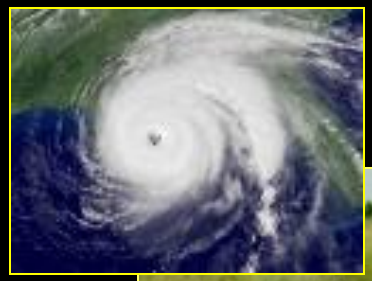
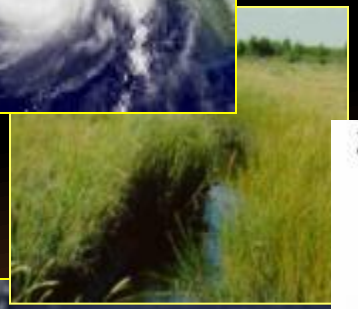
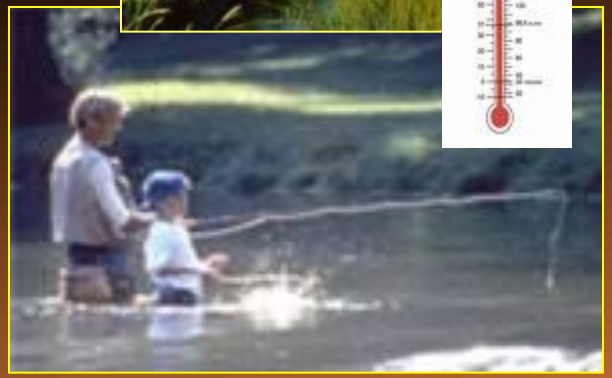
Importance of freshwater inflow for natural resources of the lower Delaware River Basin

Danielle Kreeger
Partnership for the Delaware Estuary







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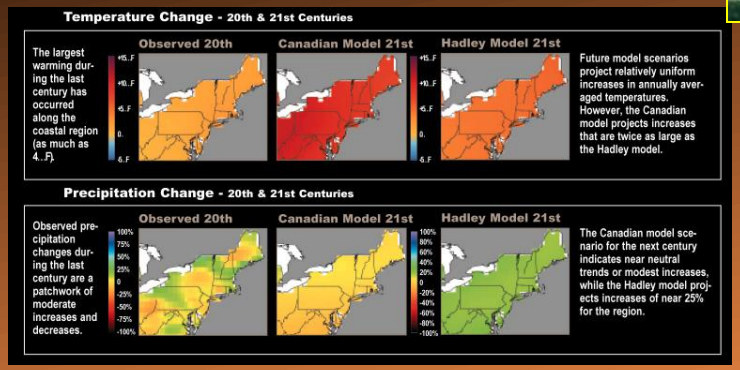
NCER
August 4, 2011



The Delaware River Basin

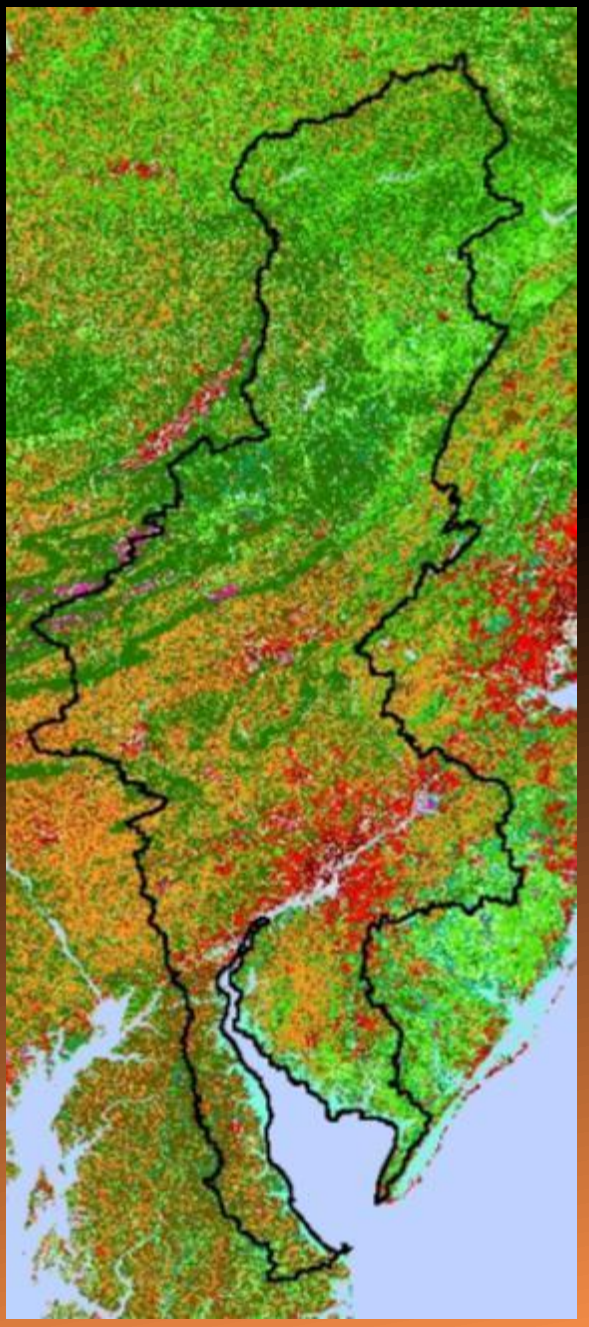
13,600 mi^2

4 States

9 million people

Delaware River
60% of fw inflow (11,700 ft^3/s)

Drinking water for 16 million people



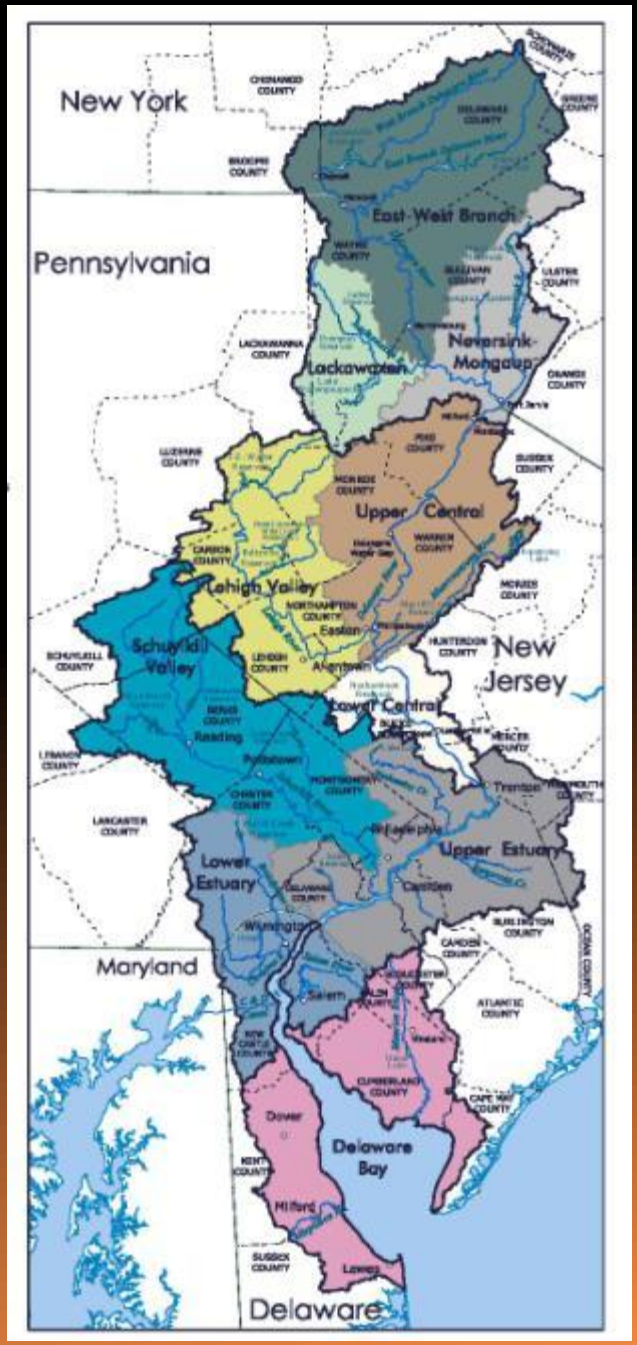
Delaware River Basin

Upper and Central Regions

- above Trenton
- pristine, wild and scenic
- longest undammed river in east

Lower and Bay Regions

- >90% of people
- legacy contaminants
- historic and modern development
- rich estuarine resources



