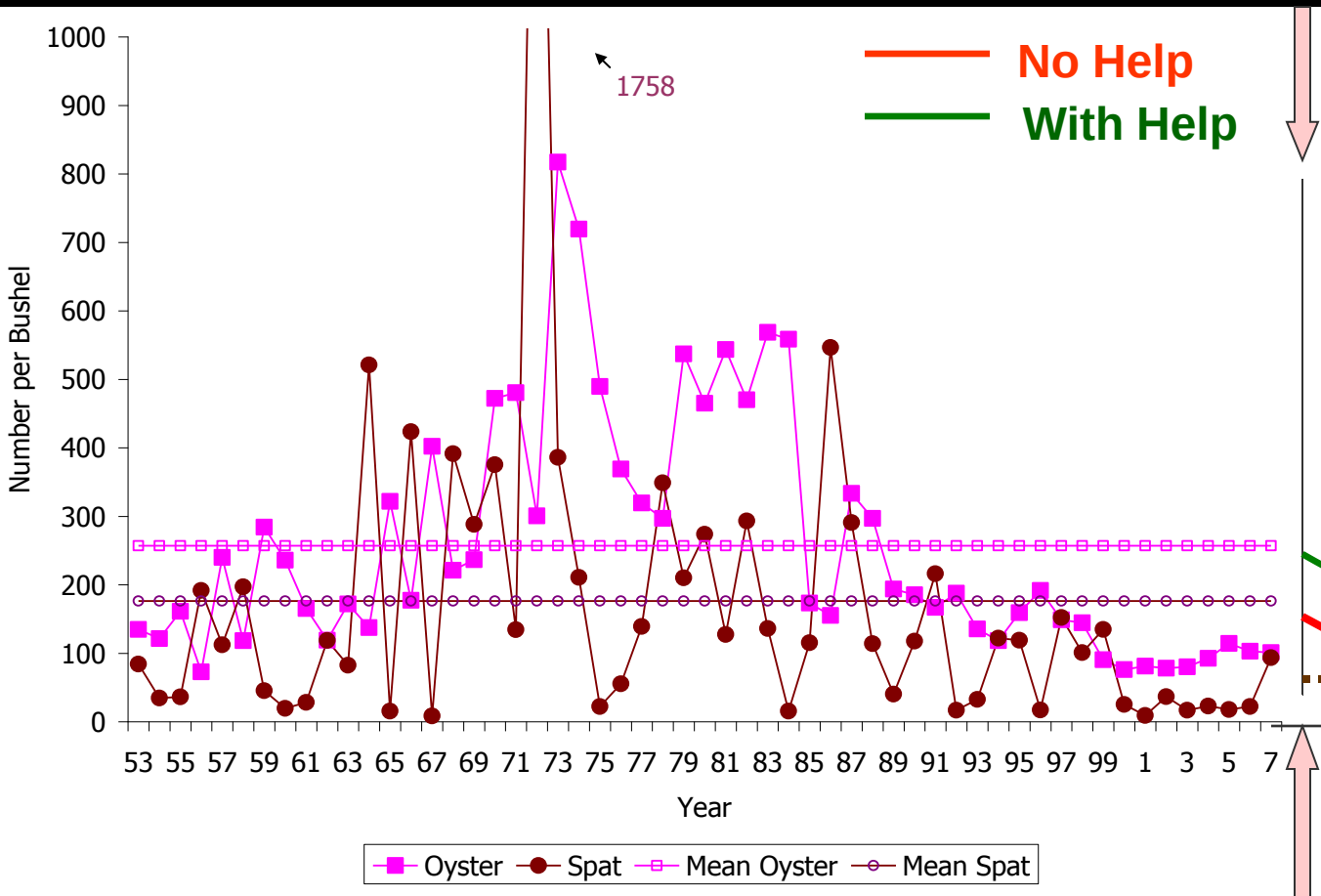


PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Oyster Management

Can they maintain (or be maintained) until they might see more optimal conditions?

