ABSTRACT

Title of Document:	PATTERNS OF WETLAND PLANT SPECIES RICHNESS ACROSS ESTUARINE RIVER GRADIENTS
	Peter James Sharpe, Doctor of Philosophy, 2009
Directed By:	Dr. Andrew H. Baldwin, Department of Environmental Science and Technology

It is widely accepted that in coastal wetlands a negative relationship exists between plant species richness (number of species) and salinity. However, the distribution of species richness across estuarine salinity gradients has not been closely examined. I hypothesized that plant species richness in coastal marshes (i.e., wetlands dominated by herbaceous plants) would follow a non-linear pattern with increased distance (salinity) downriver (Chapter 2). To test this hypothesis I conducted detailed marsh vegetation surveys along ≈ 50 km estuarine river gradients of the Nanticoke and Patuxent Rivers, MD/DE. I further hypothesized that the observed patterns of plant species richness on the Nanticoke and Patuxent Rivers could be accurately predicted by a mid-domain effect (MDE) model independent of measured abiotic factors using RangeModel 5.0 (Chapter 3). Lastly, I theorized that Marsh mesocosms subjected to intermediate salinity and inundation would exhibit significantly higher biomass and plant species richness compared to mesocosms subjected to extreme salt/fresh and flooding regimes utilizing a controlled greenhouse experiment (Chapter 4). I found that plant species richness can vary in both a linear (Patuxent River) and non-linear (Nanticoke River) pattern along an estuarine gradient. The MDE model did not explain a high proportion of the observed richness patterns for either river system compared to abiotic factors like porewater salinity. The controlled marsh mesocosm experiment supported the non-linear pattern of plant species richness observed along the Nanticoke River gradient, but did not show a significant difference in plant biomass or richness/diversity between purely fresh and low-salinity marsh mesocosms ($\alpha = 0.05$). The results of this research suggest that tidal marsh plant richness/diversity patterns do not always conform to a simple linear relationship with increasing salinity and that the MDE is not as important of a mechanism in these communities compared to porewater salinity or flooding frequency. Furthermore tidal low salinity marshes exposed to elevated salinity and flooding frequencies are likely to see a shift in their plant community structure to more salt tolerant plants and less rich/diverse communities assuming they can accrete at a rate equal to or exceeding the present rates of sea-level rise in the Chesapeake Bay.

PATTERNS OF WETLAND PLANT SPECIES RICHNESS ACROSS ESTUARINE RIVER GRADIENTS

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By

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2009

Advisory Committee:
Professor Andrew H. Baldwin, Chair
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Dedication

To Kate who made everything possible and to Andy for giving me the opportunity

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Chapter 1 - Introduction

Over at least three decades, numerous observational and experimental studies have sought to characterize plant community richness within tidal marsh ecosystems in response to various biotic and abiotic factors (Ferren et al. 1981, Latham et al. 1994, Baldwin and Mendelssohn 1998, Hacker and Bertness 1999, Zedler et al. 2001, Crain et al. 2004, Pennings et al. 2005, and Dunn et al. 2006). These researchers have examined the roles that interspecific competition, disturbance, stress, facilitation, and Mid-Domain Effect constraints play in determining tidal marsh plant species distributions and plant species richness.

One of the principal themes of these studies has been the role of salinity and inundation in driving tidal marsh plant community structure and function. Recent studies examining the mechanisms affecting plant distributions within tidal marsh ecosystems in New England, USA have modified or expanded on these ideas. These studies have looked more specifically at interspecific competition, disturbance and salinity stress as the principal mechanisms behind plant species distributions (Hacker and Bertness 1999, Crain et al. 2004). Salinity “stress” in these cases can be defined as continuous exposure to salinity levels, which, over time, diminishes plant biomass and thus competitive ability. Disturbance in these ecosystems is defined as a temporary discrete event that abruptly kills or displaces individuals, or that directly results in a loss of biomass (Mackey and Currie 2001). This body of research suggests that tidal marsh plant species distributions are determined by a number of factors, including disturbance, salinity stress, competition, and facilitation.

Another potential factor affecting plant species distributions along gradients such as the Nanticoke and Patuxent Rivers is the Mid-Domain Effect (MDE). MDE theory seeks to explain species richness gradients through simple geometric constraints on species range boundaries in the absence of any environmental or historical gradients (Colwell et al. 2004, Dunn et al. 2006, and Grytnes 2003). The basic idea behind MDE is that in either one or two dimensional space if species geographic ranges are placed on a bounded map a peak in species richness will occur near the center – this is in essence the mid-domain effect (Colwell et al. 2004, Colwell and Lees 2000, and Zapata et al. 2003).

Tidal marshes are defined as wetland areas dominated by herbaceous vegetation under tidal influence with salinity ranges from 0-0.5 parts per thousand (freshwater marshes) to 18-30 ppt or higher (polyhaline or salt marshes) (Cowardin et al. 1979). Marsh habitats with a mixture of fresh and salt water are considered brackish and fall into two categories: the 0.5-5.0 ppt range (oligohaline) and the 5.0-18.0 ppt range (mesohaline) (Odum et al. 1984, Odum 1988).

Tidal freshwater and saline marshes have similar geographic distributions along coastlines and estuaries, although tidal freshwater marshes usually occur in association with large river systems (e.g., in the Mid-Atlantic: Nanticoke, Choptank, Patuxent, Delaware, and Potomac Rivers) (Odum 1988). In many cases within river systems, such as those draining into Chesapeake Bay, a generalized vertical gradient of salinity versus plant species diversity can be observed as one moves upstream. Plant species diversity tends to increase as salinity concentrations decrease along this gradient (Anderson et al. 1968, Odum 1988, Mitsch and Gosselink 2000, Greenberg et al. 2006) (Figure 1). The overall hypothesis of this dissertation research is that the "null" condition of plant species richness along these salinity gradients is more complex than a simple linear relationship. There are two broad hypotheses that may explain richness patterns along estuarine gradients: environmental variables and the Mid-Domain Effect (MDE). This dissertation examines the importance of environmental variables and the MDE theory in explaining diversity patterns along salinity gradients in estuarine wetland systems

Environmental Variables

One proposed mechanism driving the hypothesized richness pattern described in Figure 2 involves the periodic intrusions of saline water (e.g., during droughts) that reduces the biomass of freshwater species, allowing salt-tolerant species to persist and creating a non-linear pattern in species richness along the tidal fresh to brackish marsh gradient similar to that shown in Figure 2.