Flow Management - Upper Basin

Flooding

- 3 of 6 floods of record in last 10 years

Coldwater Trout Fishery

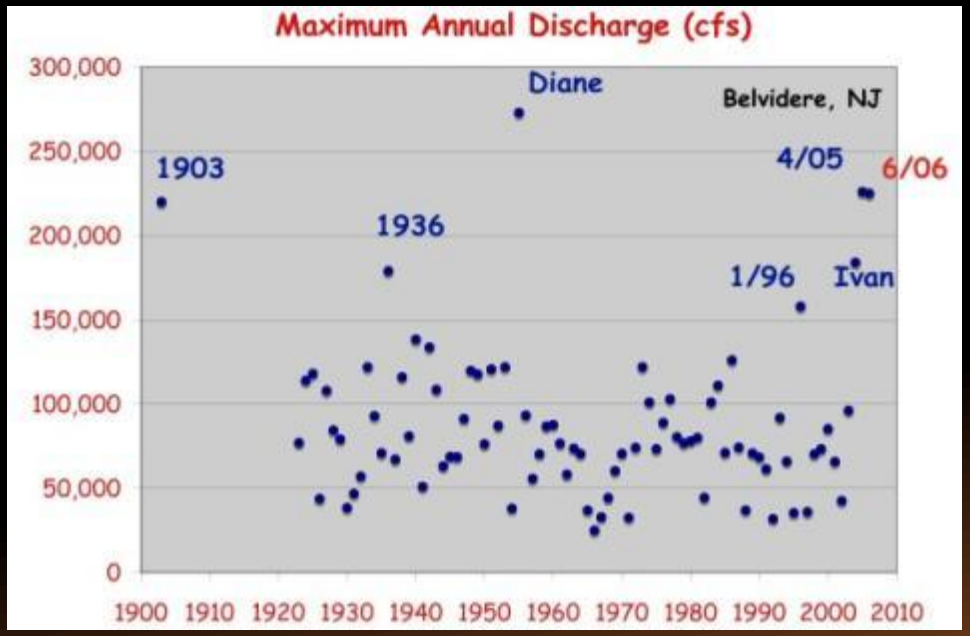
- important recreational resource

Endangered Species Protection

- dwarf wedgemussels

Flow Managed at Trenton

- Delaware River Basin Commission
- Protects ecological flows for upper basin natural resources




www.fliesandfins.com/article746.html

http://www.ct.gov/dep/cwp/view.asp?A=2723&Q=325902

Flow Management - Lower Basin **

Salinity Maintenance

- largest freshwater tidal prism in world
- broad salinity gradient & fw/sw mixing zone

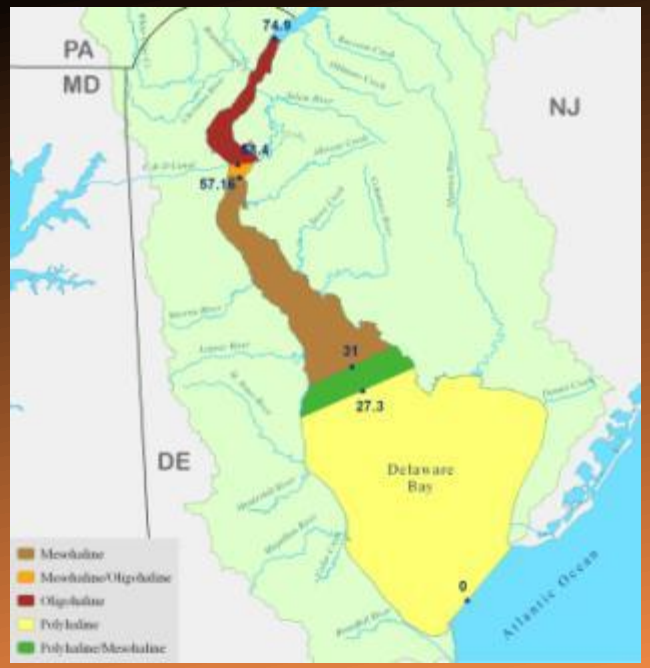
Drinking Water

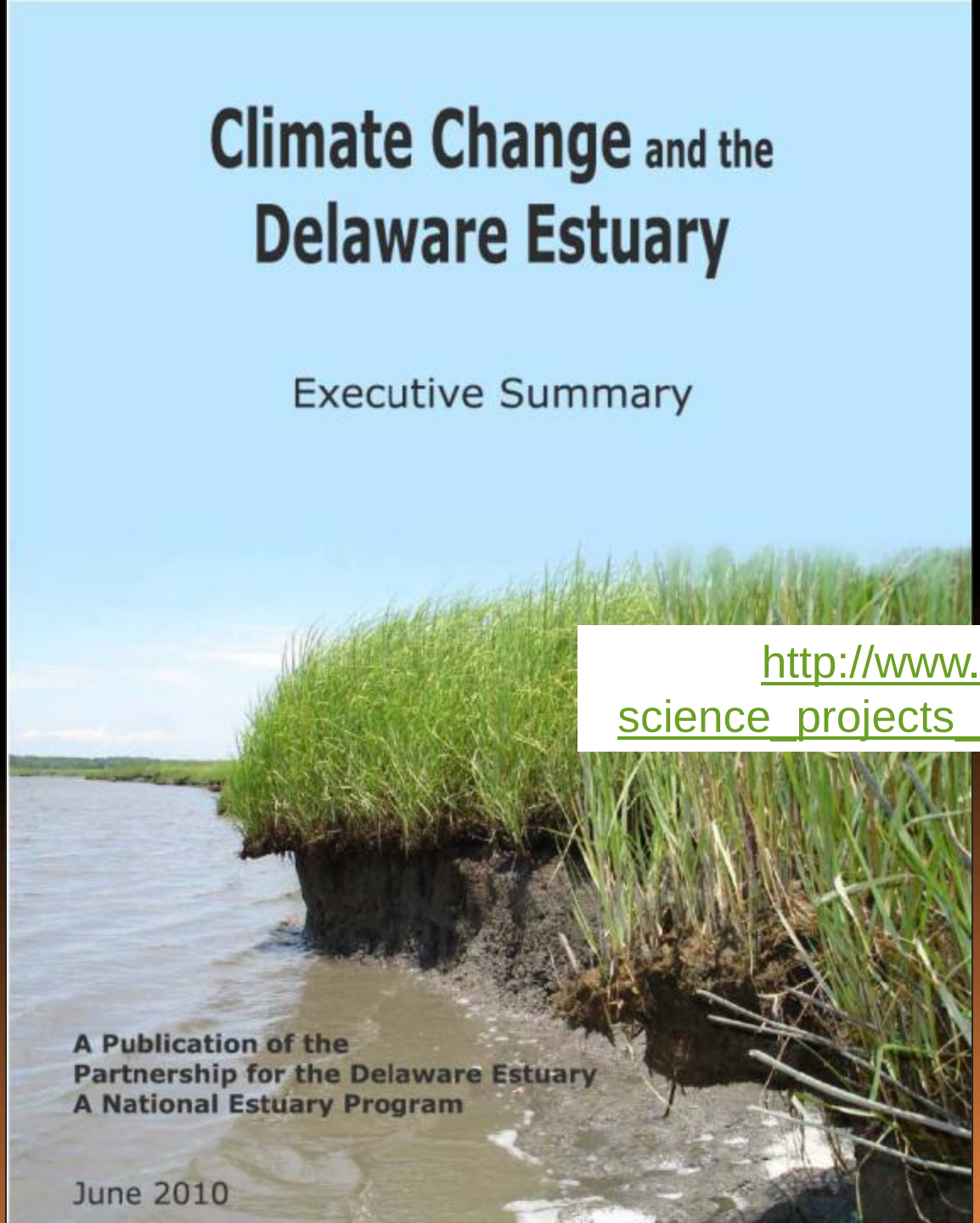
- Philadelphia intakes in fw tidal zone

Rare Freshwater Mussels

Freshwater Tidal Wetlands

Oysters





http://www.delawareestuary.org/science_projects_climate_ready_products.asp

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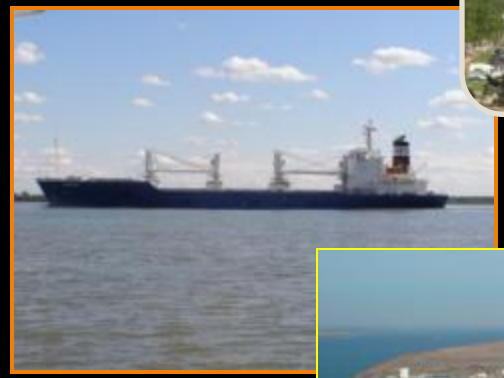
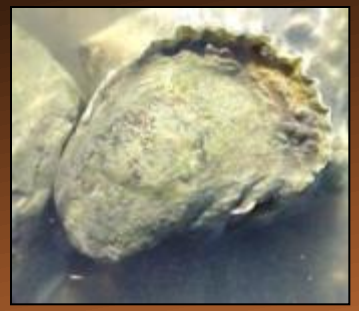


How do we even begin to plan for climate change in a system as large and complex as the Delaware Estuary?

PDE Climate Ready Pilot

3 case studies



How will climate change in the Delaware Estuary?