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC



Oyster Reef Revitalization

Importance of Bivalves to the Delaware Estuary Watershed

			Oysters *Crassostrea virginica*		
Natural Capital Value	Commercial	*Dockside Product + Secondary Value*	✓✓✓		

Importance of Shellfish to the Delaware Estuary Watershed

			Oysters *Crassostrea virginica*		
Natural Capital Value	Commercial	***Dockside Product + Secondary Value***	✓✓✓		
	Ecosystem Services	***Structural Habitat*** biological hot spots	✓✓		
		Prey	✓		
		Biofiltration top-down grazing, TSS removal, light)	✓✓		
		Biogeochemistry enrichment/turnover, benthic production	✓		
		Shoreline Protection - nearshore reefs	✓		
		Shoreline Stabilization - living edges	✓		

Importance of Shellfish to the Delaware Estuary Watershed

			Oysters *Crassostrea virginica*		
Natural Capital Value	Commercial	***Dockside Product + Secondary Value***	✓✓✓		
	Ecosystem Services	***Structural Habitat*** biological hot spots, bottom-binding	✓✓		
		Prey	✓		
		Biofiltration top-down grazing, TSS removal, light)	✓✓		
		Biogeochemistry enrichment/turnover, benthic production	✓		
		Shoreline Protection - nearshore reefs	✓		
		Shoreline Stabilization - living edges	✓		
	Cultural-Historical	***Waterman Lifestyle, Ecotourism***	✓✓		
		Native American - dietary staple	✓		

Importance of Shellfish to the Delaware Estuary Watershed

			Oysters *Crassostrea virginica*		
Natural Capital Value	Commercial	***Dockside Product + Secondary Value***	✓✓✓		
	Ecosystem Services	***Structural Habitat*** biological hot spots, bottom-binding	✓✓		
		Prey	✓		
		Biofiltration top-down grazing, TSS removal, light)	✓✓		
		Biogeochemistry enrichment/turnover, benthic production	✓		
		Shoreline Protection - nearshore reefs	✓		
		Shoreline Stabilization - living edges	✓		
	Cultural-Historical	***Waterman Lifestyle, Ecotourism***	✓✓		
		Native American - jewelry, dietary staple	✓		
	Bioindicator	***Watershed Indicators*** hallmark resource status/trends	✓✓		
		Site-specific Bioassessment NS&T, caged sentinels	✓		

Importance of Shellfish to the Delaware Estuary Watershed

			Oysters *Crassostrea virginica*	Marsh Mussels *Geukensia demissa*	
Natural Capital Value	Commercial	***Dockside Product + Secondary Value***	✓✓✓		
	Ecosystem Services	***Structural Habitat*** biological hot spots, bottom-binding	✓✓	✓✓	
		Prey	✓	✓	
		Biofiltration top-down grazing, TSS removal, light)	✓✓	✓✓✓	
		Biogeochemistry enrichment/turnover, benthic production	✓	✓	
		Shoreline Protection - nearshore reefs	✓		
		Shoreline Stabilization - living edges	✓	✓✓	
	Cultural-Historical	***Waterman Lifestyle, Ecotourism***	✓✓		
		Native American - jewelry, dietary staple	✓		
	Bioindicator	***Watershed Indicators*** hallmark resource status/trends	✓✓	✓	
		Site-specific Bioassessment NS&T, caged sentinels	✓	✓	

