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# Does salinity variation affect *Spartina patens* growth?

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## Abstract

*Spartina patens* is native to the Atlantic coast, and is one of the most wide spread species in the Louisiana coastal zone. This plant is a hay-like, grassy plant that lives in brackish waters. *Spartina patens* has many beneficial aspects for the environment and humans such as protecting against storms and erosion and providing food and shelter for wildlife. Like other coastal plants, *Spartina patens* can be subjected to varying salinities from occurrences such as, flooding and saltwater intrusion. This plant is known to survive in a wide range of salinity levels and our study focused on its tolerance of varying salinity. We exposed 5 replicate pots to three salinity variability treatments for a total of 96 days. Each treatment had an average salinity of 6 ppt. The first treatment was the no salinity variation treatment and plants were exposed to water at a constant salinity of 6 ppt. The second treatment was a medium salinity variation treatment moving between salinities of 3, 6 and 9 ppt with three day exposures to each salinity level. The last treatment is a large salinity variation treatment moving between salinities of 0, 3, 6, 9 and 12 ppt with three day exposures to each salinity level. Our results show that *Spartina patens* growth is not correlated with the salinity variation treatments.

## Introduction

*Spartina patens* is a perennial whose distribution spans across the east and west coast of the United States as well as the Gulf of Mexico. This species is a grass and is native to the United States. *Spartina patens* habitat includes wet, sandy tidal shores, tidal pools, low dunes and sandy saline to brackish flats. (Godfrey and Wooten 1979) This plant is one of the most wide spread species in the Louisiana coastal zone (Chabreck 1972, Sasser and Visser 2008). *Spartina patens* thrives in many environments from barrier island dunes and swales to coastal brackish and intermediate salinity marshes (Hester 1996) *Spartina patens* can survive a wide range of salinities from 1 ppt up to 27 ppt (Lonard 2010). *Spartina patens* is a very resilient macrophyte. While *Spartina patens*

resilience can be recognized through its tolerance of a wide salinity range, it is also able to tolerate varying nutrient levels as well as moderate tidal inundation (Lonard et al 2010). Merino et al. (2010) show that *Spartina patens* has optimal growth at a salinity between 2 and 6 ppt

*Spartina patens* has many beneficial aspects for the environment and humans such as protecting against storms and erosion and providing food and shelter for wildlife. Coastal ecosystems are important for a number of reasons such as, the fact that they are highly productive, they provide habitats for many unique species (some of which could not survive elsewhere) and humans utilize these areas for living, playing and fishing. Wetland plants can also help in filtering, retaining and storing fresh water. They can also have recreational, aesthetic, spiritual and educational values for humans. (Costanza 2006) These are just a few reasons why we should understand stressors to coastal ecosystems and the responses that result from such stressors (Deegan et al. 2007).

Extensive research has been conducted examining the effects of salt water intrusion and rapid submergence of the Mississippi River Deltaic Plain. The growth of plants can be lessened by salinity overtime because the salts essentially lower the plants external water potential causing them to absorb less water. This also affects the toxicity levels in the tissues of the plants. While this process does affect *Spartina patens* somewhat it is not as drastic because the species has the ability to secrete the salt out of the plant and onto the surfaces of it leaves (Hester 2001). While *Spartina patens* is more tolerant to flooding by saltwater than other plant species, the plant can still be negatively affected. There is a point in which plant stresses from saltwater intrusion can be great enough or happen rapidly enough to cause plant mortality (DeLaune et al. 1994).

Merino et al. (2010) conclude that when dealing with restoring degraded wetland habitat dominated by *Spartina patens* that salinity should be the main concern when considering restoration plans. The study looked at nutrient and salinity interaction with *Spartina patens*

growth. The study concluded that the nutrient interactions studied were relatively insignificant. They found that regardless of any variation in nutrient concentrations consistently biomass decreased as salinity increased (Merino et al. 2010).