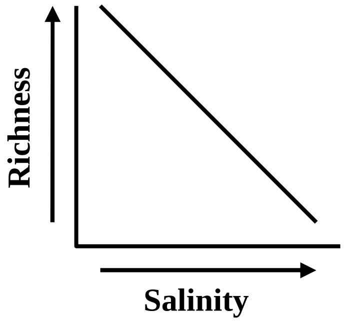

Figure 1. Generalized marsh plant richness versus salinity across estuaries

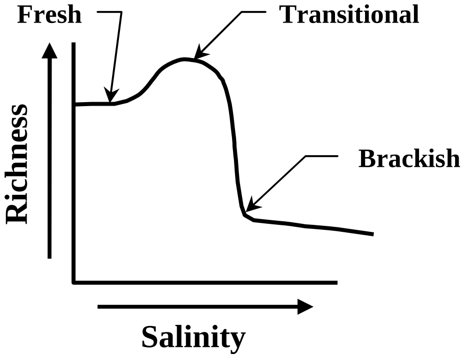

Figure 2. Hypothesized richness versus salinity curve

In a study of oligohaline marsh communities of the Mississippi River deltaic plain, the effects of salinity and inundation were manipulated to determine their effects on recruitment from the seed bank (Baldwin et al. 1996). This study found that most of the oligohaline marsh species did not show appreciable germination above 4 ppt salinity, and species such as *Amaranthus australis*, *Eleocharis fallax,* and *Ranunculus sceleratus* did not germinate above 2 ppt (Baldwin et al. 1996). More salt-tolerant plant species such as *Bacopa monnieri*, *Eleocharis parvula*, and *Leptochloa fascicularis* exhibited some germination at salinity levels as high as 8 ppt. These results suggest that periodic salinity and flooding pulses within the freshwater/brackish boundary should suppress the competitively dominant freshwater species sufficiently to allow less competitive, salt/flooding tolerant plants to occupy habitat niches otherwise unavailable to them. This condition would create a freshwater/brackish transition zone (oligohaline) community possessing the highest plant species richness found within the tidal marsh system.

In a related study, Baldwin and Mendelssohn (1998) assessed the effects of disturbance (clipping of aboveground vegetation) under different salinity and water level treatments from oligohaline marsh mesocosms on collected sods from Madisonville, LA marshes. They found that salinity and water levels had significant effects on plant species richness following disturbance. Other studies conducted in New England and Georgia have found similar results regarding the importance of salinity and flooding on plant species richness (Hacker and Bertness 1999, Crain et al. 2004, and Pennings et al. 2005).

Hacker and Bertness (1999) assessed plant species interactions across intertidal zones characterized by different soil conditions in Rumstick Cove, Rhode Island. They found that competition played a stronger role in the high intertidal marsh (low stress) by decreasing leaf area and flower production and causing 100% mortality of one of the species tested (*Limonium nashii).* In contrast, they found that stress (e.g. salinity and flooding) was most important in the lower intertidal zone, causing 100% mortality of three of the four species tested (*Atriplex patula*, *Iva frutescens*, and *Solidago sempervirens*). The highest species diversity was observed within the upper middle intertidal marsh, the area with an intermediate level of soil salinity levels and flooding. Hacker and Bertness (1999) also found that plots containing *Juncus gerardi* had the highest diversity compared to those without, suggesting *J. gerardi*'s role as a facilitator for other marsh plants. These studies illuminate the important role that salinity and competition play in shaping plant community richness and the overall patterns of tidal marsh species observed along estuarine gradients in Chesapeake Bay.

Crain et al. (2004) and Pennings et al. (2005) found similar results among tidal marsh ecosystems in Georgia and New England. Pennings found an increase in *Spartina alterniflora* performance (i.e. number of shoots or leaves) in the presence of *Juncus roemerianus* under physical disturbance/stress conditions on Sapelo Island, GA. He concluded that both the physical conditions and the presence of a facilitator improved *Spartina alterniflora* performance. Crain's experimental research on marsh plants, collected from Narragansett Bay, Rhode Island, found that competition and physical disturbance were both important components affecting tidal marsh plant species distributions.

A Non-Environmental Explanation of Richness Patterns: The MDE

My hypothesized pattern of plant species diversity along the fresh-brackish salinity gradient of the Nanticoke and Patuxent Rivers may also be explained to some degree through the Mid-Domain Effect (MDE). The implicit null model many river ecologists have traditionally assumed when examining species richness along the entire length of a river course is that species richness would remain constant along the entire river course in the absence of the influences such as environmental, historical, or biological gradients (Dunn et al. 2006 and Tabacchi et al. 1996). Mid-Domain Effect theory suggests that this underlying null model is inaccurate and that a more appropriate null model for species richness patterns along river courses is more of a bell shaped curve representing a species richness peak at a mid-point along the river course.

Mid-gradient peaks in species richness have been noted in non-estuarine wetland and riparian systems. For example, middle-course plant richness peaks have been reported in riparian areas in Northern Sweden (Kalix and Torne Rivers) (Dunn et al. 2006) and SW France (Adour River) and the NW United States (MacKenzie River) (Tabacchi and Tabacchi 1996). Mid-gradient richness peaks have also been reported for non-wetland systems, including along elevational gradients for some vascular plant species in Borneo (Grytnes et al. 2006), breeding birds along longitudinal gradients in Africa (Jetz and Rahbek, 2001), and elevational and latitudinal gradients for butterflies in Madagascar (Lees et al. 1999). In addition to the influence of environmental stressors, geometric constraints and overlap of species ranges may result in species richness maxima in the middle of bounded systems (Colwell and Lees 2000, Colwell et al. 2004, Cardelús et al. 2006, Dunn et al. 2006, but see Zapata et al. 2003, 2005).