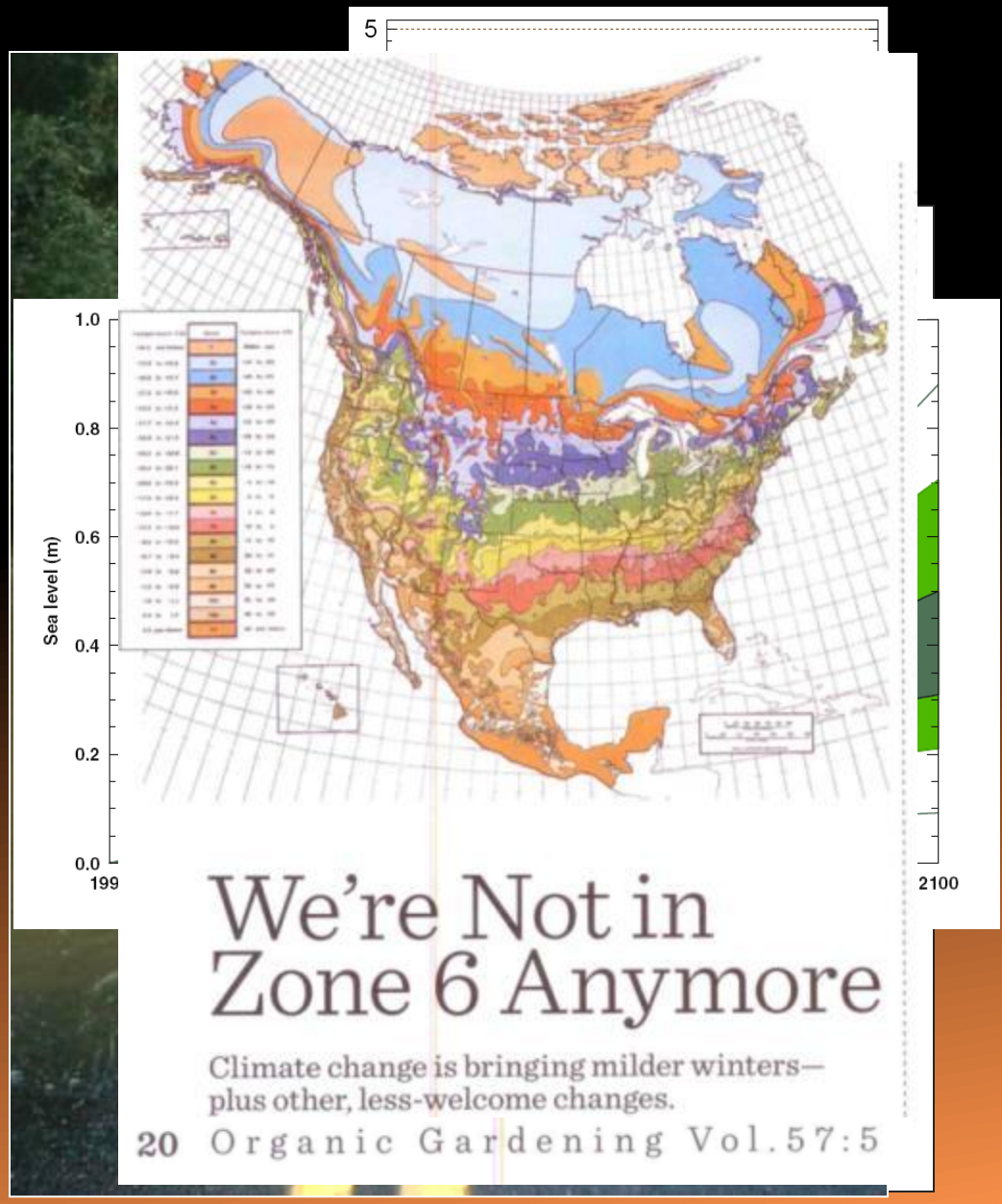
How will changes impact key resources?

What actions are recommended to make these resources more resilient?

What if we don't take action?

How Will Climate Change Affect Flow?

- **Temperatures**
  - *More in summer than in winter*
  - *Locked in for next 30 years*
- **Precipitation**
  - *More in winter than in summer*
  - *More heavy events*
- **Sea Level**
  - *0.6 - 1.5 m by 2100 (or more)*
  - *local rates >> global*
- **Salinity**
- **Storms** ?
- **Growing Season**



Case Studies

CLIMATE READY ESTUARIES
EPA
Delaware Estuary Pilot

Vulnerability and Options

↓

Future Status

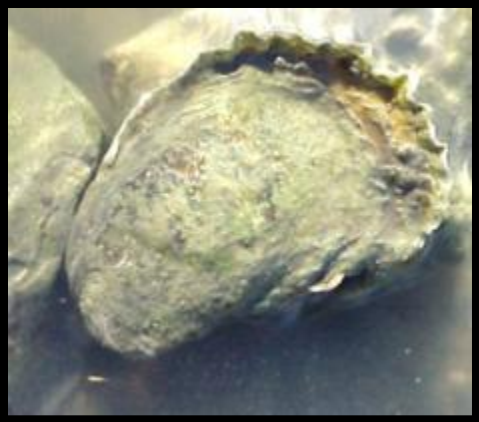
↓

Rankings

↓

Recommendations

Tidal Marshes



Bivalve Shellfish

Drinking Water

Tidal Wetlands – Why?

A Signature Trait of System

Near Contiguous Band

Diverse: *Freshwater Tidal Marshes*
Brackish Marshes
Salt Marshes

<u>Nature's Benefits</u>

Flood Protection
Water Quality
Fish and Wildlife
Natural Areas
Carbon Sequestration

Tidal Wetland Vulnerability

Freshwater Tidal Marshes

- Salinity Rise
- Barriers to Landward Migration
- Others: Tidal Range, Seasonal Drying/Wetting

Salt Marshes

- Sea Level Rise
- Storms and Wind Wave Erosion
- Barriers to Landward Migration
- Others: Seasonal Wetting/Drying, Invasives

Tidal Wetlands – Adaptation Options

- Protection of Natural Buffers
- Structure Setbacks
- Living Shorelines
- Strategic Retreat
- Manage Water Flows (salinity)
- Manage Sediments

Needs

- Geospatial Approach
- Sediment Budget - Tidal Wetland Ecosystem Model
- LIDAR and Climate Monitoring Data
- Assessment Methods for Adaptation Tactics