Many studies have concluded that *Spartina patens* tend to be far more resilient than most plants found in a similar niche. One study explained that when compared to coincident species *Spartina patens* had the greatest ecological amplitude. This study described ecological amplitude as a sort of measure of evolutionary adaptability and how a species fulfills its ecological requirements relative to species with similar niche requirements. (Silander et al. 1979)

The salinity tolerance of *Spartina patens* has even been studied on a cellular level (Wu et al. 1998). In order for the species to maintain a low sodium concentration in its cytoplasm the plant has a mechanism in which it can control the ion movement across plasma membranes. This regulated ion movement across the plasma membrane creates a mechanism that increases plant tolerance to NaCl. This mechanism occurs because of an electrochemical gradient created by plasma membrane H<sup>+</sup>-ATPase. Wu et al. (1998) suggest that *Spartina patens* salinity tolerance is related to the fact that this species has evolved the ability to regulate its plasma membrane H<sup>+</sup>-ATPase when its cells are subjected to NaCl. As a result, when cells of *Spartina patens* are subjected to higher salinities the regulation of plasma membrane H<sup>+</sup>-ATPase activity result in more efficient ion transportation and osmoregulation.

Although the tolerance of *Spartina patens* to salinity has been extensively studied (see above) all previous studies have examined the response to a constant salinity regime. In coastal marshes the plants are exposed to varying salinity. We hypothesized that *Spartina patens* growth is inversely related to salinity variability. We assume that a stable environment is more conducive to plant growth than a variable environment.

## Methods

Five large tubs with different saline environments (0 ppt, 3 ppt, 6 ppt, 9 ppt or 12 ppt) were used in this project. The tubs were kept in a greenhouse at the Center for Ecology and Environmental Technology in Lafayette, Louisiana. Saline environments were created using a highly concentrated solution of Instant Ocean dissolved in approximately two gallons of water. Each large tub contained freshwater and then the concentrated solution was added to each until the desired salinity was reached. Salinity in the tub was determined using a YSI meter. During the experiment salinity in each tub was measured every three days. Depending on the salinity measurement, water or a solution of Instant Ocean dissolved in water was added to each tub to re-establish the correct salinity.

The experiment began by separating 15 *Spartina patens* plantlets and then planting them into individual pots. The medium in which the plants were planted in consisted of peat moss, sand and potters clay. The plants spent the first week in a freshwater environment to reduce transplant stress and were then placed in the 6 ppt saline environment tub for a week to adjust to the average salinity. Water level was kept below the soil surface to keep a saturated soil condition. For the next 96 days the plants were moved between the tubs every three days with five of the plants remaining at a constant salinity, five experiencing a low salinity variation and five experiencing a high salinity variation (Figure 1). The five *Spartina patens* plants that were kept at a constant salinity treatment were kept in the tub at 6 ppt throughout the entire duration of the experiment. The five plants that were subjected to the low salinity variation treatment were rotated between the 0 ppt, 3 ppt, and 6 ppt tubs every three days. The five plants subjected to high salinity variation treatment were moved between the 0 ppt, 3 ppt, 6 ppt, 9 ppt and 12 ppt tubs every three days. After every three days the plants were removed and given time to drain before being placed in their next tub.

