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

Danielle Kreeger
Partnership for the Delaware Estuary

NCER
August 4, 2011
The Delaware River Basin

13,600 mi²
4 States
9 million people

Delaware River
60% of fw inflow (11,700 ft³/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

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
Climate Change and the Delaware Estuary

Executive Summary

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

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*

Nature’s Benefits
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
Wetland Loss in Lower Basin 1996-2006

- **Freshwater Wetlands**
- **Brackish and Salt Marshes**
Effect of Salinity Rise
Conversion of Freshwater Tidal to Salt Marsh

1986

2002
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
Tidal Marshes

Bivalve Shellfish

Drinking Water

Case Studies

Vulnerability and Options

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Recommendations
Bivalves of the Delaware

- **Elliptio complanata**
- **Geukensia demissa**
- **Crassostrea virginica**
- **Mya arenaria**
- **Rangia cuneata**
- **Corbicula fluminea**
- **Mytilus edulis**
- **Ensis directus**
- **Mercenaria mercenaria**

11 Other Species of Freshwater Unionid Mussels
Nature’s Benefits

Bivalve Shellfish are “Ecosystem Engineers”

Mussel Beds

Oyster Reefs
Biofiltration Potential

Start

No mussels

8 adult mussels

Slide from Dick Neves, VA Tech
Biofiltration Potential

Later

No mussels  8 adult mussels

Slide from Dick Neves, VA Tech
Freshwater Mussels

Most Imperiled Animals and Plants

Conservation Status of United States Taxa

Taxa

Percent of Species

- Presumed/Posibly Extinct
- Critically Imperiled
- Imperiled
- Vulnerable

Source: The Nature Conservancy, 1997
### Bivalve Projections – FW Mussels

**Shifting Species Ranges, But No Dispersal**

**Patchy, Impaired**
- *Elliptio complanata*

**Rare**
- *Strophitus undulatus*

**Extirpated**
- *Alasmidonta heterodon*

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Scientific Name</th>
<th>DE</th>
<th>NJ</th>
<th>PA</th>
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<tbody>
<tr>
<td><strong>ALASMIDONTA HETERODON</strong></td>
<td>DWARF WEDGEMUSSEL</td>
<td>Enda</td>
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<td><strong>ALASMIDONTA UNDULATA</strong></td>
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<td>Extirpated ?</td>
<td>Threatened</td>
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<td><strong>LIGUMIA NASUTA</strong></td>
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<td>Critically Imperiled</td>
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<td>SQUAWFOOT</td>
<td>Extremely Rare</td>
<td>Species of Concern</td>
<td>Apparently Secure</td>
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</table>
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

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?

![Graph](image)

*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

- Shellplanting for Oysters
- Propagate Mussels
- Monitoring & Research
- Water Quality & Flow Management
- Riparian Restoration
- Fish Passage Restoration
- Living Shorelines
## What if We Don’t Manage Flow Wisely?

### Natural Capital at Risk

<table>
<thead>
<tr>
<th>Bivalve Natural Capital</th>
<th>Oysters</th>
<th>Marsh Mussels</th>
<th>FW Mussels</th>
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<tbody>
<tr>
<td><strong>Millennium Ecosystem Assessment Categories</strong></td>
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<td>Provisioning: Food &amp; Fiber</td>
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<td>Bio-filtration</td>
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<td>✔️ ✔️</td>
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</table>

*Note: The table uses symbols to indicate the relative importance scores for each service or value.*
Climate Change + Other Changes

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

- Ecological Flows
- Spills, NRDA

Added Complexity

11/27/2004
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