SPARTINA SPECIES ZONATION ALONG THE ALTAMAHA RIVER ESTUARY

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Abstract. Changes in freshwater inflow can cause changes in the distribution and diversity of marsh vegetation in estuarine habitats. In the fall of 2002 bankside vegetation was surveyed along the 24 km length of the Altamaha River estuary (n= 14 sites). Sites were quantified for multiple plant and edaphic parameters, including plant density, height, and tiller diameter. In this paper we present the characteristics of the bankside marsh vegetation as they change along the estuarine salinity gradient, and evaluate the use of a proportional relationship between two marsh grasses, *Spartina cynosuroides* and *S. alterniflora*, as a way to identify a transition line between salt and brackish marsh communities. *S. alterniflora* densities were greatest at the mouth of the estuary and decreased upstream and *S. cynosuroides* densities showed the opposite pattern, but there was not a well defined transition between these two plant communities. The percent *S. cynosuroides* cover along the estuary is a potentially useful way to document the response of the estuary to changing amounts of freshwater inflow.

INTRODUCTION

Estuarine environments are adversely impacted by reductions in freshwater inflow, sea level rise, and coastal land submergence. Changes in water resource management, such as increased withdrawals from rivers, may cause changes in the distribution and diversity of marsh vegetation in estuarine habitats by influencing water quality (i.e. temperature, salinity, nutrient load, turbidity, dissolved gases, and mineral concentrations) downstream. Increases in surface water withdrawals are anticipated in Georgia as groundwater use becomes more restricted, and this may in turn cause changes in habitat structure and function in estuaries due to increasing salinity intrusion into freshwater and brackish habitats. The current challenge is to develop policies that can be used to allocate available groundwater and surface water resources. These policies must be designed to maintain adequate freshwater inflows to the coastal environment so as to protect estuarine communities and their environmental functions.