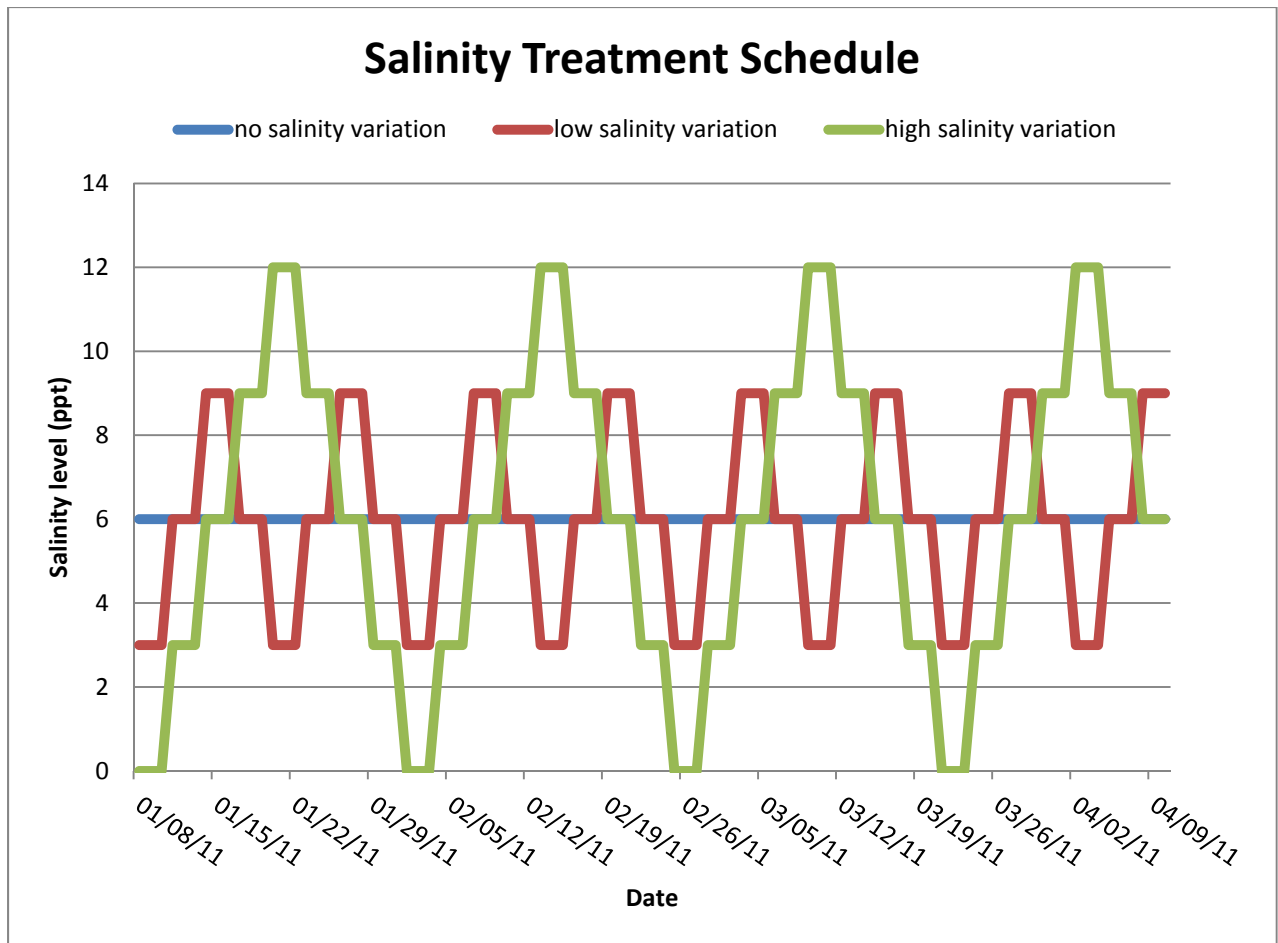


Figure 1: The application of the three salinity variation treatments is shown

The schedule of tub rotation followed (Figure 1) assured that no more than ten plants were kept in the same tub at the same time to prevent shading from one pot to the next. Every three days, while the plants were draining their lengths were measured using a meter stick and recorded in centimeters. Following the 96 day treatment period, all 15 *Spartina patens* plants were harvested making sure to collect all of the dead and living above ground plant material. After washing any soil material from the roots, plants were divided into aboveground and belowground parts. Finally, the plant parts were dried to constant weight in a 70°C oven and weighed in order to determine the biomass of each plant part.

Growth rates for each plant were determined by fitting a linear regression to the plant height measurements from each pot using SAS. The slope of the regression is the average growth rate per day for each pot. Growth rate, aboveground biomass, belowground biomass, and total biomass were tested for significant differences among the salinity variability treatments using Analysis of Variance.

## Results

Of the 15 plants studied there was no significant difference in the average total growth among the three different salinity treatments tested (Figure 2). Although the plants from the constant salinity treatment showed slightly higher growth at the end of the experiment (Figure 2), growth rates were not significantly different among sites.

