Tidal Wetlands of the Delaware Estuary: Their Ecology and Future

Danielle Kreeger
Science Director
Partnership for the Delaware Estuary
The Watershed

Delaware Estuary

Delaware River Basin

United States Department of the Interior
U.S. Geological Survey
Wetlands 101

What is a Wetland?

**EPA:** “Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.”

**US Fish and Wildlife:** “Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season each year.

Most definitions include the following common elements:
- presence of water
- unique soils from uplands, and
- special vegetation adapted to the presence of water or wet soil
Wetlands 101

**General Terms** (many are ambiguous)

- **Swamp.** Dominated by trees, shrubs
- **Marsh.** Frequently or continually inundated wetland with emergent herbaceous vegetation
- **Bog.** Peat-accumulating wetland with restricted or no flow through it, supports acidic mosses like sphagnum
- **Bottomland.** Lowlands on floodplains of streams and rivers that are periodically flooded
- **Wet Meadow.** Grassland with waterlogged soil near the surface
- **Pothole, Playa.** Shallow ponds that resemble marshes
Major Types

A. *Inland = Palustrine*

1. **Freshwater Marshes**
   - examples: the Everglades of FL, prairie potholes of the Dakotas
   - emergent soft-stemmed aquatic plants, water is shallow
   - can be isolated, or found along lakes, streams and rivers

2. **Northern Peatlands**
   - northern temperate regions, previously glaciated depressions
   - highly waterlogged, acidic and deficient in nutrients
   - specially adapted organisms (low nutrients)

3. **Southern Swamps**
   - woody wetlands having continuous water coverage
   - canopy species often dominated by cypress and gum trees

4. **Riparian Wetlands**
   - wet-adapted vegetation fringing larger aquatic systems
   - high productivity, inundation is usually periodic
   - can be forested or not
**Major Types**

**B. Coastal = Estuarine**

1. **Tidal Freshwater Marshes**
   - ecotone habitat at nexus between terrestrial, fw and marine systems
   - located at the head of the estuary below the fall line, but far enough removed from the ocean so that waters remain fresh at all times
   - often high productivity and biodiversity

2. **Salt Marshes**
   - along protected shorelines in middle and high latitudes mainly
   - often dominated by a particular type of emergent vascular plant
   - salt exposure usually limits biodiversity, but not productivity

3. **Mangroves**
   - fills the same niche as the salt marsh at lower latitudes
   - limited range in continental US
   - over 14 million hectares worldwide, however
   - several different species of mangrove trees
The Watershed

Delaware Estuary

Delaware River Basin

NEW YORK

NEW JERSEY

MARYLAND

ATLANTIC OCEAN

PENNSYLVANIA

United States Department of the Interior
U.S. Geological Survey
Tidal Marshes

Delaware Estuary

Geononpic Setting
- Baci barrier lagoon, other
- Baci barrier lagoon, flood tidal delta
- Baci barrier lagoon, lagoonal fill
- Esturine marsh
- Esturine, fringe
- Esturine, encroder
- Saline fringe
- Tidal fresh forest
- Tidal fresh marsh

Delaware Bay
Pennsylvania
New Jersey
Delaware

United States Department of the Interior
U.S. Geological Survey
Estuarine / Marsh Coastal Ecosystem

Tidal Freshwater Marsh

Salt Marsh

River

Estuary

Ocean

Slide from Nat Weston, Villanova
Tidal Range up to 9’
Salinity <0.5 ppm
High Production
Delaware Estuary Science Conference

Goals:

• Assess knowledge
• Assess science and management needs

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
### 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

Ecological Values:
  Structural
  habitat for fish and wildlife
  nurseries for imperiled taxa

  Functional
  food web
  water quality
  flood protection
An estuarine food web. The arrows indicate the feeding relationships of a North European estuary. The dotted lines indicate the division into producers, consumers and secondary consumers used in this book.
Nursery Habitat
Recreation
Tidal Wetlands

A Signature Trait of the Delaware Estuary System

Ecological Values:

Structural

*habitat for fish and wildlife*
*nurseries for imperiled taxa*

Functional

*food web*
*water quality*
*flood protection*

+ Many other supporting ecosystem services
Tidal Wetlands

Concerns:
Degradation
U.S. ENVIRONMENTAL PROTECTION AGENCY
SUPERFUND REMOVAL PROJECT

AUTHORIZED PERSONNEL ONLY
SIGN IN AT COMMAND POST
Degradation
Rich History as a “Working River”

1762 map showing Philadelphia on the Delaware River

Slide adapted from Jonathan Sharp’s
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 (DNREC)
Changes in Wetland Function Natural versus Restored

Reference Wetland Condition

Existing Wetlands

Restored Wetlands

Function

time

Slide from Amy Jacobs (DE DNREC)
Tidal Wetlands

Ecological Values:

- Structural
  - habitat

- Functional
  - food web
  - water quality
  - flood protection

Concerns:

- Degradation
- Conversion & Loss
Freshwater Tidal Wetland Acreage

Past and Present

Pre-Settlement  ?