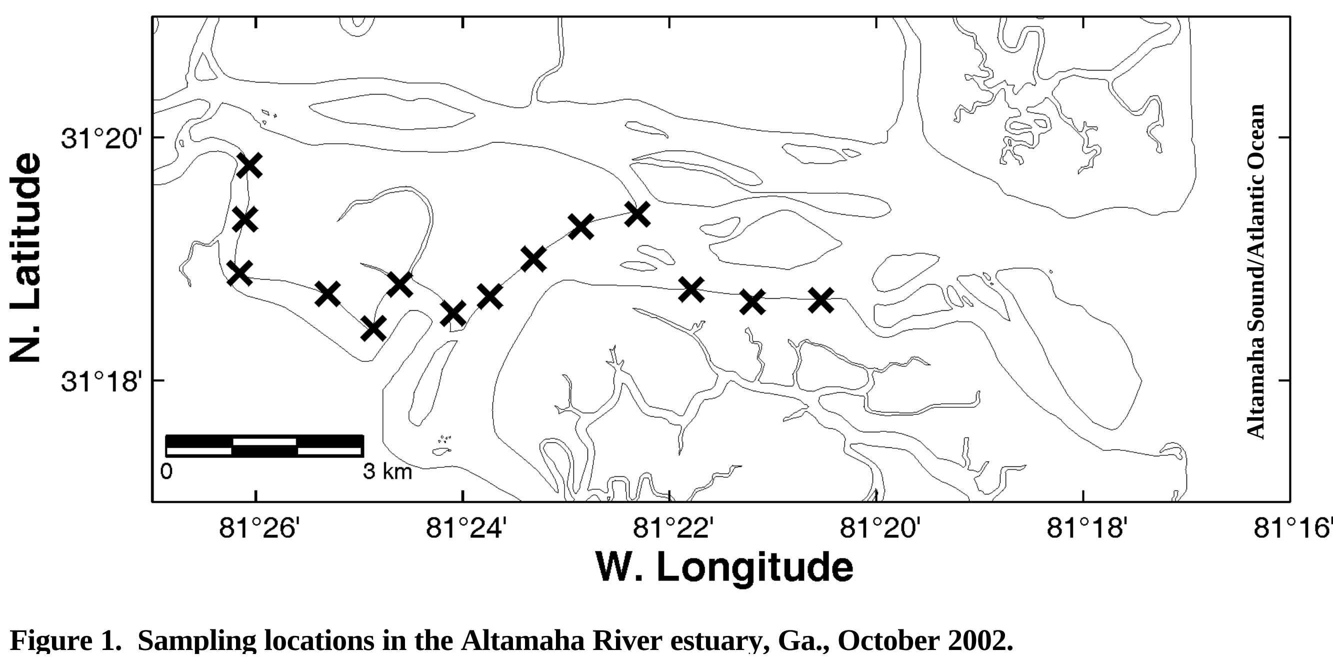

Figure 1. Sampling locations in the Altamaha River estuary, Ga., October 2002.

Salinity is often considered a key predictor for the distribution of habitats and organisms along an estuary. Temperate riverine estuaries are characterized by distinct vegetation along the salinity gradient, with salt marsh vegetation in the polyhaline range of the system (salinities greater than 18 (practical salinity units, psu), brackish marsh plants in the oligo- and mesohaline ranges (between 0.5 and 18 psu), and tidal freshwater plants furthest upstream (less than 0.5 psu) (Odum, 1988).

A crucial component of evaluating if there are adequate freshwater inflows into estuarine environments is to link biological indicators with actual salinity levels along an estuarine gradient. This biological connection may then be used as a "benchmark" in the determination of how much water flows can be reduced upstream without causing unacceptable salinity changes within the estuarine environment downstream. Previous research in the Suwannee estuary in Florida successfully identified a relationship between the relative abundances of freshwater and salt tolerant vegetation and the maximum salinity that vegetation experienced (Clewell et al., 1999). The shift in relative abundance from the more salt tolerant rush, *J. roemarianus*, to the less salt tolerant sedge, *C. jamaicense*, occurred between 5 and 10 psu in the Suwannee estuary.

The Altamaha River estuary is considered a piedmont estuary with an extensive watershed and substantial freshwater discharge (Dame et al., 2000). The tidal marshes of the Altamaha River estuary consist of salt marsh communities (predominantly *S. alterniflora* with some *Distichlis spicata*) found up to 6 km from the mouth, brackish marsh communities (predominantly *S. cynosuroides* with *S. alterniflora* near the creek bank) between 6 and 16 km upriver (although there are patches further downstream near 3 km), and freshwater marsh communities (wild rices, *Zizania* and *Zizaniopsis*) upstream of 16 km (Smith et al., submitted). Although salinity explains the general distribution of tidal marsh vegetation, there is also a more dynamic, local scale variation that results in changing border positions between vegetation types (Smith et al., submitted).

The research presented in this paper focuses on describing the distribution and plant characteristics of two *Spartina* species (*S. alterniflora* and *S. cynosuroides*) in relation to the salinity gradient of the Altamaha River estuary. A vegetation survey was completed to evaluate connections between the distribution of plants and their location along the length of the estuary and to assess whether there is a distinct transition point where salt tolerant *S. alterniflora* communities shift to freshwater/brackish *S. cynosuroides* communities that could serve as a benchmark for freshwater inflow assessment in this system.

METHODS

A vegetation survey targeting the overlap between *S. alterniflora* and *S .cynosuroides* was conducted in October 2002 (n=14 sites) (Fig. 1). Sites were established approximately every 1 km between 3 and 19 km from the mouth of the estuary. Further upstream from 19 km the vegetation shifts to wild rice (*Zizaniopsis*), while downstream of 3 km vegetation is generally a monoculture of *S. alterniflora.* Each site was located within 2 m of the riverbank and consisted of 3 quadrats (1.0 m^2) at least 2 m apart. Two randomly selected 0.25 m^2 block areas were either assessed in the field or harvested and brought back to the laboratory for analysis. *S. alterniflora* and *S. cynosuroides* were identified and counted, and plant performance was assessed based on plant height, tiller diameter, and number of leaves.

