The Effects of Nitrogen Species on the Biomass of *Spartina alterniflora* in a restored salt marsh

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INTRODUCTION

Salt marshes are environments where nutrients, Sulfur, Nitrogen, and Carbon are exchanged. When excess nutrients are exchanged or present in a system, rapid plant growth and subsequent depletion of oxygen can result in eutrophication. Increased levels of nitrogen (N), nitrate (NO), and ammonia (NH_3) can contribute to eutrophication, ocean acidification, and algal blooms, and NO has been shown to decrease plant root mass (2).

From 1978-1992, Barn Island's salt marsh ecosystems (Stonington, CT; Figure 1) was partially restored. The restoration project included repair of the tidal flow of the marsh, removal of weir boards, and fallowed vegetation.

The purpose of this study was to identify if nitrogen species affect the aboveground and belowground biomass of common cordgrass *(Spartina alterniflora)* in a field and lab based setting. The goal was to be able to make coastal resiliency recommendations based on our results.

MATERIALS AND METHODS

Pore Water Sampling

On 9/16/18, three sampling sites were identified on Barn Island in Stonington, CT (Figure 2). At each site:

- A pore water sample was collected by inserting a slitted tube 15 cm into the ground and pipetting approximately 100 ml from the sample that filtered through the tube. Samples were sent to UConn's CESE Lab for nitrogen analysis.
- The salinity, temp, and conductivity from each pore hole was obtained using a YSI meter.

Field Plant Sample Collection and Preparation

- A 15 cm "block" of salt marsh was removed from each site with a shovel (Figure 1).
- Blocks were gently cut into 1" squares .
- Samples were washed with well water, and any roots not connected to the shoot of the plant fell off.
- Roots (below ground) and shoots (above ground) of each sample were cut separately, dried in a field oven for 48 hours at 60 °C, and weighed with an analytical balance
- The mass of each root and shoot was recorded, and results were compared to the lab analyzed pore water samples for nitrogen species.
- The biomass at each site was compared to the nitrogen species presence and presence in the pore water samples.

Polybot Grown Samples

- On 9/26/18, *S. alterniflora* plugs were planted in a small pot with clay beads, and distributed evenly between 3 polybot systems (Figure 6).
- Each polybot was maintained at 15 ppm salinity, 1 atm pressure, and 12 hours of daylight.
- Once per week, 10 mg of either nitrate or ammonium was added to a polybot. Nutrient uptake was recorded.
- The intent was to dry experimental plants in a similar way to the field samples, and measure root and shoot biomass. However, plants desiccated on each of 2 experimental trials, and analysis was not possible.

Figure 1: Photos from the field. From left to right: Barn Island as seen from Site 1; *Spartina alterniflora* (Short-form common cordgrass); taking a pore water sample; Plant sample before separating into 1" sections.

Symbol	Site	Description
★ (green)	1	Unrestored, near shore
★ (purple)	2	Near a culvert, away from shore, wetter
★ (orange)	3	Unrestored, very dense foliage

Figure 2. Map of Barn Island and sampling sites in Stonington, CT.

