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NJ Wetlands Past, Present and Future

• Background
• Project objectives
• Project design and methods
• Results
• Next steps
Background

• Restoration, enhancement and maintaining the sustainability of our wetland assets have become the focus of wetland management programs.
• To be successful, these programs require knowledge of reference (background) conditions and ecosystem change over time and event; this knowledge is necessary to set reasonable and achievable restoration targets.
• The EPA approved New Jersey Wetlands Protection Plan identifies the lack of knowledge on reference conditions as a gap. This knowledge can be acquired through long-term monitoring programs.
• Unfortunately these programs are sparse, relatively recent and introduced after the wetlands were already impacted.
Background

Environmental monitoring – a matter of time scales. The time scales shown in the figure to the left are on a logarithmic scale; the figure to the right shows a more realistic representation of the relative amount of information potentially available from sedimentary deposits (Modified from Smol 2008).
The four major sources of data for environmental assessments (Modified from Smol 2008).
Using sediment cores to reconstruct past environmental conditions - the surface ("top") = present-day limnological conditions, the deepest sediment sample ("bottom") = conditions to marked anthropogenic influences. Intermediate sediment intervals = different time periods in-between present day and the time represented by the core bottom.
Background

• The reconstruction of wetland systems based on investigations of sediment archives (cores) can provide a valuable tool to comprehend and quantify the magnitude of anthropogenic and natural impacts, thus filling the gap due to the absence of historical records.

• Our project goal is to use information from sediment cores to track the impact of human activities since the European settlement on NJ wetlands. In order to reconstruct reference conditions and the magnitude of human impacts, we are using biogeochemical proxies preserved in sediment cores, such as diatoms, pollen, organic and inorganic contaminants to assess past salinity, nutrients, sea level, and contaminant concentrations.

• This information is essential to provide restoration targets that are achievable and, importantly protect and sustain NJ wetlands.
Objectives

Use information preserved in sediment cores to:

• Assess wetland reference conditions and impact of anthropogenic activities
• Assess impact of climate and natural events on wetland characteristics
• Refine the use of microscopic algae (diatoms) as ecological indicators for wetlands
• Inform future coastal wetland restoration targets
Select Sampling sites
Collect sediment cores
Sub-sample sediment cores in depth intervals
Multi-proxy analysis
Core interval

Core Chronologies:
- Cs-137, Pb-210
- Pollution markers
- Pollen horizons

Sediment Chemistry:
- C, N, P
- LOI
- Organic/inorganic components

Diatom Analysis:
- Sample prep (diatom slides)
- Species identification and counting

Pollen Analysis
Vegetation remains

GIS-land use:
- Assess disturbance gradients
- Historical land-use profiles

Apply diatom-based transfer functions (Barnegat Bay-Great Bay diatom inference models)

Reconstruct:
- Nutrients
- Salinity
- Chla
- pH

Incorporate data from existing cores from Barnegat Bay, Great Bay, and Delaware Estuary

Compile core sediment data, GIS historic land use, historical archives to determine:
- Reference conditions and Natural variability
- Timing, direction and magnitude of change along disturbance gradients
- Relationships to known human and natural disturbances and Rate of recovery

Inform Future Coastal Wetland Restoration Targets
Disseminates Results to Public
Design and methods

Coring sites:
North – more developed anthropogenic impacts
South – less developed storm impacts

Current project:
Raritan Bay: 2 cores
Delaware Estuary: 2 cores
Cape May: 1 core

Previous project:
NJDEP funded Barnegat Bay – Great Bay: 4 cores
Design and methods

• Chronology
  – Radioisotopes Cs-137, Pb-210, C-14, Pollution and pollen markers

• Sedimentary Geochemistry
  – C, N, LOI
  – Organic / Inorganic Components

• Diatom analysis
Results

• Transfer functions for paleoecological reconstructions
• Diatom species indicator of reference/high nutrient conditions
• Preliminary results from sediment core reconstructions
Results – Diatom analysis

- Most abundant and diverse microscopic algae in marine ecosystems
- Silica cell walls are well-preserved in sediments
- Water quality indicator

- Used in this project:
  - Calibration/Transfer functions
  - Paleo-reconstructions in sediment cores
Results – Diatom analysis

CALIBRATION: 100 samples, 603 species, 29 environmental variables
Which diatom species are potential indicators of human impacts, including eutrophication?
Results
Diatom transfer function

Modern ‘calibration dataset’
Diatoms and environmental parameters

Regression
\[ Y = \hat{U} (X) \]

Inverse regression
\[ X = \hat{U} (Y) \]

\( \hat{U} \) = empirical calibration functions or regression coefficient

Salinity TF

Sediment N TF
“Reference” diatoms

Paralia sulcata

Diploneis smithii

Navicula digitoradiata

Cyclotella striata

Nitzschia brevissima

Caloneis bacillum
High nitrogen indicators

*Cyclotella choctawatcheeana*

*Cyclotella atomus var. gracilis*

*Planothidium frequentissimum*

*Nitzschia frustulum*
Results – Sediment Core Reconstructions

Specific goals:
- To assess the effect of pollution/eutrophication on wetlands
- To assess marsh recovery after storm events

Core locations:
- I. Cheesequake core
- II. Sea Breeze core
- III. Fortescue core F11A & F9E
- IV. Cape May core 8
Core BB1: salinity and sediment Nitrogen reconstructions

Manasquan Inlet

Cranberry Inlet
Manasquan Inlet opening project started in 1930 and the inlet was completely open in 1931 until now (2016).

Cranberry Inlet opened by vicious storm in 1740 and remained opened for 62 years.

Herring Inlet (North of Inlet Sandy cut in 2012) was closed after the storm in 1740.
Diatoms indicate sediment nitrogen increase since 1700s and especially in recent decades.
Cape May Courthouse Core
Upper 50 cm (~300 years)
Cheesequake Core

Relative abundance (%)

Salinity (ppt)  N sed (%)  Total sum of squares
## Land Use – Cheesequake & Cape May

- 5 km radius around coring sites

<table>
<thead>
<tr>
<th>Site/Landuse (acres)</th>
<th>Buffer Radius (km)</th>
<th>AG</th>
<th>BARREN LAND</th>
<th>FOREST</th>
<th>URBAN</th>
<th>WATER</th>
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<td>2264</td>
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Land Use Comparison
Cape May / Cheesequake

Cape May
Cheesequake

AG  URB  WET  AG  URB  WET
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**Diatoms representing reference conditions**

Diatoms indicating high N and increasing abundance with time
1600 – 1950 trends
Summary

- Barnegat Bay: diatom based transfer functions (Potapova et al, in review J Coastal Res)
- Sediment cores from Barnegat Bay, Cheesequake State Park (Raritan Bay) and Cape May reveal important changes through time
- Nutrient increase accelerated after 1950s consistent with development, human activities
- Cores from less impacted sites display significant deviation from reference conditions
- Top core changes suggest impacts from additional factors
- Sea Breeze (Nikitina et al., 2014) & Fortescue
  - Storm history reconstructed; diatom analysis ongoing
Sediment cores proved an important tool in providing information on wetland condition for New Jersey study sites otherwise unavailable to stakeholders.
Next steps

• Complete Lab analyses, Land-use history, data interpretation

• Use core multi-proxy results to:
  - Quantify Nutrient reference conditions
  - Quantify magnitude and direction of anthropogenic impacts
  - Assess storm erosion events and marsh recovery
  - Assess potential impacts of climate change

• Inform future coastal wetland restoration targets
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