Sea-Level Rise And Wetland Plant Diversity

Coastal marshes are increasingly under threat from climate change impacts most notably a possible increase in the rate of global sea level rise, deeper salinity intrusions upriver of estuarine systems, and from watershed land use changes leading to subsidence. In the Chesapeake Bay, rates of relative sea level rise are 2.5-3.6 mm/year (among the highest on the U.S. Atlantic coast), resulting in the loss of tidal marsh habitats (Stevenson et al. 1985, Kearney et al. 1988). Kearney et al. (1988) assessed marsh loss in the Nanticoke River between 1938 and 1985 and determined that tidal freshwater marshes were somewhat stable and were accreting sufficiently to keep pace with sea level rise. The Kearney study also found that, proceeding downstream along the estuary, deterioration rates were increasing while sediment accretion rates were generally decreasing (Kearney et al. 1988). In contrast, a 2.5-year sediment accretion study performed within Jug Bay (Patuxent River) found 1.4 mm/yr decreases in surface elevations within tidal marshes (Childers et al. 1993). In short, the Jug Bay marshes were not accreting at rates sufficient to keep pace with relative sea level rise (Childers et al. 1993).

As relative sea levels within the Chesapeake Bay and its tidal rivers continue to rise, soil salinities will increase, presumably leading to an overall decline in tidal marsh plant biodiversity. Current climate models for the Chesapeake Bay region suggest an increase in salt intrusions into estuarine river systems and continual increases in relative sea level rise as this region of the country is expected to see more extreme climate patterns, specifically extreme wet conditions in winter and early spring, followed by extreme dry conditions in the summer and early fall months (Hayhoe et al. 2007, Pyke et al. 2008).

Goals, Objectives, and Hypotheses

This dissertation research sought to examine the existing (observed) patterns in tidal marsh plant species richness/diversity along two estuarine river systems in Chesapeake Bay (Chapter 2). The outcome of those observations was tested against MDE predictions of plant species richness along those same gradients to determine the importance of abiotic factors versus MDE modeled outcomes (Chapter 3). In essence I sought to identify the appropriate null expectation of plant species richness patterns and examine the possibility that my observed patterns of plant species richness could be explained by an underlying mid-domain effect that functions independently of factors such as soil salinity, flooding frequency, and competition. Lastly, through a controlled greenhouse experiment subjecting synthetic marsh mesocosm communities to varied salinity and flood frequencies I sought to quantify the importance of those abiotic factors on plant community composition and richness/diversity in the absence of the MDE (Chapter 4).

The overall goal of this research is to identify and describe the principal mechanisms controlling plant species richness along river salinity gradients of Chesapeake Bay. This research also sought to simulate the potential impacts of climate change (i.e. sea-level rise and salt intrusions) on low-salinity marsh mesocosms. The goal of this final component was to allow scientists and resource managers a means of predicting tidal marsh community changes over time and develop additional controlled experiments examining plant community responses to altered physical and biotic conditions, such as those caused by global climate changes. To address these goals I developed separate objectives and hypotheses for my dissertation research:

Objective 1 (Chapter 2): Describe changes in plant species richness across a gradient from tidal freshwater to brackish marshes along the Nanticoke and Patuxent Rivers (Maryland and Delaware – Delmarva Peninsula, USA). USA). Under this objective I also cataloged the various freshwater and brackish plant species that co-exist within these tidal fresh/brackish transitional areas.

*Primary Research Hypothesis 1***:** The pattern of observed plant species richness/diversity for both river systems will follow a non-linear relationship with increasing salinity.

Objective 2 (Chapter 3): Determine if the observed patterns of plant species richness along the Nanticoke and Patuxent Rivers (2006) could be solely or at least partially explained by an underlying mid-domain effect.

*Primary Research Hypothesis 2***:** The observed patterns of plant species richness on the Nanticoke and Patuxent Rivers will be accurately predicted by the MDE model independent of measured abiotic factors.

Objective 3 (Chapter 4): Quantify the importance of salinity and inundation on plant community richness and biomass using constructed marsh mesocosms.

*Primary Research Hypothesis 3***:** Marsh mesocosms subjected to intermediate salinity and inundation will exhibit significantly higher biomass and plant species richness compared to mesocosms subjected to extreme salt/fresh and flooding regimes.

Chapter 2 - Patterns of Wetland Plant Species Richness Across Estuarine Gradients of Chesapeake Bay

Abstract

It is widely accepted that in coastal wetlands a negative relationship exists between plant species richness (number of species) and salinity. However, the distribution of species richness across estuarine salinity gradients has not been closely examined. I hypothesized that plant species richness in coastal marshes (i.e., wetlands dominated by herbaceous plants) would follow a non-linear pattern with increased distance (salinity) downriver. A series of 1,000-m2 plots (with nested subplots) were established along 50-km sections of the Nanticoke and Patuxent Rivers across the fresh (< 0.5 ppt) to mesohaline (5–18 ppt) salinity gradients to describe the distribution of plant species richness/diversity. Repeated measures ANOVA analysis and curve fitting results support my research hypothesis on the Nanticoke River (sigmoidal pattern not linear), but not on the Patuxent River. The Patuxent River gradient displayed a significant linear decrease in plant species richness/diversity with increasing distance downstream across the estuary. The curve fitting results of the Patuxent River were verified by repeated measures ANOVA analysis of the Shannon-Wiener diversity data for that showed a clear differences between means at the 0.05 level and thus supported the null hypothesis of a linear relationship between plant species richness/diversity and distance downstream. The non-linear patterns of both plant species richness/diversity observed along the Nanticoke River may be the typical pattern in relatively undisturbed estuaries. While the Patuxent River richness/diversity relationships were likely confounded by past

and present anthropogenic disturbances within the marshes and watershed that produced the observed linear patterns.