The biomass of the 15 plants showed no significant difference (ANOVA  $\alpha=0.05$ ) among the three salinity treatments tested (Figures 3, 4, and 5). The constant salinity treatment has a slightly greater aboveground biomass than the plants from the varying salinity treatments however this difference is not statistically significant (Figure 3).

Below ground biomass was unaffected by the salinity variation treatments and averaged 1.18 g/pot (Figure 4). Differences in total biomass (Figure 5) reflect differences in aboveground biomass, but are also not statistically significant.

Our alternative hypothesis was rejected. *Spartina patens* growth was not inversely related to salinity variability but the *Spartina patens* plants grew at basically the same rate regardless of how often and drastically the salinity levels changed within the scope of the experiment.

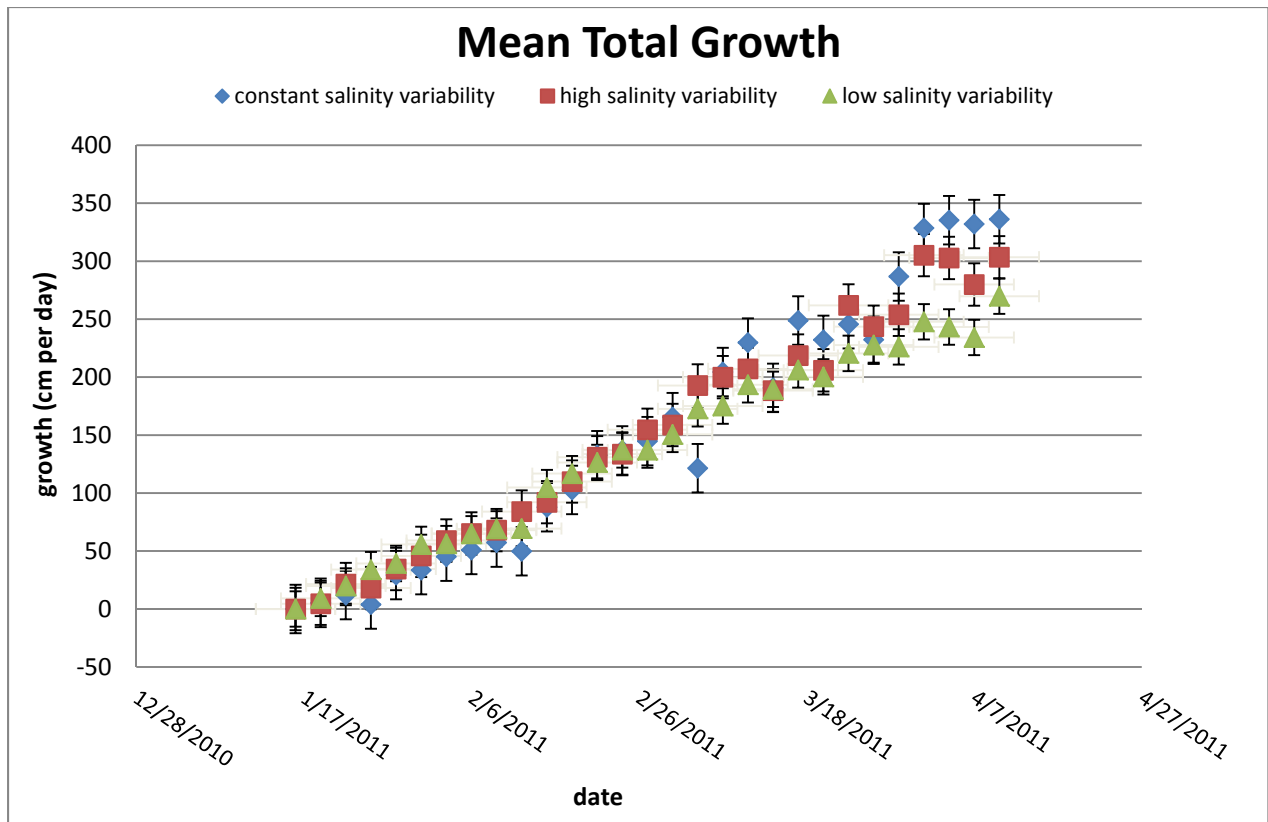


Figure 2: Scatter plot showing the average total growth of the plants from each of the three salinity variability treatments