Importance of Shellfish to the Delaware Estuary Watershed

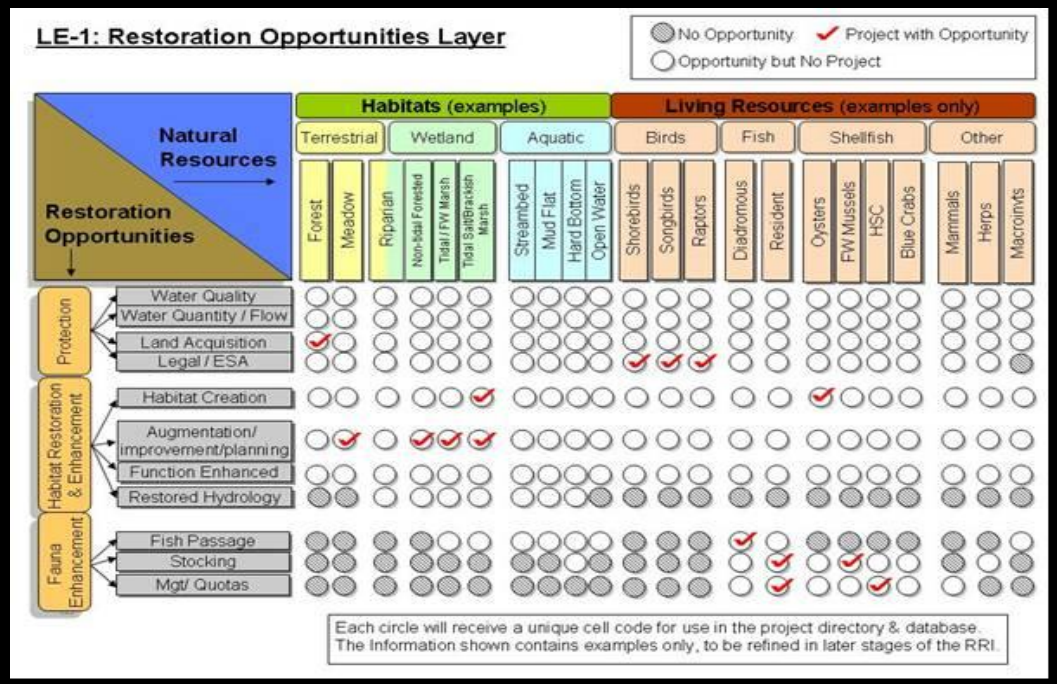
			Oysters *Crassostrea virginica*	Marsh Mussels *Geukensia demissa*	FW Mussels *Elliptio complanata*
Natural Capital Value	Commercial	***Dockside Product + Secondary Value***	✓✓✓		✓
	Ecosystem Services	***Structural Habitat*** biological hot spots, bottom-binding	✓✓	✓✓	✓✓
		Prey	✓	✓	✓
		Biofiltration top-down grazing, TSS removal, light)	✓✓	✓✓✓	✓✓
		Biogeochemistry enrichment/turnover, benthic production	✓	✓	✓
		Shoreline Protection - nearshore reefs	✓		
		Shoreline Stabilization - living edges	✓	✓✓	
	Cultural-Historical	***Waterman Lifestyle, Ecotourism***	✓✓		
		Native American - jewelry, dietary staple	✓		✓✓
	Bioindicator	***Watershed Indicators*** hallmark resource status/trends	✓✓	✓	✓
		Site-specific Bioassessment NS&T, caged sentinels	✓	✓	✓✓
	Conservation	**Biodiversity** fw mussels most critically impaired biota			✓✓✓

ESV Applications

Watershed-Level Activities

- Science Priority Setting
- Conceptual Framework
- Monitoring
- State of the Estuary
- **Regional Restoration Initiative**

Project Registry



Restoration Activity			Scale	Key			Terrestrial			Wetland	
							hab 1	hab 2	hab 3	hab 4	hab5
							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

Applications

Watershed-Level Activities

- Science Priority Setting (White Paper)
- Conceptual Framework
- Monitoring
- State of the Estuary
- **Regional Restoration Initiative**

Ecological Inventories

- Natural Vegetation Classification System
- Delaware Estuary Benthic Inventory

Applications

Watershed-Level Activities

- Science Priority Setting
- Conceptual Framework
- Monitoring
- State of the Estuary
- Regional Restoration Initiative