Introduction

Tidal freshwater and saline marshes have similar geographic distributions along coastlines, where tidal freshwater marshes occur at the head of estuaries and saline marshes in the lower portions of estuaries (Odum 1988). In many coastline river systems, such as those draining into Chesapeake Bay, an increase in plant species richness, i.e., the number of species within an area, can be observed as one moves upstream from saline to freshwater portions of the estuary. The general pattern that plant species richness increases as salinity decreases along the estuarine gradient is widely accepted (Anderson et al. 1968, Odum 1988, Tiner and Burke 1995, Greenberg et al. 2006). However, I have observed species-rich wetlands, including both marshes and tidal freshwater swamps (forested wetlands), in portions of the Nanticoke River in Maryland (USA) where salinity is generally < 0.5 ppt but occasionally increases as high as 7 ppt (unpublished data). Furthermore, in a New Jersey, USA estuary, the middle portion of an island that received an intermediate level of “disturbance” (salt stress and flooding) displayed the highest species richness (Ferren et al. 1981). Although data on the exact number of species and their estuarine distributions were not reported, the coexistence of freshwater species, such as *Peltandra virginica*, and more salt-tolerant species, such as *Spartina alterniflora*, was noted (Ferren et al. 1981). These observations suggest that the distribution of plant species richness across estuaries may be more complex than a linear model of decreasing richness with increasing salinity; richness may be particularly high in the fresh-brackish transition zone.

Mid-gradient peaks in species richness have been noted in non-estuarine wetland and riparian systems. For example, middle-course plant richness peaks have been reported in riparian areas in Northern Sweden (Dunn et al. 2006) and SW France and the NW United States (Tabacchi and Tabacchi 1996). Mid-gradient richness peaks have also been reported for non-wetland systems, including along elevational gradients for some vascular plant species in Borneo (Grytnes et al. 2006), breeding birds along longitudinal gradients in Africa (Jetz and Rahbek, 2001), and elevational and latitudinal gradients for butterflies in Madagascar (Lees et al. 1999). In addition to the influence of environmental stressors, geometric constraints and overlap of species ranges may result in species richness maxima in the middle of bounded systems, a phenomenon termed the mid-domain effect (Colwell and Lees 2000, Colwell et al. 2004, Cardelús et al. 2006, Dunn et al. 2006, but see Zapata et al. 2003, 2005).

Chesapeake Bay contains one of the greatest concentrations of tidal low-salinity marshes (i.e., fresh and oligohaline marshes) in the United States, covering approximately 16,000 ha in Maryland alone (Tiner and Burke 1995, Mitsch and Gosselink 2000). Low-salinity marshes as defined by Mitsch and Gosselink (2000) are wetlands close enough to the coasts to experience significant tides but are above the reach of oceanic saltwater. Extensive low-salinity tidal marshes are associated with many of the rivers flowing into the Bay, including the Patuxent, Choptank, Wicomico, and Pocomoke Rivers in Maryland, and the James, York, and

Rappahannock Rivers in Virginia (Tiner and Burke 1995). These wetlands are of tremendous importance to the Chesapeake Bay ecosystem. Tides and river flooding supply abundant nutrients, generating primary productivity as high as any ecosystem on earth, including agroecosystems (Tiner 1993; Mitsch and Gosselink 2000).

As relative sea levels within Chesapeake Bay and its estuaries continue to rise, soil salinities and the frequencies of inundation within tidal marsh ecosystems may increase, presumably leading to an overall decline in tidal marsh plant biodiversity or the conversion of these systems into open water habitats (Baumann et al. 1984). While hydrologic regime differs among years, eustatic rates of sea level rise (SLR) have been 1–2 mm/year over the last 100 years (Gornitz 1995), and the rates of rise relative to the land surface (relative SLR) can be higher due to land subsidence and decreases in sediment influx. Rising sea levels result in greater frequency and duration of inundation (Boesch et al. 1994) and are responsible for rates of wetland loss of 65.6 km^2/year in coastal Louisiana, including both fresh and saline wetland types (Britsch and Dunbar 1993, Boesch et al. 1994). In Chesapeake Bay, rates of relative SLR are 2.5–3.6 mm/year, among the highest on the U.S. Atlantic coast (Stevenson and Kearney 1996), resulting in loss of brackish marshes (Stevenson et al. 1985, Kearney et al. 1988).

The objectives of this study were to describe patterns of plant species richness across a gradient from tidal freshwater to brackish marshes along the Nanticoke and Patuxent Rivers. My hypothesis was that the pattern of observed plant species richness for both river systems would follow a non-linear relationship with increasing salinity. Understanding patterns of plant species richness across estuaries will help to identify biodiversity “hot spots” for conservationists and wildlife habitat managers, and support predictions of how plant richness may shift in response to salinity intrusion associated with sea level rise. Furthermore, the results of this study will add to our understanding of the effects of “stressors” such as salinity on maintenance of plant species richness and contribute to a growing body of ecological literature focusing on species distributions across environmental gradients.