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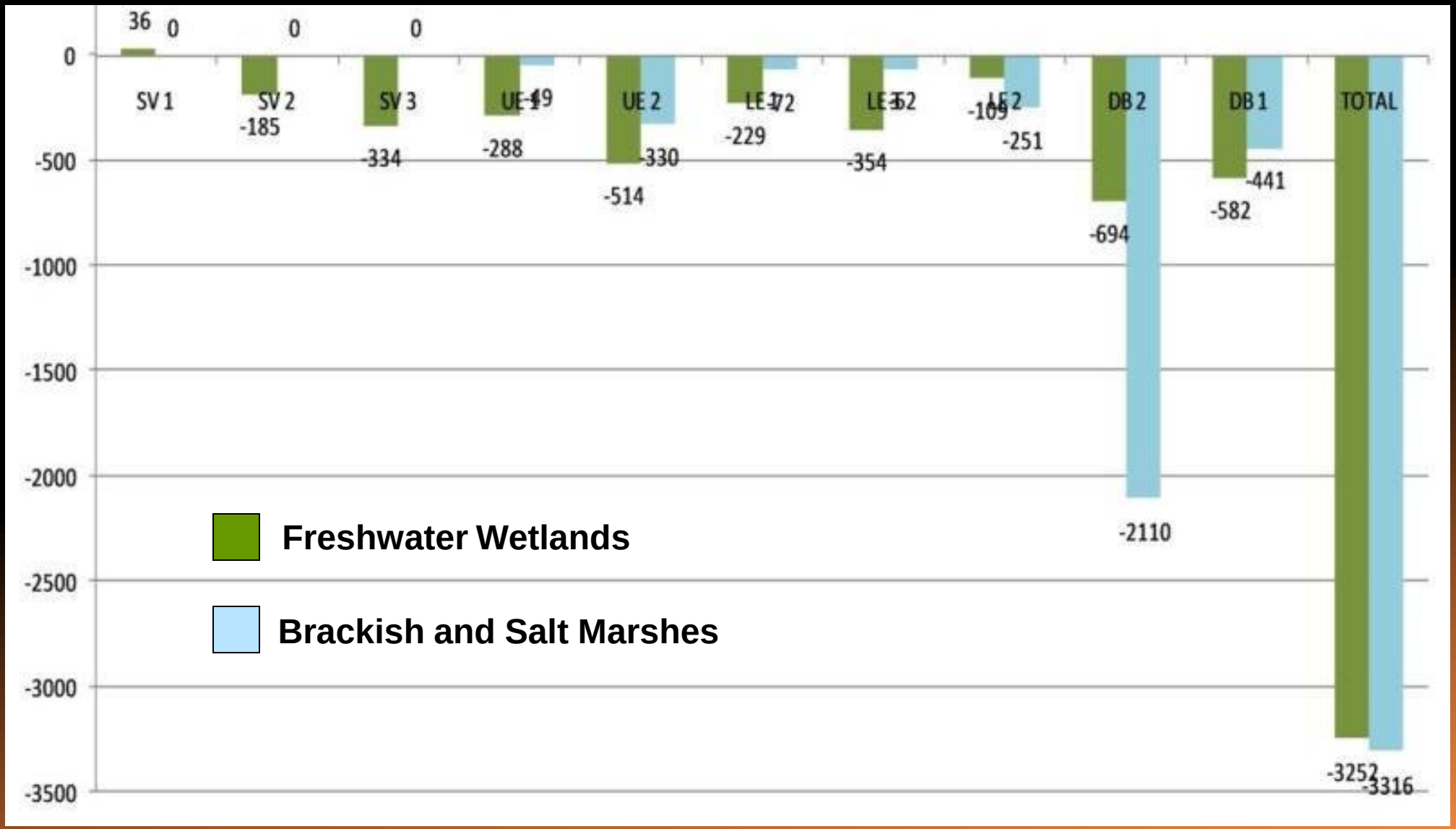
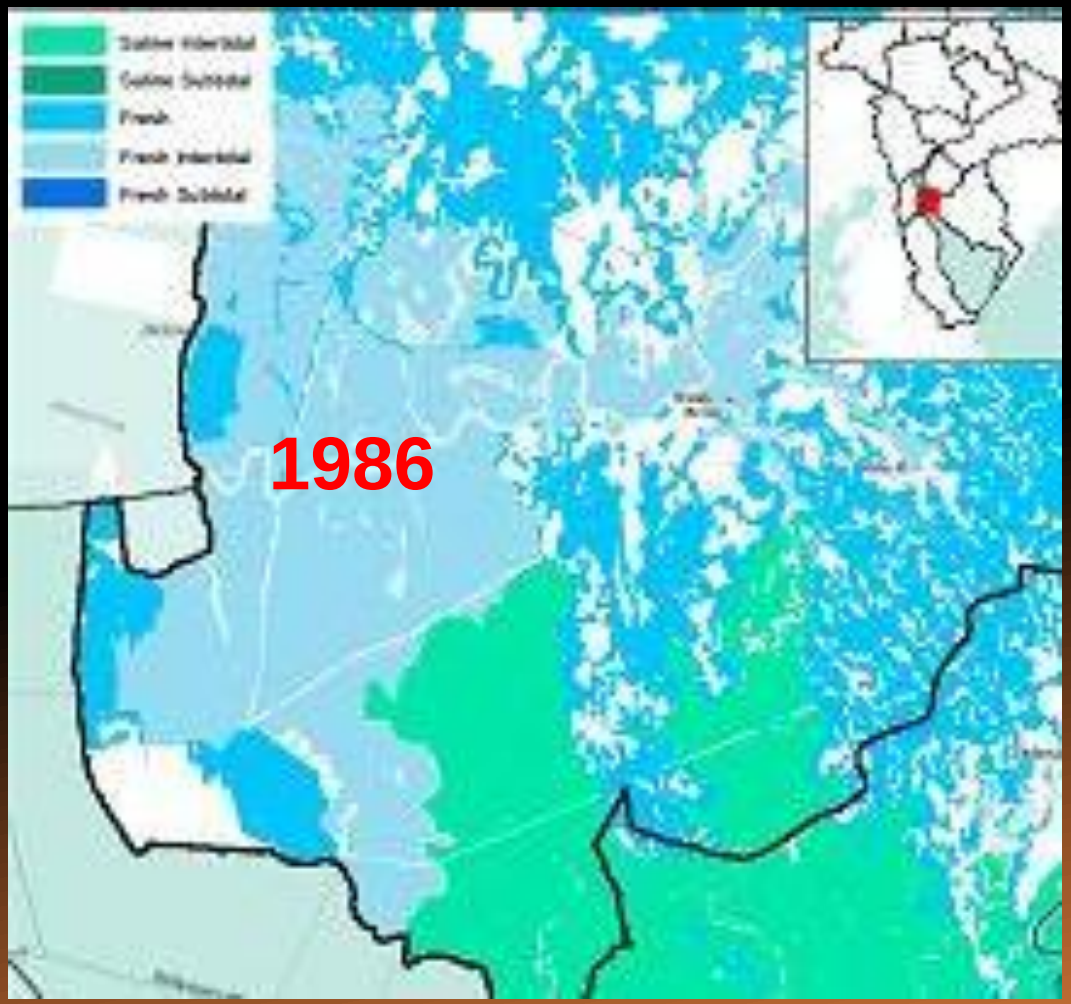
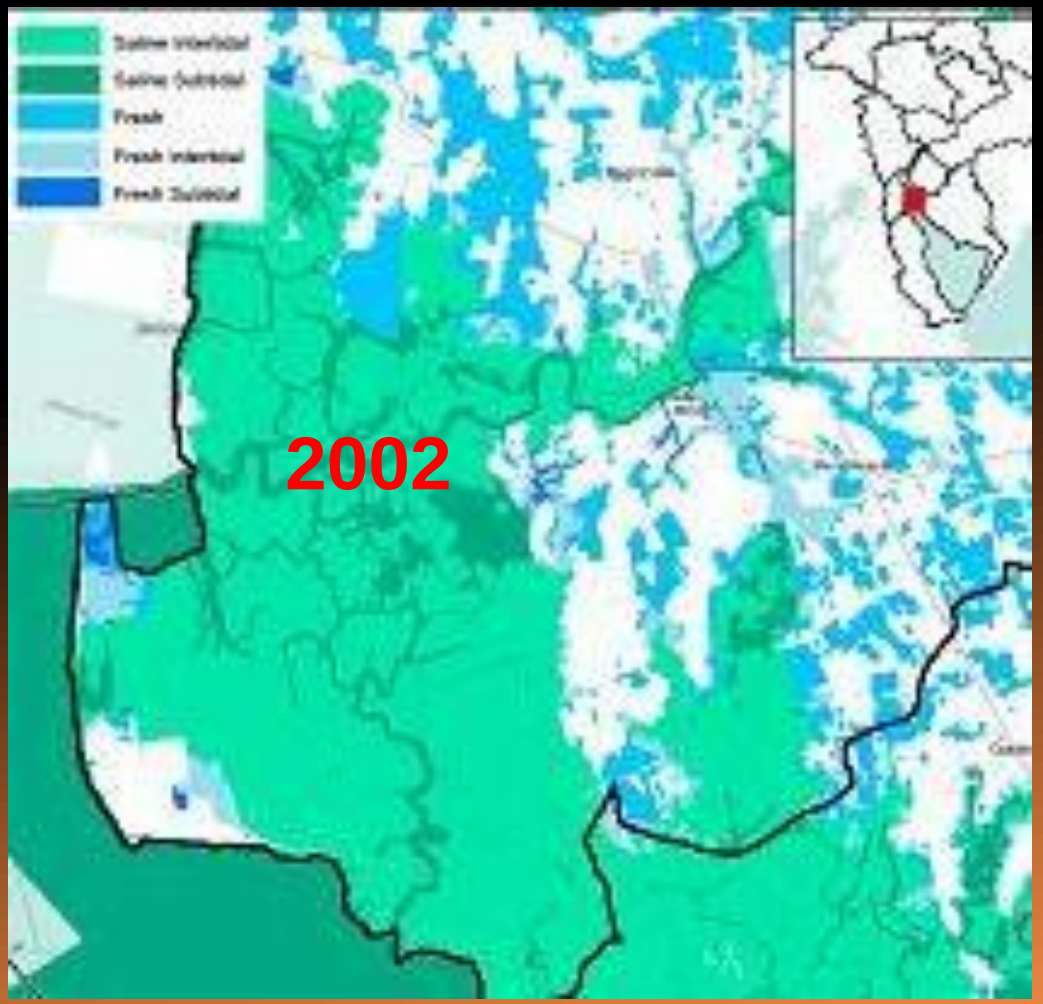
Wetland Loss in Lower Basin 1996-2006