FIELD SAMPLING RESULTS

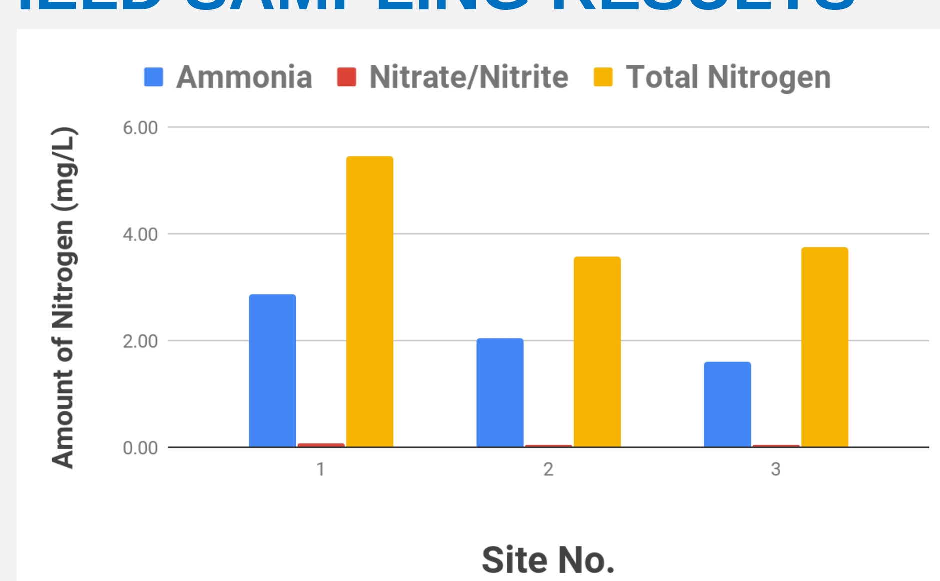

Figure 3: Nitrogen species and levels present in the pore water samples obtained at Barn Island, CT.

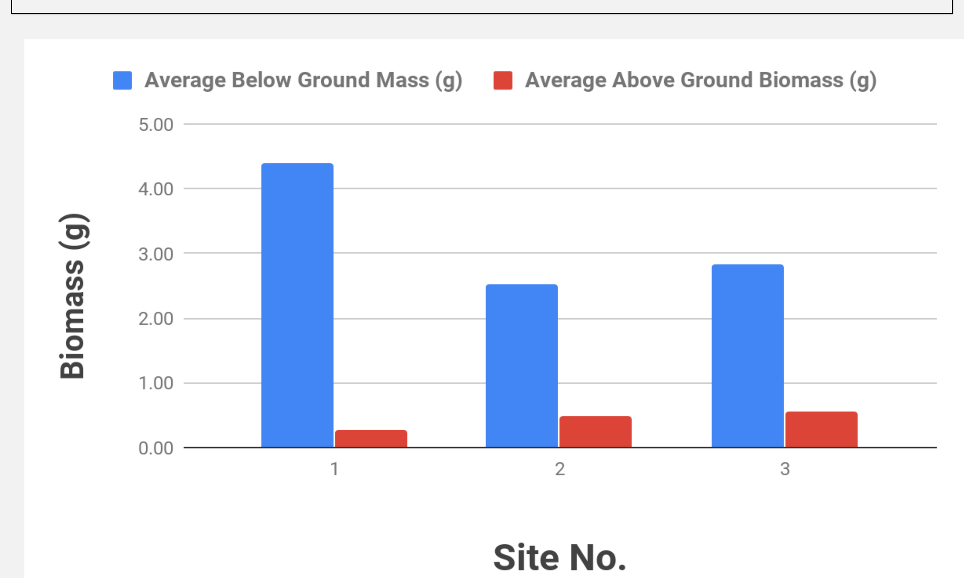

Figure 4. Average aboveground and belowground biomass at each site.

- Site 1 has the highest average nitrogen levels, highest root mass, and lowest average above/below ground ratio, compared to the two other sites (Figures 3,4,5).
- There is more ammonium than nitrate/nitrite in the water at Barn Island, CT (Figure 3).
- Sites 2 and 3 have very similar nitrogen levels as well as plant biomass patterns (Figures 3,4,5).
- The aboveground and belowground ratio between all three sites is significantly significant (*p*=0.02) (Figure 5).