STUDY AREA

This project was carried out in tidal marshes (i.e., wetlands dominated by herbaceous plants) along two ≈ 50 km gradients within the Nanticoke and Patuxent Rivers in Chesapeake Bay, Maryland, USA (Figure 3). These two gradients spanned the known freshwater (0–0.5 ppt) to mesohaline (5–18 ppt) salinity zones and includes high richness/diversity marshes of intermediate (Transitional) fresh/oligohaline salinities (0.49 – 5.0 ppt salinity modifier) (Cowardin et al. 1979) of each river and were chosen for their extensive tidal marsh habitats and to provide a regional evaluation of tidal marsh plant biodiversity

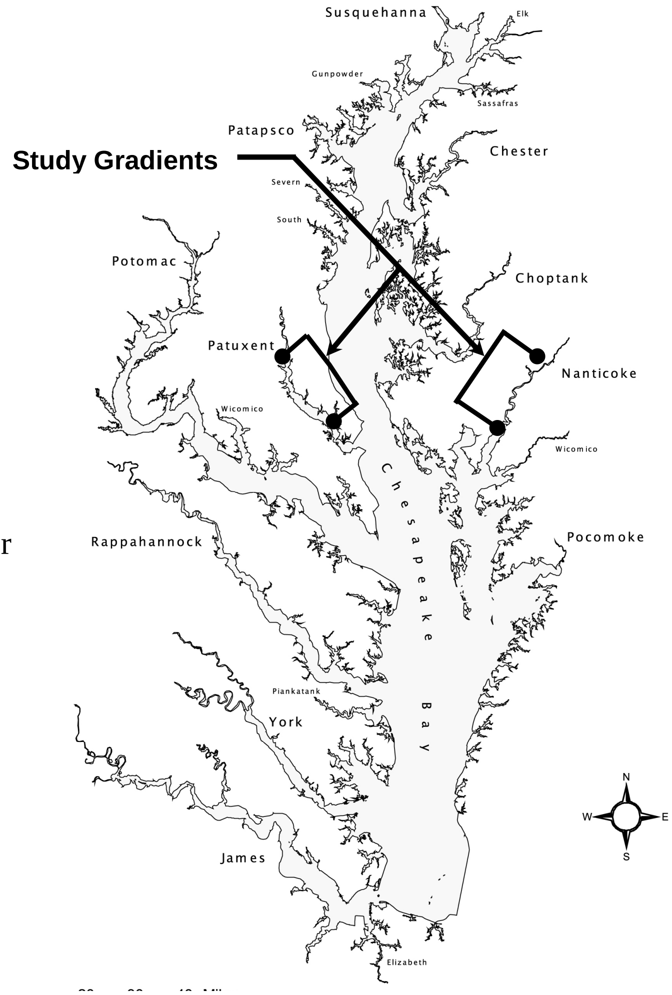

Figure 3. Chesapeake Bay and its major tributaries showing the Patuxent and Nanticoke Rivers and general study gradient locations. Source of base map: The Chesapeake Bay Foundation (http://www.cbf.org)

within Chesapeake Bay. Plots within each gradient were selected beginning with the upper most limit of tidal freshwater marsh habitat containing at least 1000 m^2 (our plot size) in each river. Subsequent vegetation survey plots were established in a systematic pattern every ≈5 km downstream, depending on the presence of at least 1000 m^2 of marsh habitat for survey and access to land. If a steep drop off in plant species richness (i.e., > 10 species/1000 m^2) was observed between two plots, then a middle plot approximately 2.5 km between the two primary plots was surveyed to refine the observed plant species richness pattern along the gradient. I define plant species richness as the total number of species within a plot.

The Patuxent River has a 2,136-km^2 watershed dominated by agricultural (30%), forest (40%), and urban (20%) land uses (Jordan 2001). The Patuxent watershed has experienced forest losses of > 2400 ha/year between 1985–1990 and agricultural land losses of > 800–1600 ha/year over the same time period (Costanza et al. 2002). The Nanticoke River, in contrast, has a 2,356-km^2 watershed dominated by agriculture (48%), forest (41%), and urban (2%) land uses (The Nature Conservancy 1998).

Methods

Vegetation and Environmental Measurements

Vegetation was described in 16 1000-m^2 plots (20 m x 50 m) along the Nanticoke River and 13 1000-m^2 plots along the Patuxent River. Sampling of each plot was conducted once in May/June and once in August 2006. To capture within-season variation, plots were sampled non-destructively during both surveys using the

North Carolina Vegetation Survey protocol. This “module” method combines larger scale sampling (1000 m^2) with smaller scale nested plots (Peet et al. 1998) (Figure 4).

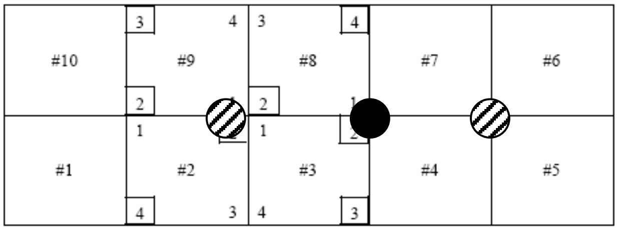

Figure 4. Diagram of a typical 1000-m^2 vegetation survey plot, adapted from Peet et al. (1998). Striped circles show the location of porewater measurements and the solid black circle depicts the water level recorder location. The nested survey plots were assigned to modules 2, 3, 8, and 9 and the locations of the intensive survey corners are represented by the smaller squares within each of the numbered modules. Nested plot sizes were 0.01 m^2, 0.1 m^2, 1 m^2, 10 m^2, and 100 m^2 (10 x 10 m module).

The large (1000 m^2) plot size is well suited for capturing dominant plant species richness within fresh-brackish tidal marsh areas because of the patchiness often observed in these habitats. The five nested sample plots ensured that I captured small, less frequent marsh plants within the plot (Peet et al. 1998); only data from the 1000-m^2 plots are reported in this paper as the 1000-m^2 plot size best represented the full range of plant species observed at each location. The coverage of each species within the sample plots was assessed visually using the cover class scheme described by Peet et al. (1998). This arrangement is based on a ten point scale whereby 1 = trace, 2 = 0–1%, 3 = 1–2%, 4 = 2–5%, 5 = 5–10%, 6 = 10–25%, 7 = 25–50%, 8 = 50–75%, 9 = 75–95%, and 10 = > 95%. Cover-class mid-points were then used in calculating means, (e.g., Class 5 = 5–10% so use midpoint of 7.5%). Nomenclature follows the USDA PLANTS database (http://plants.usda.gov); name authorities are listed in the text only if not listed in Table 1.