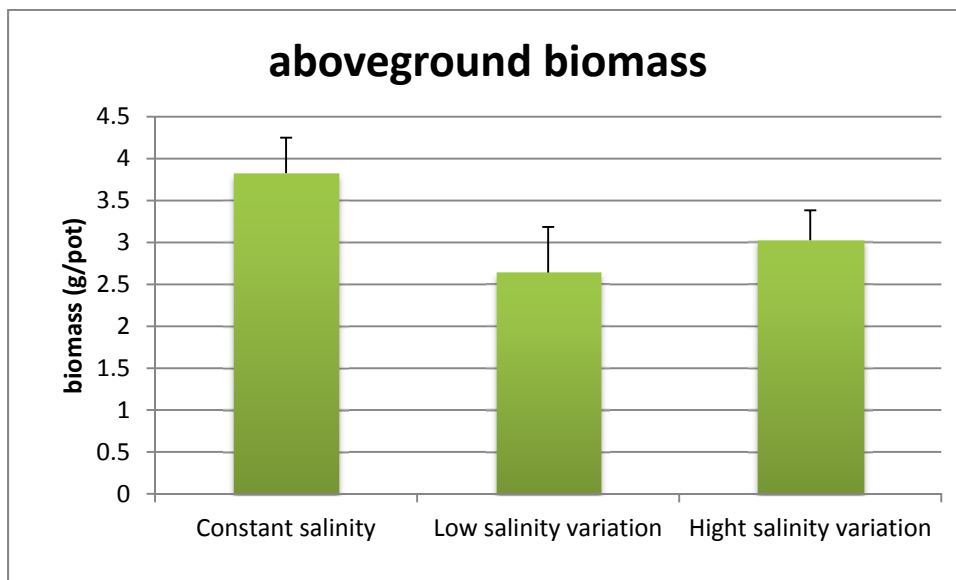


Figure 3: Total aboveground biomass is shown by treatment. Error bars represent one standard error.

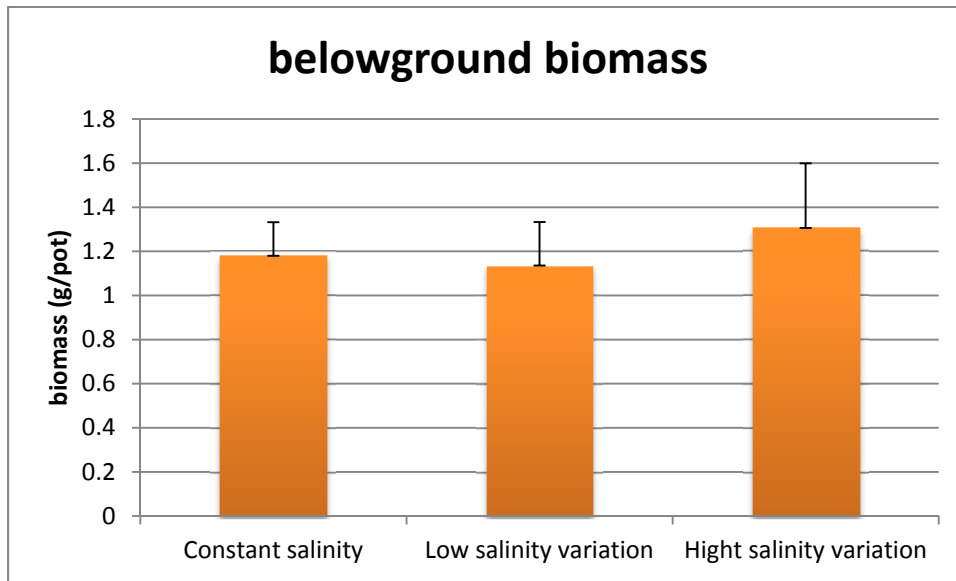


Figure 4: Total belowground biomass is shown by treatment. Error bars represent one standard error.