RESULTS

There was large variability in the abundance of both *S. alterniflora* and *S. cynosuroides* along the length of the Altamaha River estuary in 2002 (Fig. 2). When plant measures were averaged for the entire survey, *S. cynosuroides* was taller than *S. alterniflora*, whereas tiller diameter and average number of leaves were greater for *S. alterniflora* (Table 1).

S. cynosuroides density was less than that of *S. alterniflora* in estuarine regions closest to the ocean, and the pattern switched at approximately 11 km upriver. In the furthest reaches of the estuary, however,

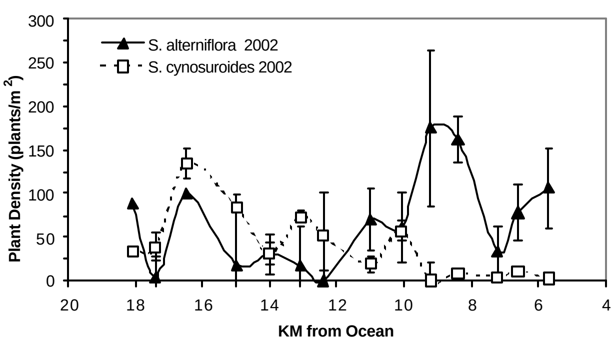

Figure 2. *S. alterniflora* and *S. cynosuroides* plant density along the length of the Altamaha River estuary (± std dev), 2002.

the high density of *S. alterniflora* and low density of *S. cynosuroides* was unexpected. Similar variation in *Spartina* distributions were found in a 2000 vegetation survey (data not shown). Overall, neither *Spartina* distribution nor plant characteristics (height, tiller diameter, and number of leaves) showed a significant correlation with distance along the estuary. Average water salinities were also calculated from a logistic curve determined by mean salinities recorded over the course of multiple sampling cruises (1994-2000) along the Altamaha River (J. Sheldon, unpublished data) and again, no correlation was found.

The proportion of marsh grass represented by *S. cynosuroides* increased with distance from the ocean (Fig. 3). The trend, although noisy, shows a significant correlation ($P<0.01$, $r=0.67$, $n=14$) between distance along the estuary and percent of *S. cynosuroides* cover.

Table 1. *Spartina* Plant Characteristics for the 2002 Vegetation Survey (± std dev)

Plant Characteristic	*S. alterniflora*	*S. cynosuroides*
Height (m)	1.16 (± 0.34)	1.36 (± 0.48)
Tiller diameter (mm)	9.35 (± 1.75)	7.55 (± 1.27)
Number of leaves	9.05 (± 1.79)	7.42 (± 1.83)

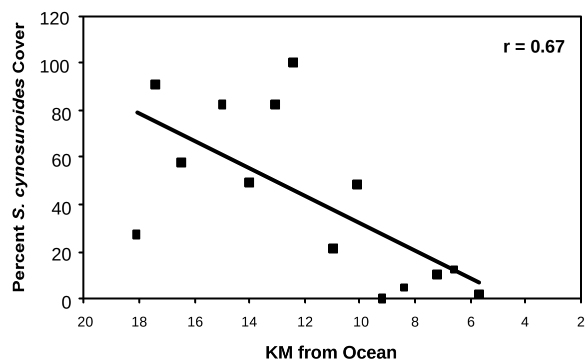

Figure 3. Percent *S. cynosuroides* cover along the length of the Altamaha River estuary, 2002.

DISCUSSION

In the Altamaha River estuary in Georgia, the density of *S. alterniflora* was greatest at the mouth of the estuary and decreased upstream, whereas *S. cynosuroides* densities showed the opposite pattern (Fig. 2). However, the border between these two grasses on the Altamaha is not well defined and we were unable to identify a distinct transition between the two plants. Instead, the abundances of both *S. alterniflora* and *S. cynosuroides* were variable along the length of the entire estuarine gradient. Thus, the concept of using the relative abundances of these two species as an indicator of changing freshwater inflow to the Altamaha is not applicable to these observations.