Salinity, temperature, and electrical conductivity were measured in each plot at the time of sampling (May/June and August 2006) by measuring substrate porewater at two fixed locations within the plot in holes where PVC marker poles were removed and at one location within the river near the plot with a hand-held salinity-conductivity-temperature meter. Four 10 x 10 m modules were selected for "intensive" nested plot examinations (Peet et al. 1998) at each plot and soil samples were randomly collected from one location within each intensive module of every plot using a Dutch auger with a 25-cm blade. Soil samples were collected from each of the four intensive modules and composited into one aggregate sample per plot in June 2006. The soil samples were tested for macro-nutrients and organic matter content at the University of Delaware Soil Testing Lab and the results were incorporated into the non-metric multidimensional scaling analysis (see Data Analysis below). Specific soil analytes tested from the composited soil samples included: organic matter content (by loss on ignition); phosphorus, potassium, calcium, magnesium, manganese, zinc, iron, boron, sulfate, and aluminum content (Mehlich 3 Extraction); total nitrogen and carbon, ammonia-nitrogen, and nitrate-nitrogen (2M KCI Extraction); total phosphorus and sulfate (microwave digestion (EPA3051-P and EPA3051-S); and pH.

Plot locations were recorded using a handheld Global Positioning System accurate to within 4.6 m. Datalogging water level recorders were placed within each plot to monitor frequency of inundation (model WL-15, Global Water, Gold River, CA). The recorders were programmed to record water level every six minutes over a two-week period in either July or August (depending on the river).

Data Analysis

The 28 vegetation plots were grouped based on similarity of plant species distributions using a hierarchical, polythetic, agglomerative cluster analysis with a Sorenson (Bray-Curtis) distance measure and a flexible beta group linkage method ($\beta = 0.25$) (McCune and Grace 2002). Rare species (occurrence < 2 individuals) were removed from the plant species cover data prior to performing cluster analysis. The cluster analysis was used as a quantitative measure of establishing groups for the various plots and as a precursor to running indicator species analysis and non-metric multidimensional scaling (NMS). Three groups were identified using cluster analysis (see Results), which I named Fresh, Transitional, and Brackish based on their location within the estuary. Environmental resource variables were log-transformed for use in NMS analysis because plant abundance generally varies linearly with log-transformed values of resource variables (Palmer 1993, Graves 2006).

To characterize clusters (groups) using the combined data from both rivers I used indicator species analysis (McCune and Grace 2002), which identifies taxa useful in differentiating groups. Indicator species analysis accounts for the frequency and relative abundance of each taxon in predefined clusters and produces indicator values for each taxon ranging from 0 (non-indicator) to 100 (perfect indicator). The higher the indicator value, the greater the group fidelity for a given species. A species was required to have a Monte Carlo significance value of $P < 0.05$ based on 4,999 permutations to be considered an adequate indicator species for one of our three groups of plots (Fresh, Transitional, Brackish). Cover data were summarized for the five most important plant species from each group within the Patuxent and Nanticoke Rivers by averaging data from the two sampling events.

NMS was also employed as a multivariate analysis tool for determining the relative strength of relationships between vegetation and environmental data. The NMS analysis used a Sorenson (Bray-Curtis) distance measure with a 0.0000001 stability criterion and a maximum of 500 iterations (McCune and Grace 2002). In the NMS analysis plots were identified as Fresh, Transitional, or Brackish based on the groupings identified in the previous cluster analysis. Cluster, NMS, and Indicator Species Analyses were completed using PC-ORD Version 5.0 (MjM Software Design, Gleneden Beach, OR).

Two approaches were used to examine patterns of richness/Shannon-Wiener diversity (herein called diversity) in relation to distance across each estuary. First, a curve-fitting regression approach was used to determine if either a curve or a straight line resulted in a better fit of the data, based on R^2 and model significance. Curve fitting was performed using SigmaPlot version 10.0 (Systat Software, Inc., San Jose, CA). Second, a repeated measures ANOVA analysis was conducted to compare richness/diversity values between plots grouped as fresh, transitional , or brackish in the multivariate cluster analysis using SAS version 9.1 (SAS Institute, Inc., Carry, NC). The significance value for this analysis was set at 0.05 and the effects of group, time, and the interaction of group and time were tested. Normality and variance heterogeneity were examined prior to analysis to ensure ANOVA assumptions were met.

Results

Plant species richness was highest in the middle reaches of the Nanticoke estuary (Figure 5). Historic river salinity data from two long term monitoring stations bracketing the plot (Figure 5) indicate that salinity increases periodically to 4 ppt or higher in this region of the estuary.