Effect of Salinity Rise

Conversion of Freshwater Tidal to Salt Marsh

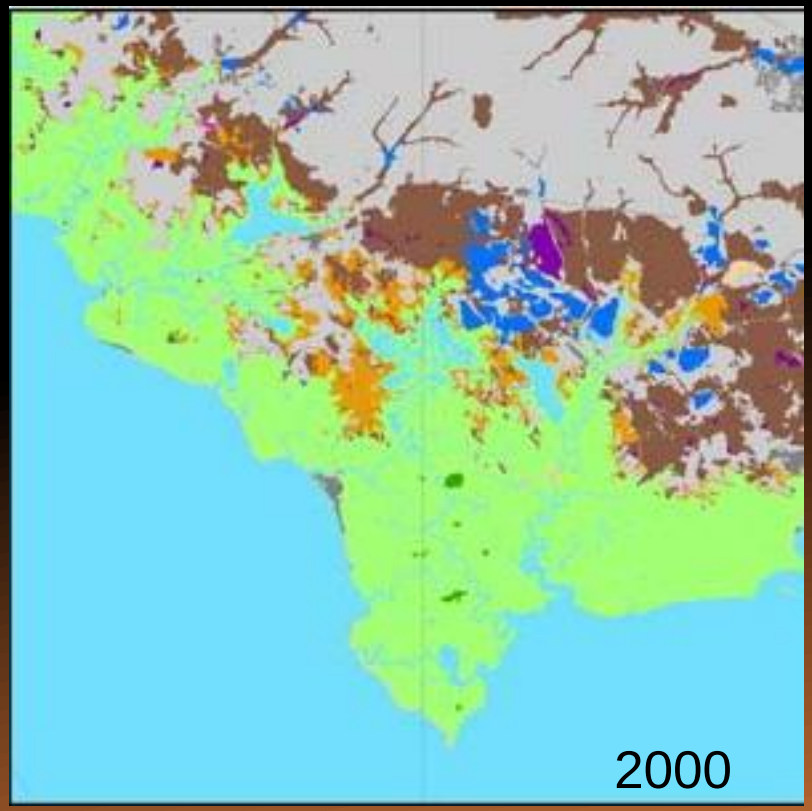


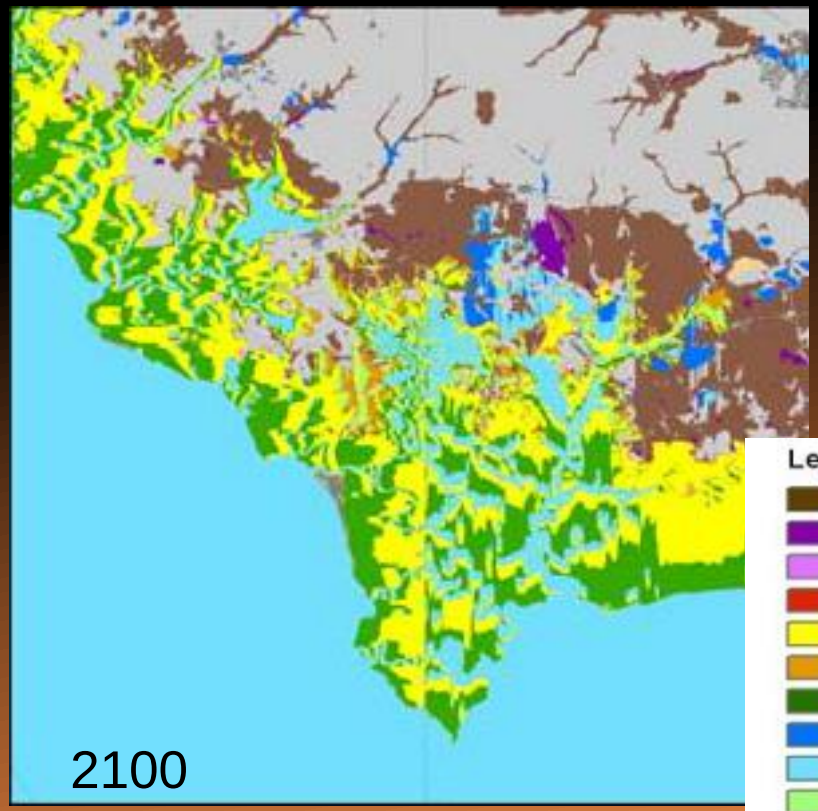


Projected Changes

25-75% Loss of tidal wetlands!

- Conversion of >40,000 ha Uplands to Wetlands
- Conversion of >100,000 ha Wetlands to Water
- Loss of Services >> Acreage Losses





Case Studies

CLIMATE READY ESTUARIES
EPA
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- Vulnerability and Options
- Future Status
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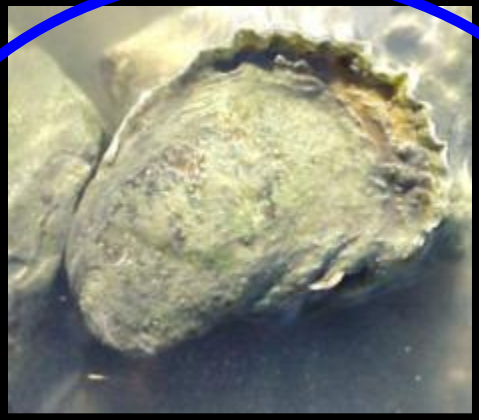
Tidal Marshes



Bivalve Shellfish

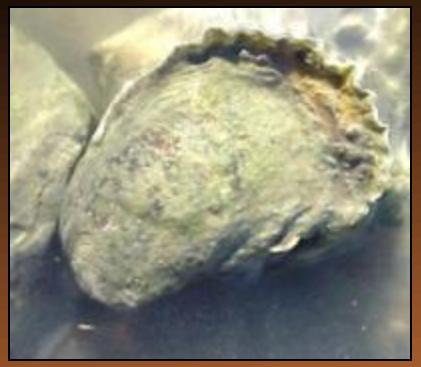
Drinking Water

PARTNERSHIP FOR THE DELAWARE ESTUARY, INC

Bivalves of the Delaware

Elliptio complanata

Geukensia demissa



Crassostrea virginica

11 Other Species of Freshwater Unionid Mussels

Corbicula fluminea

Rangia cuneata

Mya arenaria

Mytilus edulis

Ensis directus

Mercenaria mercenaria

Nature's Benefits

Bivalve Shellfish are "Ecosystem Engineers"

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Mussel Beds

CTUIR Freshwater Mussel Project

Oyster Reefs

Kreeger

Mussels Are Habitat
INITIATIVE
Restoring Our Nation's Water Quality

Biofiltration Potential

Slide from Dick Neves, VA Tech

Mussels Are Habitat
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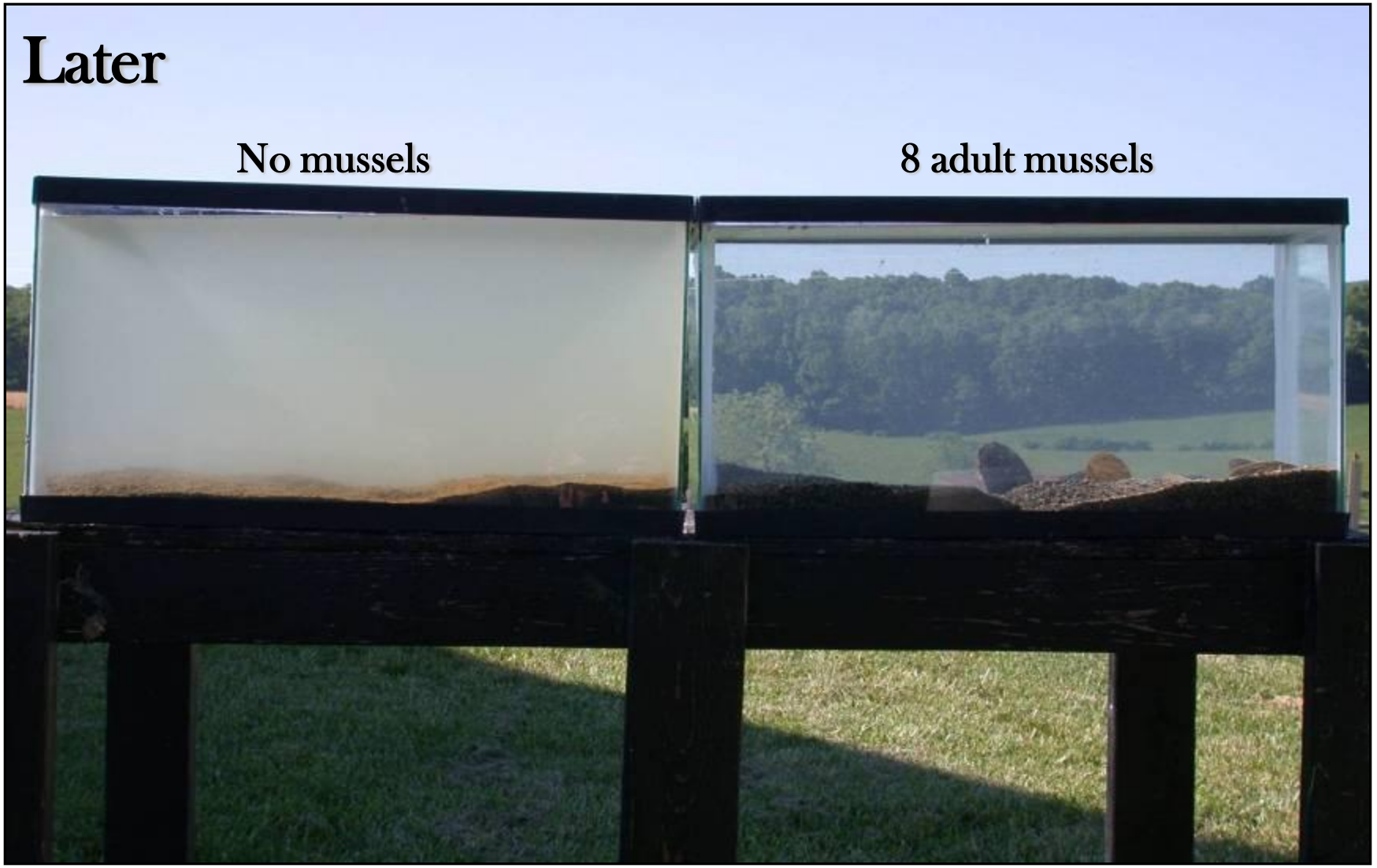
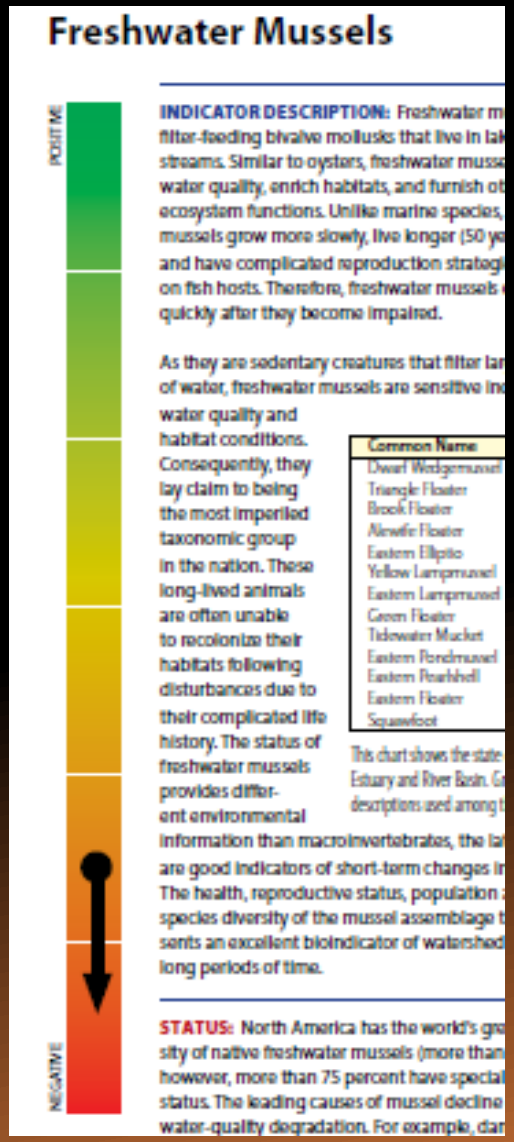
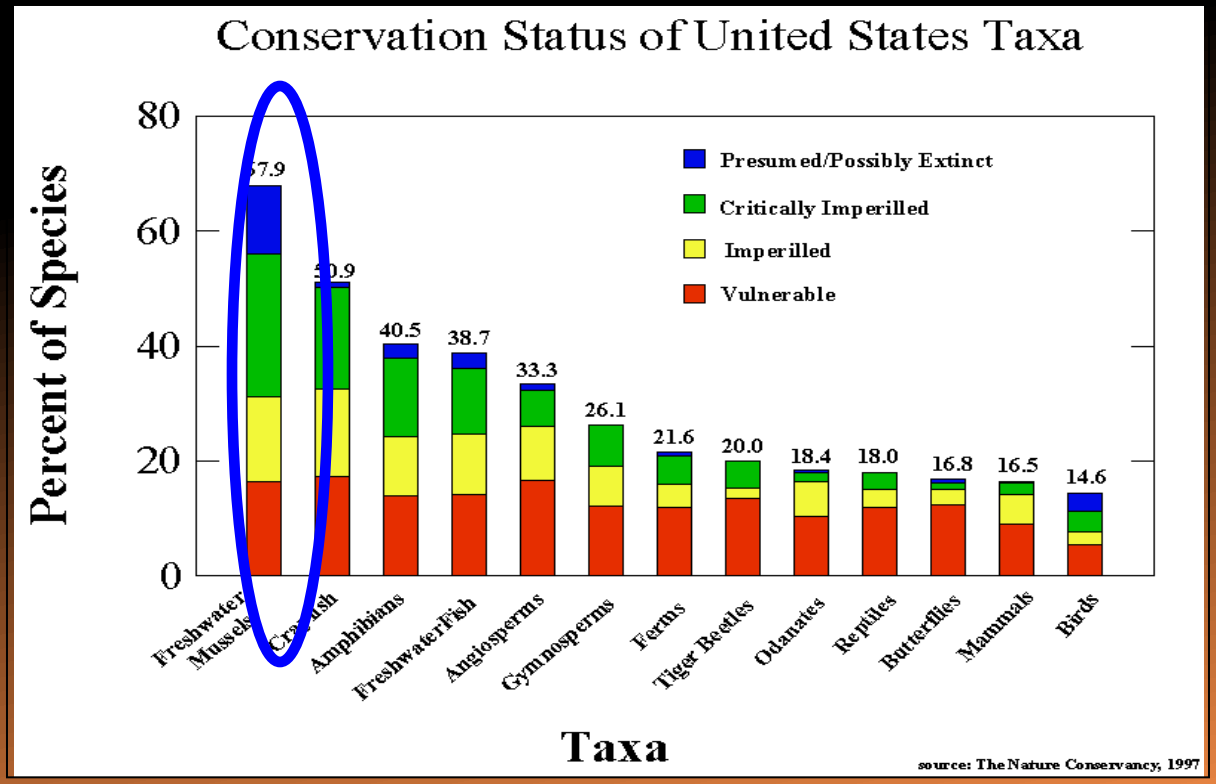