Ecological Inventories

- Natural Vegetation Classification System
- Delaware Estuary Benthic Inventory

Science & Restoration Projects

- Freshwater Mussel Recovery Program

Propagation and Reintroduction

Hatchery

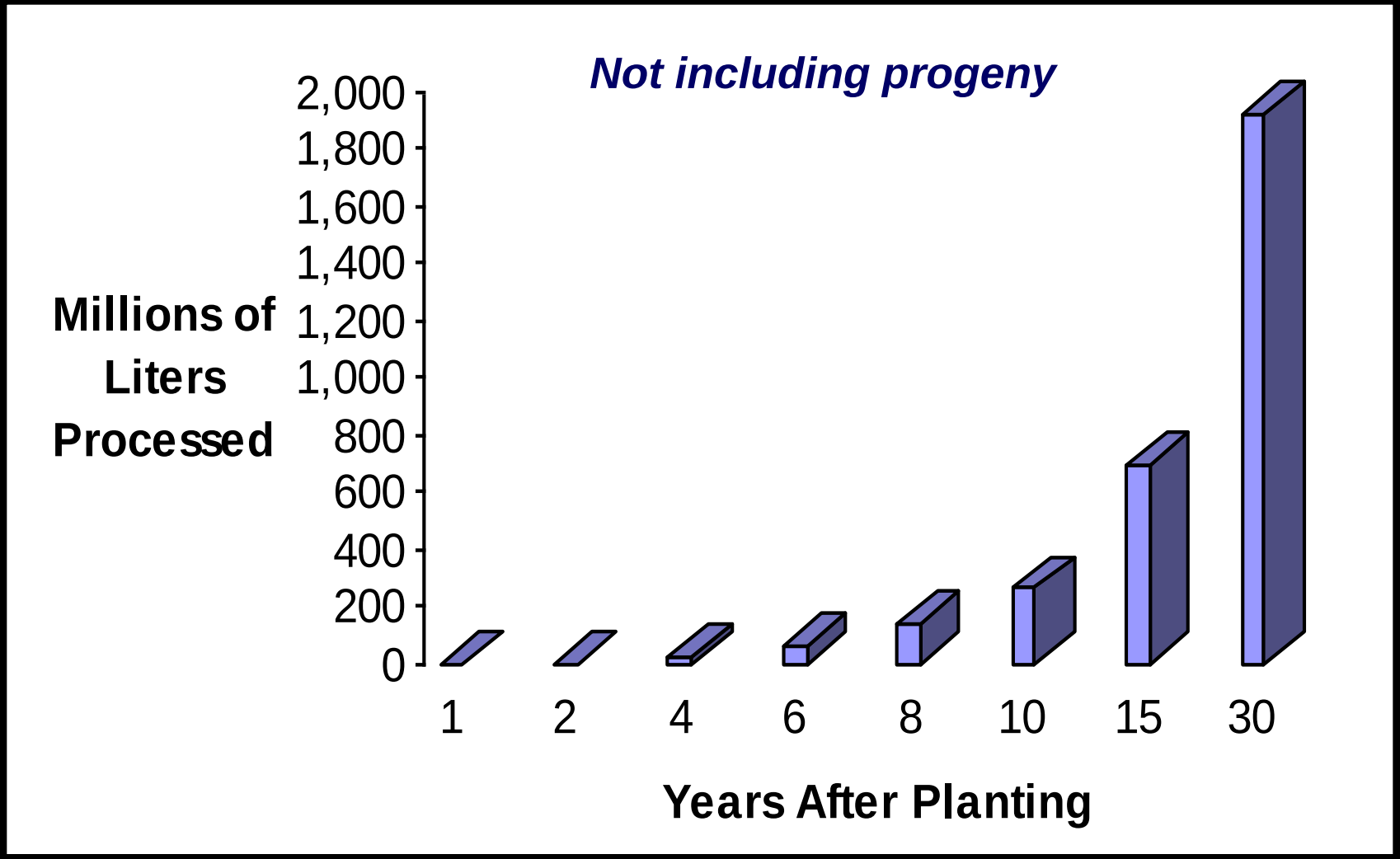
Propagation and Reintroduction

Propagated Juveniles

Photos, R. Neves, VA Tech

Freshwater Mussel Recovery Program

Goals are Being Set Based on Ecosystem Services



Applications

Watershed-Level Activities

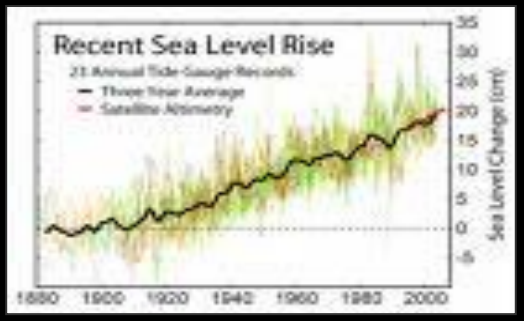
- Science Priority Setting (White Paper)
- Conceptual Framework
- Monitoring
- State of the Estuary
- Regional Restoration Initiative

Ecological Inventories

- Natural Vegetation Classification System
- Delaware Estuary Benthic Inventory

Science & Restoration Projects

- Freshwater Mussel Recovery Program
- Delaware Estuary Living Shorelines



Sea Level Rise