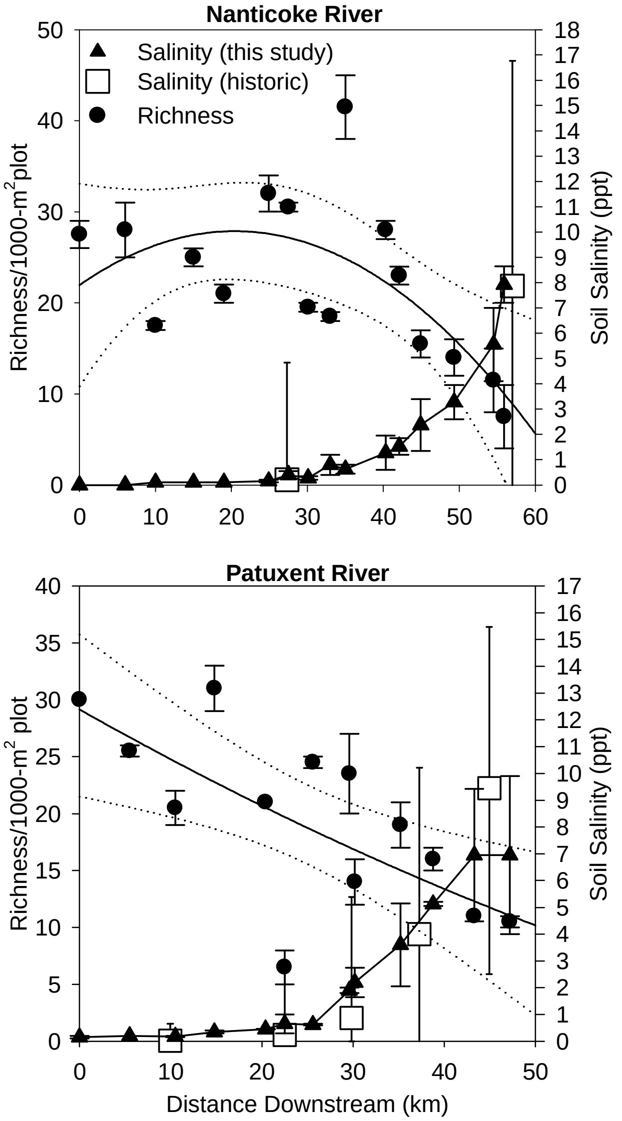

Figure 5. The relationship between plant species richness (number of species) and distance across the Nanticoke and Patuxent River estuaries. The x-axis is distance downstream from the upper most tidal fresh marsh plot along each river. Plotted values are the mean ± SE error bars (with wide end caps) except for historic salinity data, which are the mean and range (narrow end caps). Included on each graph are the best curves fits and 95% confidence interval bands (dashed lines) for each curve. Patuxent River historic salinity data are from 1985–2007, Nanticoke River historic salinity data range from 1984-2007.

The highest richness was observed at river-kilometer 35 (river-km 35), where soil pore water salinities ranged between 0.5 and 0.8 ppt during sampling. The Nanticoke River data showed a distinctly non-linear relationship between richness and distance along the estuary. Curve fits of the Nanticoke River plant species richness data were better explained by a simple quadratic equation ($R^2 = 0.43$, $F_{2,13} = 4.93$, $P = 0.02$) compared to a linear equation ($R^2 = 0.22$, $F_{1,14} = 4.02$, $P = 0.06$).

However, at the Patuxent River a simple linear equation ($R^2 = 0.47$, $F_{1,11} = 9.73$ $P = 0.01$) fit the data as well as the quadratic curve ($R^2 = 0.47$, $F_{2,10} = 4.42$, $P = 0.04$; not plotted). Historic salinity data from the Patuxent River indicate that salinity levels near river-km 15 (our plot with highest richness) can experience salinities ranging from 0.65 to 2.65 ppt. Soil porewater salinities at river-km 15 ranged from 0.3 to 0.4 ppt (fresh) during the summer 2006 sampling events. The lowest plant species richness/diversity occurred at a plot approximately at river-km 23 on the Patuxent River in a large stand of *Phragmites australis.*

Shannon-Wiener diversity calculations are sometimes a more useful tool for assessing plant community structure as the index incorporates not only the number of species present, but also the frequency of occurrence. Diversity was calculated using the species frequency data obtained from the nested 1-m^2 plots at each river location, the results in Figure 6 show a significant improvement ($R^2 = 0.76$, $F_{2,13} = 21.28$, $p < 0.01$) over the quadratic curve fit results. Neither a linear or non-linear curve provided a significant fit for the Patuxent River diversity data until the low richness plot at river-km 23 was removed from the data set. Upon removal of the outlier plot from the data set a significant sigmoidal curve ($R^2 = 0.58$, $F_{2,9} = 6.45$, $p = 0.02$) fit the diversity data as well as a linear curve ($R^2 = 0.52$, $F_{1,10} = 11.06$, $p < 0.01$).