Although the distribution of grasses along the Altamaha River estuary does not correspond well with either salinity or distance from the ocean, *S. cynosuroides* percent cover increased with distance from the ocean (Fig. 3). While the data are variable, the relationship between *S. cynosuroides* and distance from the ocean is significant and meets our expectations that there should be greater *S. cynosuroides* cover further upstream where salinities are lower. This information supports the general premise that, as salinity decreases with distance from the ocean, the salt marsh grass, *S. alterniflora* is generally replaced by the freshwater/brackish marsh grass *S. cynosuroides*. In fact, during 2000 monotypic stands of *S. cynosuroides* were identified where salinities were between 0.5 and 1.5 psu (S. White, pers. obs.). However, while the general ecological contention is that salinity is the primary factor that determines tidal marsh vegetation distribution along an estuary (Odum 1988), the variability in our vegetation distribution suggests that additional factors are also important.

The occurrence of *S. alterniflora* in the furthest upstream sites was unexpected. One possible explanation for this observation is that the 2002 vegetation survey was completed during a 5-year drought period. Median discharge for the Altamaha River from 1968-1997 was 250 m^3s^{-1} (Alber and Sheldon, 1999) while median discharge for the drought years, 1999-2002, was 124 m^3s^{-1} (J. E. Sheldon, pers. com). Monthly median discharges during the years 1999-2002 were lower than those calculated over the 30 previous years (Fig. 4). These conditions may have allowed for the successful establishment of *S. alterniflora* in regions of the marsh previously inaccessible to this plant due to competitive displacement by *S. cynosuroides*. The typically brackish marsh areas where we observed *S. alterniflora* patches may therefore be the result of microhabitat changes along the riverbank during drought conditions. Once established, *S. alterniflora* is able to grow successfully in less saline conditions and may well be

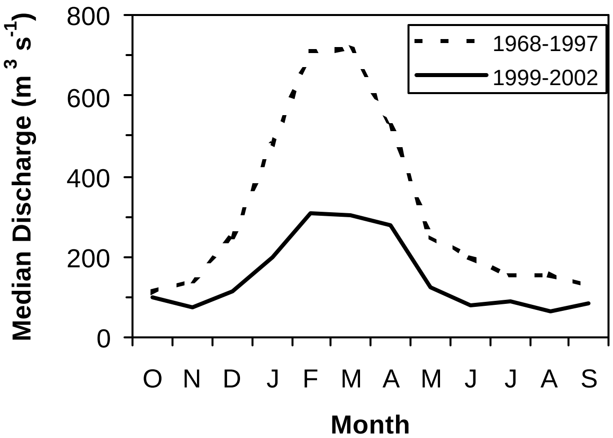

Figure 4. Reduction in Altamaha River fresh-water inflow during drought years 1999-2002.

able to invade *S. cynosuroides* marsh environments.

Although a transition line between *S. alterniflora* and *S. cynosuroides* is not likely to be identified for this estuary, it may be that with additional surveys over the next few years we will be able to assess whether these *S. alterniflora* patches are increasing in size in the brackish marsh environment. Rather than using changes in the distribution of these two grasses to signify changes in estuarine plant community response to low freshwater inflows, we may be able to use the amount of *S. alterniflora* community expansion upriver as a more useful proxy. Changes in the percent *S. cynosuroides* cover upriver may also be useful. Additionally, increasing survey sample size, frequency, and coverage of the Altamaha River estuary would also improve the likelihood of relating plant characteristics (height, tiller diameter, number of leaves) to estuarine salinity, thus presenting other potential bioindicators for freshwater inflow assessment. These survey efforts provide important baseline descriptive information for the Altamaha River estuary and the plant communities located along its length.

The creation of an adequate freshwater inflow strategy that maintains ecosystem integrity and function in coastal systems will continue to be one of the greatest challenges facing coastal policymakers in this decade. A recent *Estuaries* special issue "Freshwater Inflow: Science, Policy, Management" details many of these challenges and looks at how science, policy and management efforts are addressing freshwater inflow issues (Montagna et al., 2002). Continued ecological research that explores relationships between estuarine salinity, distance upriver, and the distribution of plant and animal communities along the length of an estuary can offer policymakers potential benchmarks that may help describe how an estuary responds to changes in freshwater inflows.

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