Slide from Dick Neves, VA Tech

Freshwater Mussels



Most Imperiled
Animals and Plants



Bivalve Projections – FW Mussels

Shifting Species Ranges, But No Dispersal

Patchy, Impaired

Elliptio complanata

Rare

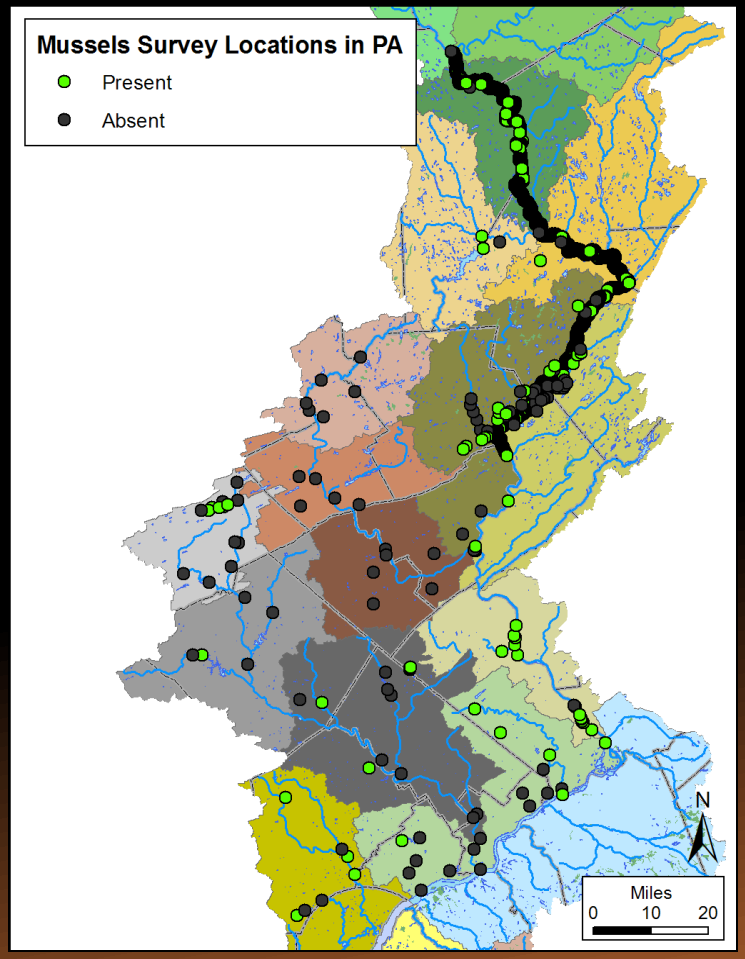
Strophitus undulatus

Extirpated

Alasmidonta heterodon

		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

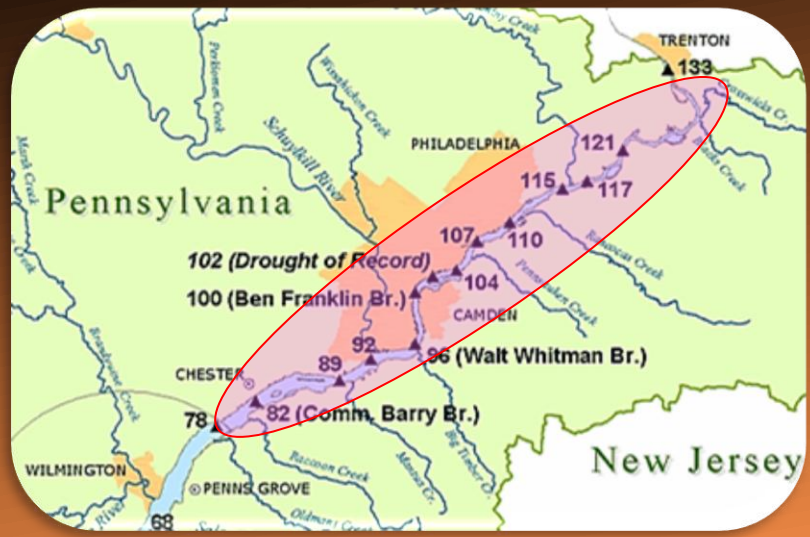
Mussel Protection and Restoration Needs



- Most streams no longer have any mussels
- When they do, they are small beds, old and only 1-2 species

- More than 7 historic species found in freshwater tidal reach in 2010
- Several state T&E species
- Reproducing
- Broodstock for restoration elsewhere

- **Freshwater flow** just as critical to sustain these beds as rare mussels in upper river



Oysters

Oysters
Crassostrea virginica

DESCRIPTION: Eastern oysters are a nutritious f
and an important fishery in Delaware Bay. In 188
1,400 sailing vessels harvested approximately 1.5
bushels, or 22 million pounds of oysters. Today, h
deliver about 100,000 bushels with a dockside va
of $3 million to $5 million, but efforts are under w
boost those numbers. Oysters also provide impor
ecosystem services by creating reef habitats for fi
other organisms, filtering water, recycling nutrien
stabilizing sediments. However, these filter-feede
be sensitive to degraded water conditions. Like o
bivalve mollusks, oysters are world-renowned as
bioindicators of environmental conditions.

STATUS: Although only a fraction of their histori
today's oyster populations are carefully managed
maintain and increase abundance through the in
of harvest, oyster disease mortality, and recruitm
tunately, oysters in Delaware Bay have developed
resistance to MSX disease, which devastated the p
tion from 1957 to 1986. However, Dermo disease
been a persistent problem since 1990, especially
lower Bay's high-salinity waters. After an unprece
seven years of low "recruitment" by juvenile oyst
spat), 2007 marked a return to average levels.