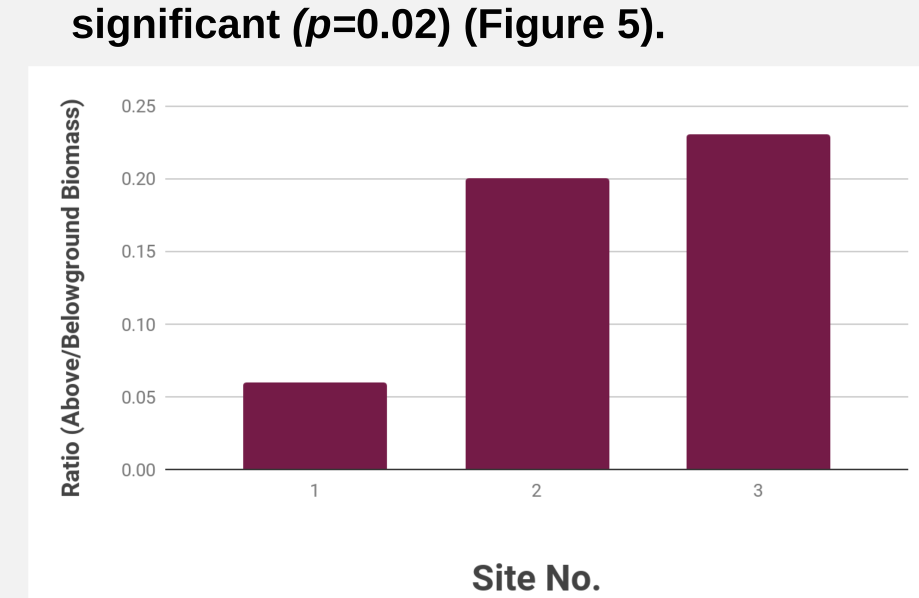

Figure 5. Ratio of above ground:below ground biomass at each site.

POLYBOT RESULTS

- After 3 days in the polybots, the plants lost all vegetative color and became brittle.
- Salt buildup was also observed at the base of each plant.
- Within 1 week, all plants died. The experiment was repeated a second time, and had similar results.
- The salinity of the polybots likely "shocked" the plants and killed them.

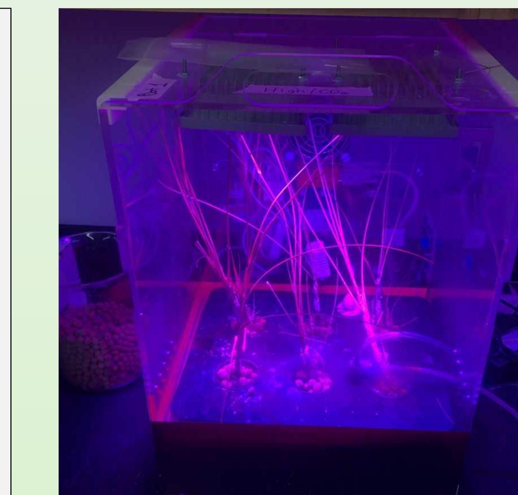

Figure 6. Polybot experiment of greenhouse grown *Spartina alterniflora*, before the plants died.

DISCUSSION & CONCLUSIONS

The results in this survey go against the research that an excess of nitrogen decreases root mass (2). The site with the highest nitrogen (Site 1) has the highest average root mass and the lowest average aboveground biomass. In addition, the nitrogen species most common in all three sites was ammonium, not nitrate/nitrite. This is against the expected that nitrate and nitrite make up most of the nitrogen content in salt marsh water (1). These two factors may be correlated, and should be further analyzed in an in-situ study.

The polybot experiment did not yield the expected results. All of the plants desiccated shortly after being placed into the polybot system. This finding could shed light on coastal resiliency, as sea levels are predicted to rise. As plants are exposed to saltier conditions in coming years, they may react in a way similar to the plants in the polybot experiment.

Nitrogen pollution contributes to soil acidification and is the leading factor in eutrophication (5). Learning about how nitrogen affects the flora of salt marshes is essential in monitoring the health of estuarine salt marshes. Because these salt marshes play a key role in nutrient exchange and water chemistry, conservation of the areas contribute to the health of the watershed. The findings in this study present a compelling case for why salt marshes must continue to be restored and protected.

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