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

Living Shorelines

Applications

Watershed-Level Activities

- Science Priority Setting (White Paper)
- Conceptual Framework
- Monitoring
- State of the Estuary
- Regional Restoration Initiative

Ecological Inventories

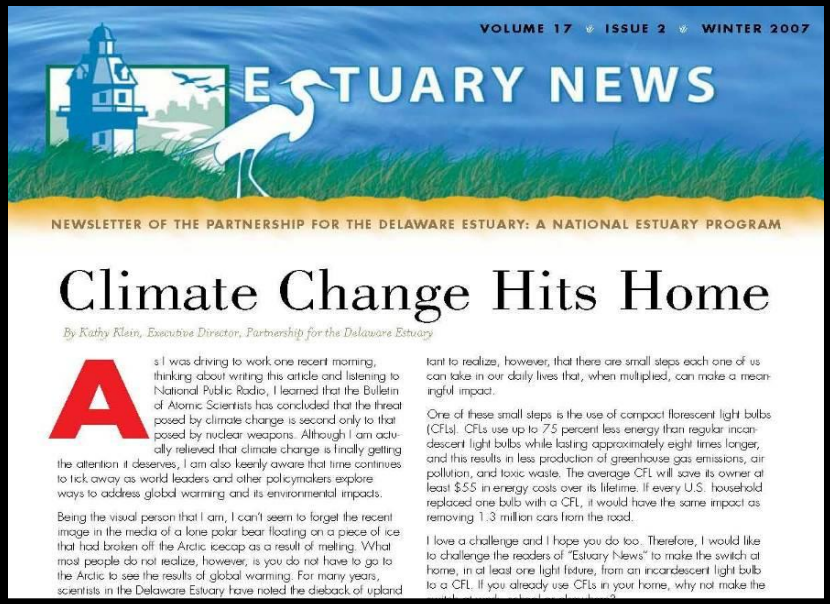
- Natural Vegetation Classification System
- Delaware Estuary Benthic Inventory

Science & Restoration Projects

- Freshwater Mussel Recovery Program
- Living Shorelines

Climate Adaptation Planning

- Ready Estuaries Pilot



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

CLIMATE READY ESTUARIES

EPA

PDE Climate Ready Approach

Adaptive Adaptation

Climate Workgroup

Case Study Subgroups

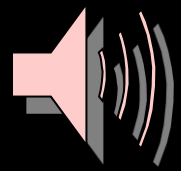
	Vulnerability Assessment	Natural Capital Valuation	Management & Adaptation Options
Drinking Water			
Tidal Wetlands			
Bivalve Shellfish			