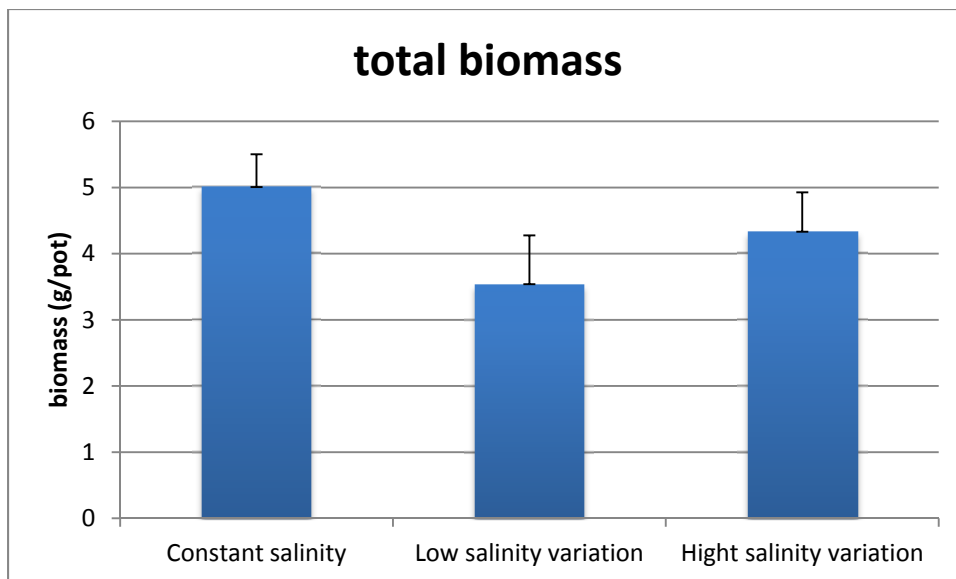


Figure 5: Total biomass is shown by treatment. Error bars represent one standard error.

## Discussion

Overall *Spartina patens* plants did not show any significant difference when subjected to varying salinity ranges. Baldwin and Mendelssohn (1998) determined that a combination of disturbance and flooding increased mortality in *Spartina patens*, while the plant was not significantly affected by salinity. They found that *Spartina patens* was more affected by disturbance while *Sagittaria lancifolia* was more effected by salinity (Baldwin and Mendelssohn 1998). In our experiment 15 *Spartina patens* plants exhibited great resilience and rapid growth throughout the entire experiment regardless of varying salinity regimes. Ewing et al. (1995) examined different indicators of salinity stress on *Spartina patens* and found that aboveground biomass of the plants in 0 ppt and 7 ppt treatments was significantly greater than the plants in the 14 ppt, 21 ppt and 24 ppt treatments after 42 days. The results from Ewing et al. (1995) gives an indication at what level salinity begins to limit *Spartina patens* growth. We can infer that *Spartina patens* would have significantly less aboveground biomass somewhere around 12 ppt to 14 ppt after a period of 42 days. It is important to note that in this study significant differences weren't realized until the end of the 42 day experiment. Measurements of all indicators were taken at 7, 14 and 42 days. (Ewing et al. 1995).

Hester et al. (2001) in an experiment involving salinity stress on wetland plants designated a sublethal salinity level of 20 ppt for *Spartina patens* and it was concluded at the end of the study that the salinity level was not high enough to cause sufficient stress. They referred to previous research in which six populations of *Spartina patens* were subjected to weekly salinity increases in order to determine the plants lethal salinity level. They defined the lethal level to be salinity that resulted in 50% death of aboveground tissue. Of the six populations studied the lethal levels

ranged from 63 ppt to 93 ppt (Hester 1996). These results show the high salinity tolerance of *Spartina patens*.

Our experiment lasted 96 days, but the high variability plants were exposed to 12ppt for only 12 days (Figure 1). We therefore conclude that our salinity range was too small or that our experiment was applied for an insufficient duration. Repeating the same experiment at a higher average salinity (for example  $12 \pm 6$  ppt) or extending the experiment to 192 days has a higher likelihood of showing significant effects.

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