Nitrogen Effects on Salt Marshes

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Some Mechanisms for Changes in Marsh Structure and Function due to Nitrogen Over-enrichment

- **N loadings**
- **Bare Spots**
  - **Nitrogen Fixation Rates**
  - **Denitrification Rates**
  - **Soil Respiration Rates**
  - **Sediment Macro-Organic Matter**
  - **Water Quality Maintenance**
  - **Erosion & Flood Control**

- **Marsh N**
  - **(tall) S. Alterniflora**
  - **Plant Species Richness**
  - **Wildlife Habitat** (e.g. nesting habitat for sharp-tailed & seaside sparrows)

- **S. patens**
  - **Short S. alterniflora**
  - **Peat Formation**

The diagram shows the effects of nitrogen loadings on various ecological factors, including marsh structure, plant species richness, and wildlife habitat.
Narragansett Bay Coastal Wetlands Survey

- Use of space-for-time substitution for selection of sites (Residential development, Watershed nitrogen loads). These sites represent a coastal wetlands reference set.

- Development of a reference set of responses (plants, animals, soils)
### Watershed and Marsh Areas and Calculated Nitrogen Loadings

<table>
<thead>
<tr>
<th>Marsh</th>
<th>Watershed Area, ha</th>
<th>Marsh Area, ha</th>
<th>Calculated Nitrogen Loads</th>
<th>Total N load (kg N yr⁻¹)</th>
<th>Marsh area normalized N load (kg N ha⁻¹ yr⁻¹)</th>
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</table>
For mussels, $r = +0.87$, $p < 0.05$

For *S. alterniflora*, $r = +0.82$, $p < 0.05$
Extent & Density of *S. patens*

- **Top graph**: % Areal Extent vs. N Load (Kg N ha\(^{-1}\) y\(^{-1}\))
  - \(r = -0.76\)
  - \(P < 0.05\)

- **Bottom graph**: Shoots m\(^{-2}\) vs. N Load (Kg N ha\(^{-1}\) y\(^{-1}\))
  - \(r = -0.75\)
  - \(P < 0.05\)
$S.\ patens$ Belowground Biomass (Kg ha$^{-1}$)

$r = -0.77$

$P < 0.05$
Plant Species Richness

$r = -0.73$
$P < 0.05$
Set up for measuring soil respiration in the field
Narragansett Bay Soil Respiration

N-load (Kg N ha\(^{-1}\) y\(^{-1}\))

Soil respiration \(\mu\text{mol m}^{-2}\text{s}^{-1}\)

- **2004**
  - \(r = +0.92\)
  - \(P = 0.03\)

- **2007**
  - \(r = +0.87\)
  - \(P = 0.05\)
High Marsh Denitrification Potential & Nitrogen Flux

Denitrification Enzyme Activity (kgN ha\(^{-1}\) y\(^{-1}\))

-6
-4
-2
0
2
4
6
8
1 10 100 1000 10000

N flux mmol m\(^{-2}\) d\(^{-1}\)

-6
-4
-2
0
2
4
6
8
1 10 100 1000 10000

N-Load (Kg N ha\(^{-1}\) y\(^{-1}\))

- $r = +0.87$
- $P < 0.05$

Davis et al. 2004
Caffrey et al. 2007
Location of study sites in Jamaica Bay, NY
Jamaica Bay Creek Bank Soil Respiration

Soil respiration $\mu$mol m$^{-2}$ s$^{-1}$

*P < 0.05 for site and year, two-way ANOVA

[Graph showing soil respiration for JoCo and Black Bank in 2006 and 2007]
**Jamaica Bay 2007**

**Aboveground biomass**
- Black Bank
- JoCo

**Belowground biomass**
- Soil core depth (cm)
  - 0-10
  - 10-20

**Locations**
- Creek bank
- Middle high marsh
- High marsh
Soil cores from the middle high marsh in Jamaica Bay, NY

JoCo (47% organic matter)

Black Bank (31% organic matter)
Marsh Cores are CT Scanned at Local Hospitals
Relationship of the % tissue-gas CAT scan voxels and belowground biomass

\[ R^2 = 0.75, \quad P < 0.05 \]
JoCo vs Black Bank High Transect for Tissue-Gas Area Ratio

Ratio TGA/TSA (Tissue-gas area / Tissue slice area)

Depth (mm)
JoCo vs Black Bank for Peat at the High Transect

Peat Ratio

Depth (mm)

JoCo-High  BB-High
Black Bank-2007: Peat Comparison between Transects

Peat Ratio

Depth (mm)

BB-CreekBank
BB-Middle
BB-High
CT Scan: % Tissue-gas (roots & rhizomes) of Total Core Volume

* P < 0.05
CT Scan: % Peat of Total Core Volume

![Bar chart showing % Peat of Total Core Volume for Black Bank and JoCo at different locations: creek bank, middle high marsh, and high marsh.](chart)

- **Black Bank**
  - Creek bank: 60% ± 5%
  - Middle high marsh: 70% ± 5%
  - High marsh: 65% ± 5%

- **JoCo**
  - Creek bank: 55% ± 5%
  - Middle high marsh: 75% ± 5%
  - High marsh: 60% ± 5%

* P < 0.05
The Time is Now

- Educate the public about conservation initiatives to minimize anthropogenic stressors
- Prioritize disturbed sites and carry out restorations
- Protect healthy coastal systems including watershed buffers
- Efforts to minimize N loads
Healthy northeastern salt marsh