Prioritization

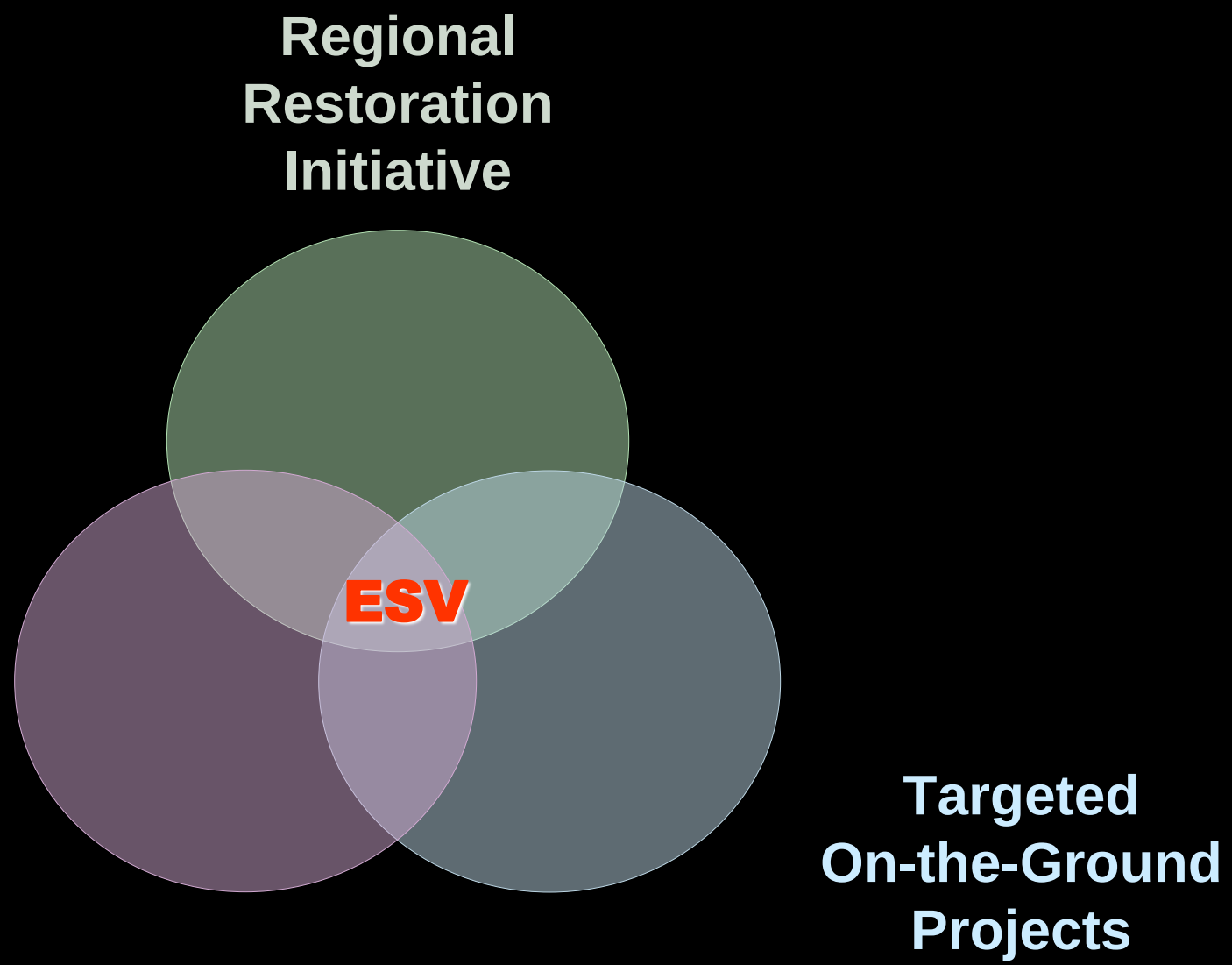
Adaptation Plan

Management and Policy

Outreach, Education, Messaging



Ecosystem Services in PDE Science



Summary

Ecosystem Services Valuation represents a powerful tool to ensure that functional processes are studied, monitored and used to prioritize CCMP activities in the same way as structural aspects (e.g., acres)

ESV can provide uniform units/currency for quantifying and comparing natural resource benefits across time and space

ESV, together with other natural capital values, can help put natural resources on a more even footing with developed assets

Caveat

ESV may be an Ecological Manhattan Project

Care must be taken not to excuse the loss of low condition, lower value resources that might otherwise be protected or restored

– End –

PARTNERSHIP FOR THE
DELAWARE ESTUARY, INC