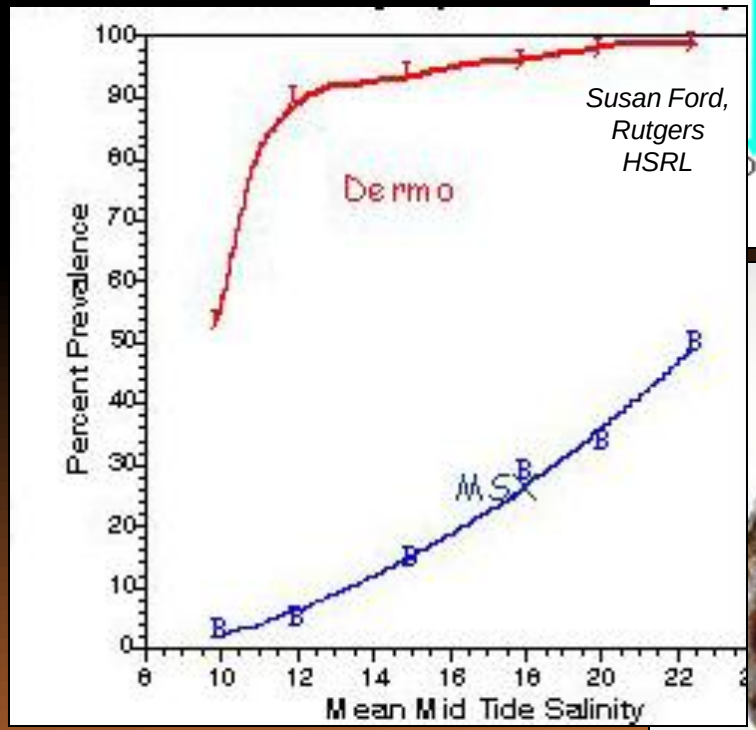
TRENDS: Oyster abundance was not accurately
before the 1950s, but landings data suggest that
tions are a fraction of their historic size in the 19th
early 20th Centuries. Seed-bed data indicate that
abundance is 39 percent of the 1953 to 2007 long
average and 78 percent of the 1989 to 2007 short
average. While recruitment in 2007 was 54 percen
long-term average, it represents 135 percent of th
term average. In fact, populations in Upper Delaw
remain relatively robust. Therefore, it is likely the
population will continue to support commercial

POSITIVE

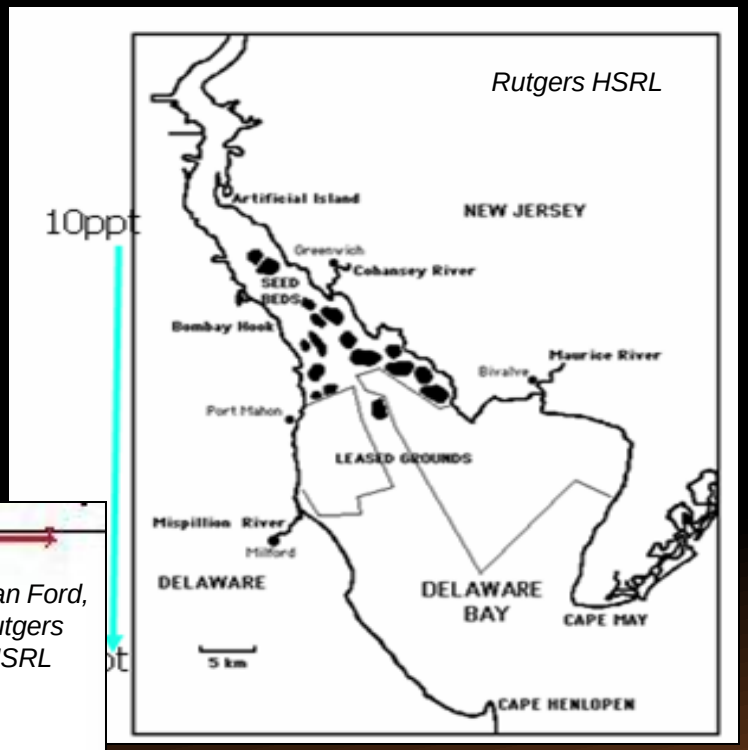
NEGATIVE

ACTIONS AND NEEDS: Oyster population healt

Oyster Disease and Salinity



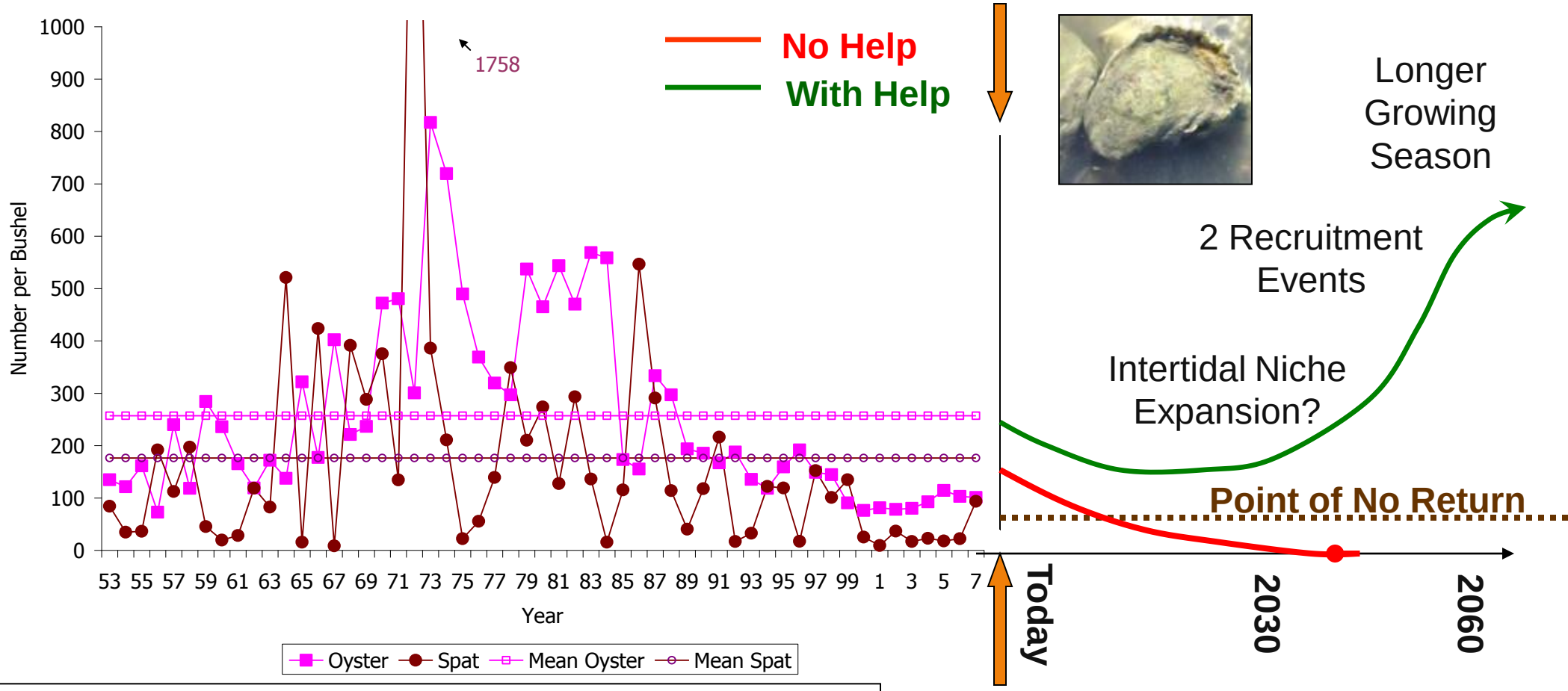
Susan Ford, Rutgers HSRL



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

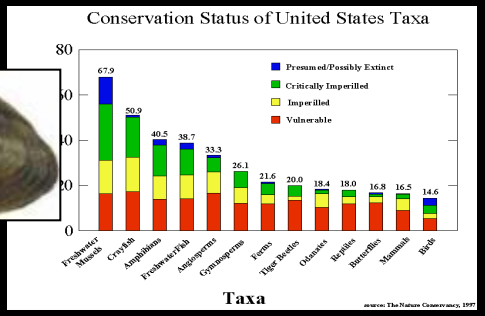
Bivalve Projections – Oysters

Can they be maintained until they might see better conditions?

