The Impact of Climate Change and Sea Level Rise on Tidal Freshwater Marshes of the Delaware River Estuary

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Delaware Estuary Science and Environmental Summit
14 January 2009
Coastal Tidal Marshes
How Will Tidal Marshes Respond to Climate Change and Sea Level Rise?
Marsh Mass Balance in Elevated Tidal Marshes With Rising Sea-Levels

Watershed Inputs

CO₂ & CH₄

Primary Production

Marsh Accretion

Inorganic Sediment

Organic Matter

Microbial Respiration

CO₂ & CH₄

Export

MSL
Estuarine / Marsh Coastal Ecosystem

- Changing Precipitation
- Salt Water Intrusion
- Rising Sea Level
- Ocean
- River
What are the impacts of salt water intrusion on TFMs?

Watershed Inputs

- **CO₂** (Primary Production)

Export

- **CO₂ & CH₄**

Inorganic Sediment

- **Marsh Accretion**

Organic Matter

- **Microbial Respiration**

- **CO₂ & CH₄**
Microbial Respiration Processes

Freshwater Marshes: Methanogenesis

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 3 \text{H}_2\text{O} \rightarrow 3 \text{CH}_4 + 3 \text{HCO}_3^- + 3 \text{H}^+ \]
Microbial Respiration Processes

Salt Marshes:
Sulfate Reduction

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 3\text{SO}_4^{2-} \rightarrow 3\text{HS}^- + 6\text{HCO}_3^- + 3\text{H}^+ \]

Sulfate - Major constituent in seawater
Long-Term Salinity Intrusion Experiment

**CO$_2$ & CH$_4$ Gas Flux Rates**

- **5% Saltwater**
- **Freshwater**

Sulfate Reduction and Methanogenesis Rates and other Biogeochemical Measurements
Sulfate Reduction Rates

![Graph showing sulfate reduction rates over time. The graph includes two lines, one for freshwater and one for salinity intrusion, with data points and error bars.](image)
Total C Gas Flux

Month

50% Higher C Flux over 1 Year
Freshwater Marsh Undergoing Salinity Intrusion

Watershed Inputs

**Plant Response?**

CO$_2$

Primary Production

CO$_2$ & CH$_4$

Inorganic Sediment

Organic Matter

Microbial Respiration

Methanogens

Sulfate Reducers

Microbial Response

MSL
Delaware River Transplant Experiment
Delaware River Transplant Experiment - Conductivity

![Map of Delaware River region with markers for Raccoon, Rancocas, and Salem locations.]

![Graph showing conductivity over time for Raccoon, Rancocas, and Salem locations. The x-axis represents months from January to October, with years 2007 and 2008 split. The y-axis represents conductivity in mS cm\(^{-1}\).]

- **Stow**
- **Salem**
- **Raccoon**
- **Rancocas**

Transplants indicated by a black arrow on the graph.

Conductivity values range from 0 to 25 mS cm\(^{-1}\) with notable peaks and troughs throughout the year.
Delaware River Transplant Experiment
Rancocas (Fresh) w (Brackish)

May 2007

June 2007

July 2007
Shift to Salt Marsh?

Watershed Inputs

Inorganic Sediment

Organic Matter

Primary Production

CO$_2$

Marsh Accretion

MSL

Microbial Respiration

Methanogens

Sulfate Reducers

CO$_2$ & CH$_4$

CO$_2$ & CH$_4$
Loss of TFM?

Watershed Inputs

Plant Response

Climate Feedback

Inorganic Sediment

Organic Matter

Loss of Marsh

Microbial Respiration

CO₂ & CH₄

Primary Production

MSL

Methanogens

Sulfate Reducers

Microbial Response
Future Work – TFM ‘Organs’

Elevation Relative to Local Marsh Platform

+20 cm

+10 cm

0 cm

-10 cm

-20 cm

-30 cm
Changes in Metabolic Activity and Community Composition of Sulfate Reducing Bacteria in Tidal Freshwater Marsh Soils in Response to Climate Change and Saltwater Intrusion

Poster: Tatjana Prša
Delaware River Transplant Experiment - Inundation
Response of Freshwater Marsh Plants to Salinity Intrusion

TFM Plant Biomass (g m⁻²) =
− 10.8 [Conductivity (mS cm⁻¹)]
+ 9.6 [Temperature (°C)]
− 1.4 [Inundation (cm)]
− 23.1

\[ R^2 = 0.37; \ p < 0.001 \]