1973 (Patrick et al.)  2310 ha

1988 (Tiner & Wilen)  1000 ha

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

Estimated < 5% remains
Tidal Wetlands

Concerns:
Degradation
Conversion & Loss
Sea level rise
Salinity rise

Canary Creek Marsh, DE
Shoreline Erosion

Maurice River Mouth 2002 aerial photograph

1890 shoreline

Courtesy J. Gebert, ACOE

Courtesy D. Bushek, Rutgers
Tidal Wetlands

Ecological Values:

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

Concerns:

- Degradation
- Conversion & Loss
- Sea Level Rise

Storms
Tidal Wetlands

Ecological Values:

Structural
  habitat
Functional
  food web
  water quality
  flood protection

Concerns:
  Degradation
  Conversion and Loss
  Sea Level Rise
  Storms

** Sediment budget
Tidal Wetlands

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

Sediment budget
Added Complexity

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

11/27/2004
Sudden Wetland Dieback – Marsh Browning

Slide from Chris Bason (Center for Inland Bays, DE)
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 wring this article and learning 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 usually 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 policymakers explore ways to address global warming and its environmental impacts.

Being the ideal person that I am, it is difficult to forget the recent image of a lone polar bear floating in the water of one of the Arctic seas, a realization of melting. What most people do not realize, however, is that we 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 discolouration of upland

...
The End?

I'll tell you what this means, Norm--no size restrictions and screw the limit.
Climate Adaptation Planning

ID Vulnerabilities

Ecological Valuation

Adaptation Options

Recommendations and Reporting

Case Studies

Tidal Marshes

Bivalve Shellfish

Drinking Water

Kreeger
Tidal Wetlands Adaptation Planning

**Goal:** Maximize long-term ecosystem health and resiliency

**Tough Choices**
- Where will wetlands will be converted to open water?
- Where can we save them?
- Where is strategic retreat the best option?
So What Are We Doing?

Priority
What Can We Do?

1. Build Resiliency
   Protect and Conserve (CCMP)
Tidal marshes need to move:

1) horizontally (landward)

and/or

2) vertically (to keep pace)

**Can they do it?**
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*
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*
Land Use in the 1000 m Buffer Landward of Tidal Marshes

Percent Built Out (Land Cover data, 1992)
What Can We Do?

2. Maintain, Enhance, Restore..

Shovel Ready Projects !!
Restoration for the Future

Restore, conserve or otherwise enhance ecosystem structure and function, targeting areas that can sustain maximum natural capital values.
Reduce wave energy
Trap silt
Reduce bank erosion
Protect salt marsh

Shellfish as Natural Breakwaters

Slide from Dave Bushek, Rutgers
Living Shorelines
Examples
Site D - Lower Energy

Log + Log + Shell Bags
What Can We Do?

3. Monitor & Study
Status, Trends, Vulnerability?

We Couldn’t Say

Slide from Chris Bason (Center for Inland Bays, DE)
Delaware Estuary Wetland Monitoring & Assessment Program (DEWMAP)

Freshwater Tidal Marsh

Salt Marsh
Heislerville WMA
MACWA

Delaware Estuary

Barnegat Bay

DE Inland Bays

Others?

Other NJ Coastal MD Coastal Bays
Wetland Monitoring Informs Other NEP Programs

Regional Restoration

State of Estuary Reporting
Fish and Wildlife Management
Climate Adaptation

Regulatory Decision-Making
Water Quality Management
Targeted On-the-Ground Projects

MACWA
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<th>1º Service</th>
<th>2º Service</th>
<th>3º Service</th>
<th>4º Service</th>
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<td>Storm Protection/ Wave Attenuation/ Flood Protection</td>
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<td>Water Quality</td>
<td>Sequestration, Filtering</td>
<td>TMDLs: Nutrients, Pollutants</td>
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<td>Aesthetic Value</td>
<td>Landscape pictures, paintings, open space</td>
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<td>Supporting</td>
<td>Habitat</td>
<td>Wildlife, shellfish, insects</td>
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<td>Biodiversity</td>
<td>Maintain Plant Communities</td>
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<td>Nutrient Cycling/Biogeochemical Processes</td>
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Valuation of New Jersey’s Natural Capital and Ecosystem Services

New Jersey Department of Environmental Protection

Slide from Bill Mates, NJDEP
Projecting the Fate of Tidal Wetlands and Their Ecosystem Services Using SLAMM Modeling - *Industrial Economics*
Global changes—future

Source: Church et al. (2008)
Slide: Ray Najjar, PSU (2009)
Global changes—future

Semi-empirical model of global-mean sea level based on global-mean surface air temperature

Source: Rahmstorf (2007)
Slide: Ray Najjar, PSU (2009)
Future regionality due to changing ocean currents

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

Source: Yin et al. (2009)
Slide: Ray Najjar, PSU (2009)
Future regionality due to changing ocean currents

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

Source: Yin et al. (2009)
Slide: Ray Najjar, PSU (2009)
Summary

- Wetlands are a hallmark feature of the Delaware Estuary, particularly tidal marshes.

- These wetlands provide critical services that sustain lives and livelihoods.

- Improved efforts to monitor wetland status and trends are underway to assist in managing and sustaining them into the future.