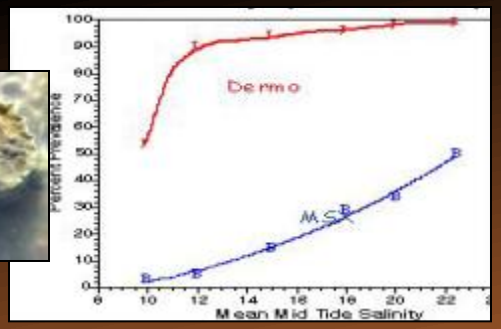


Historical data from Rutgers Haskin Shellfish Laboratory

Flow/Salinity Impacts Depend on Species and Location



Freshwater Tidal Mussels:
salinity, low flows and higher temperature



Oysters:
disease and salinity

Options for Making Shellfish More Resilient

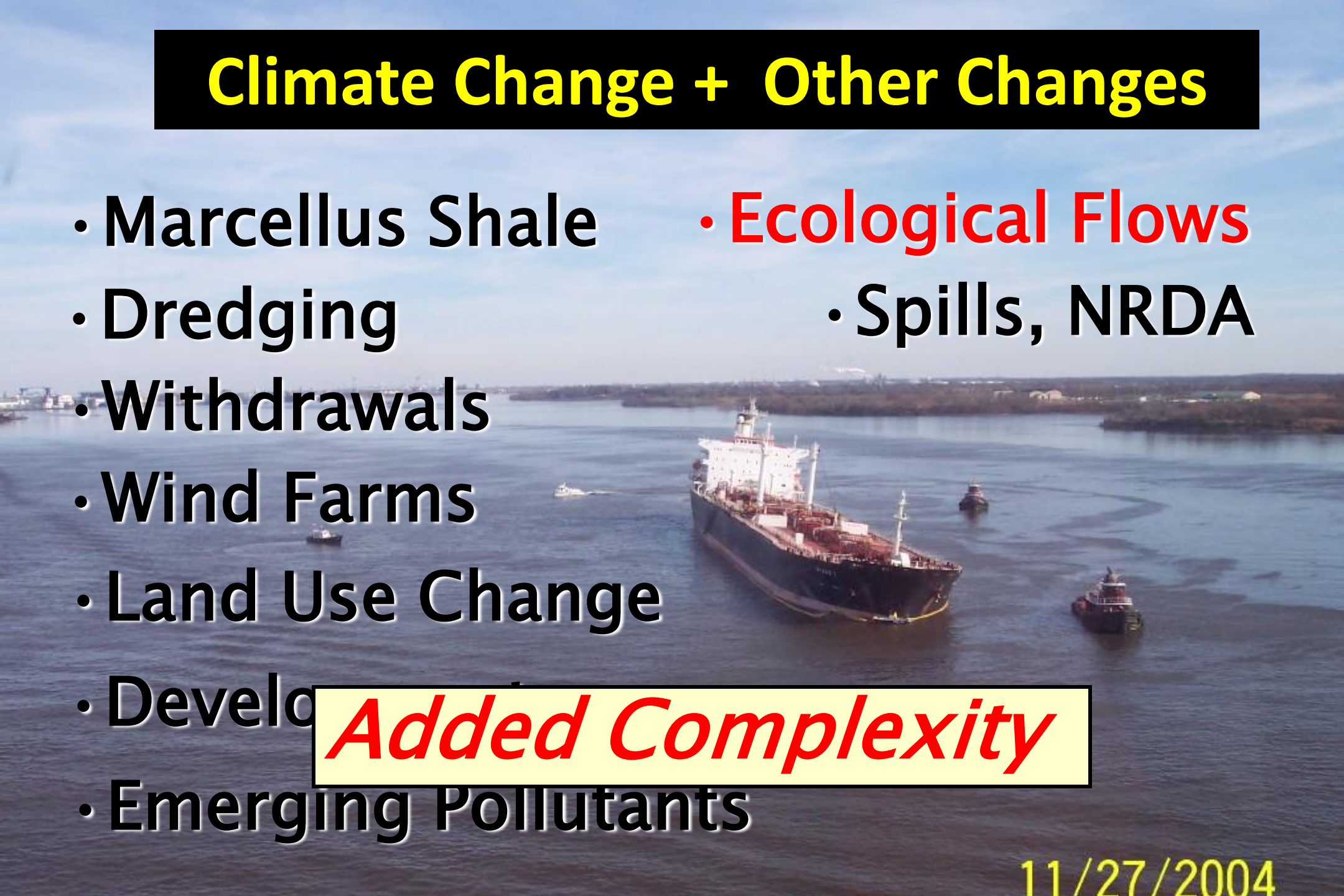
Water Quality &
Flow Management

What if We Don't Manage Flow Wisely?

Natural Capital at Risk

Bivalve Natural Capital		Oysters	Marsh Mussels	FW Mussels
Millennium Ecosystem Assessment Categories	*Specific Services/Values*	*Relative Importance Scores*		
Provisioning: Food & Fiber	*Dockside Product*	✓✓✓		✓
Regulating	*Shoreline & Bottom Protection*	✓✓		
	Shoreline Stabilization	✓✓	✓✓✓	✓✓
Supporting	*Structural Habitat*	✓✓✓	✓✓	✓✓
	Biodiversity: Imperiled Species			✓✓✓
	Bio-filtration	✓✓✓	✓✓✓	✓✓✓
	Biogeochemistry	✓✓	✓✓	✓✓
	Prey	✓	✓✓	✓
Cultural/ Spiritual/ Historical/ Human Well Being	*Waterman Lifestyle, Ecotourism*	✓✓		
	Native American	✓✓		✓✓✓
	Watershed Indicator	✓✓✓	✓✓	✓✓✓
	Bio-Assessment	✓✓✓	✓✓	✓✓✓

Climate Change + Other Changes



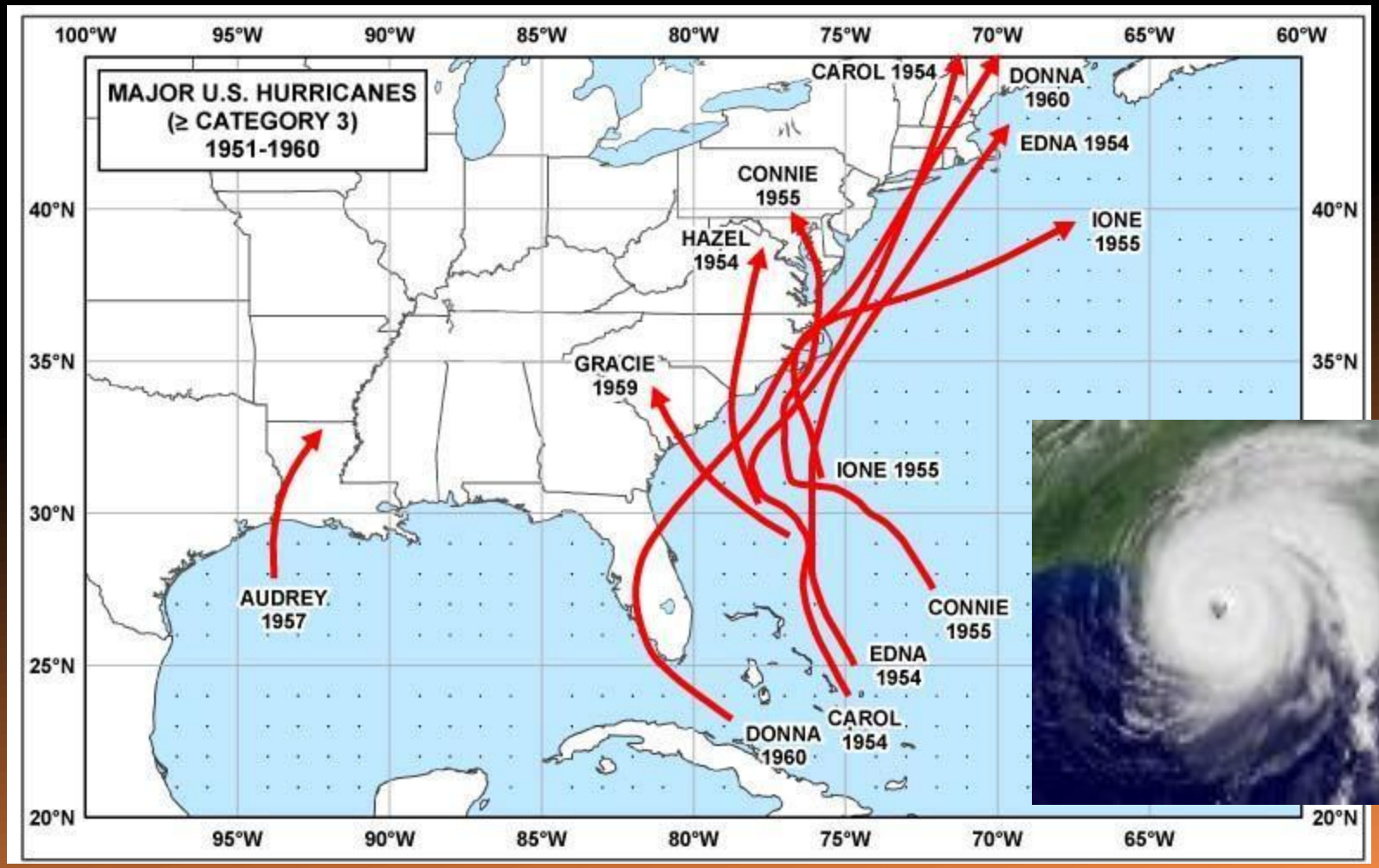
- Marcellus Shale
- Dredging
- Withdrawals
- Wind Farms
- Land Use Change
- Develo
- Emerging Pollutants

- Ecological Flows
- Spills, NRDA

Added Complexity

The Wild Card

Storms



Big Picture for Flow Management

Precipitation will Increase

- but at the wrong time and not evenly, no more snow pack
- insufficient volume to offset sea level rise and maintain salinity

Salinity will Increase

- sea level rise will swamp any added runoff, particularly in summer

Population will Increase

- expected 80% increase by 2100, increasing demand for water

Estuarine Natural Resources Need Stronger Protection

- flow management recommends “protection” of upper basin resources
- flow management recommends “study” of lower basin resources
- lower basin natural resources sustain lives and livelihoods

– End –