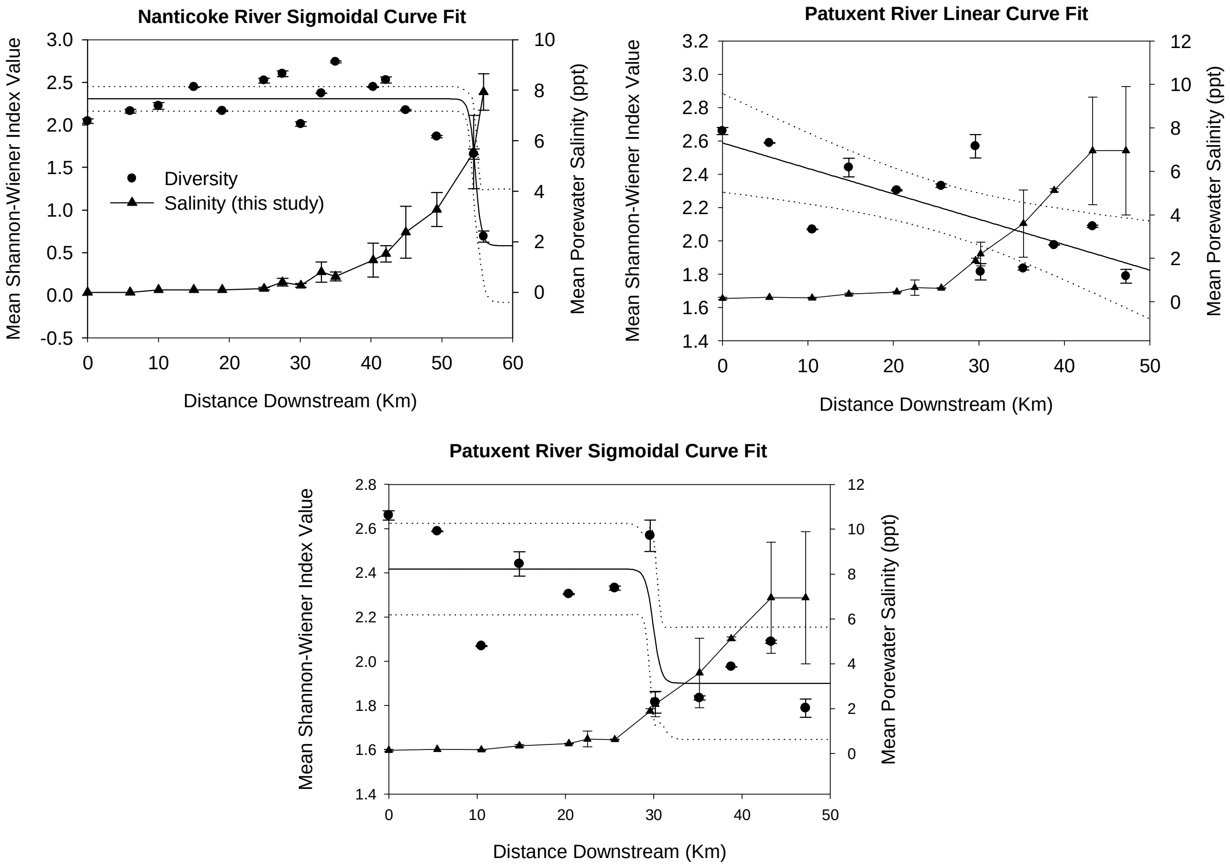

Figure 6. The relationship between plant species richness (number of species) and distance across the Nanticoke and Patuxent River estuaries. The x-axis is distance downstream from the upper most tidal fresh marsh plot along each river. Plotted values are the mean ± SE error bars. The linear and sigmoidal curve fits of the Patuxent River diversity data are shown.

The cluster analysis delineated three groups of plots (data not shown), which I labeled as Fresh, Transitional, and Brackish based on their position in the estuary (Table 1).

Table 1. Plant species indicator and P-values, corresponding to group membership (Fresh, Transitional, Brackish) along the Nanticoke and Patuxent Rivers.

Plant Species (Plant Code)	**Observed Indicator Value (IV)**	**P-value**
Fresh Marsh Group		
Polygonum arifolium L.	87.6	0.0002
Bidens laevis (L.) Britton, Sterns & Poggenb.	87.3	0.0002
Cuscuta gronovii Willd. Ex Schult.	77	0.0212
Impatiens capensis Meerb.	76.2	0.0010
Nuphar lutea (L.) Sm.	69.2	0.0016
Polygonum sagittatum L.	68.9	0.0044
Acorus calamus L.	68.1	0.0010
Cicuta maculata L.	67.6	0.0046
Bidens coronata (L.) Britton	60.5	0.0044
Sparganium americanum Nutt.	60.3	0.0054
Symphyotrichum puniceum (L.) A. Löve & D. Löve	59.6	0.0258
Peltandra virginica (Michx.) Morong	55	0.0154
Cephalanthus occidentalis L.	46.2	0.0096
Galium tinctorium (L.) Scop.	45.7	0.0278
Boehmeria cylindrica (L.) Sw.	41.7	0.0450
Apios americana Medik.	38.5	0.0368
Transitional Marsh Group		
Leersia oryzoides (L.) Sw.	76.9	0.0212
Rumex verticillatus L.	64	0.0102
Spartina cynosuroides L. Roth	63.2	0.0036
Mikania scandens (L.) Willd.	57.4	0.0430
Polygonum punctatum Elliot	56.9	0.0290
Asclepias incarnata L.	51.1	0.0184
Pontederia cordata L.	50.3	0.0108
Schoenoplectus tabernaemontani (C.C. Gmel) Palla	50.3	0.0184
Phragmites australis (Cav.) Trin ex Steud.	49.7	0.0296
Polygonum hydropiper L.	37.6	0.0416
Teucrium canadense L.	37	0.0316
Eleocharis spp.	35.8	0.0352
Cyperus strigosus L.	34.4	0.0494
Brackish Marsh Group		
Iva frutescens L.	100	0.0002
Spartina patens (Aiton) Muhl.	97.7	0.0002
Distichlis spicata (L.) Greene	96.3	0.0002
Spartina alterniflora Loisel	87.2	0.0002
Pluchea purpurascens (Sw.) DC.	64.8	0.0028
Schoenoplectus robustus (Pursh) M.T. Strong	44.8	0.0342
Atriplex prostrata Bouchér ex DC.	31.3	0.0304

The majority of Transitional plant species displayed lower indicator values (IV), i.e., lower group fidelity (mean IV value = 50.1), compared to the Fresh (IV mean = 63.1) and Brackish marsh groups (IV mean = 73.2) for both river systems. Thus many of the Transitional species also occurred in the Fresh or Brackish marsh groups. *Polygonum arifolium* and *Bidens laevis* were the two plant species with the highest indicator values for the Fresh group (IV > 87). *Leersia oryzoides* and *Rumex verticillatus* were found consistently within the Transitional group. Transitional marsh areas had observed mean soil salinities ranging from 0.4–2.2 ppt on average for both rivers. The Brackish marsh group contained plants with the most consistent group fidelity. *Iva frutescens* occurred entirely within the Brackish marsh group, along with *Spartina patens*, *Distichlis spicata*, and *Spartina alterniflora*, all of which had indicator values above 87. The Brackish marsh group had observed average soil porewater salinity readings that fell within a range of 1.5 ppt and 7.9 ppt with average Fresh marsh group soil porewater salinities ranging from 0.0 ppt to 0.8 ppt for both rivers.

The repeated measures ANOVA analysis of plant species richness between groups for each river showed results consistent with the curve fitting findings for plant species richness. The main effect of group membership had a significant effect on average plant species richness in both the Nanticoke ($F_{2,26}$ = 9.63, P = 0.0007) and Patuxent Rivers ($F_{2,18}$ = 4.95, P = 0.0194) (Figure 7). At the Nanticoke River the richness of the Fresh and Transitional groups were significantly higher than the Brackish marsh group, but did not differ

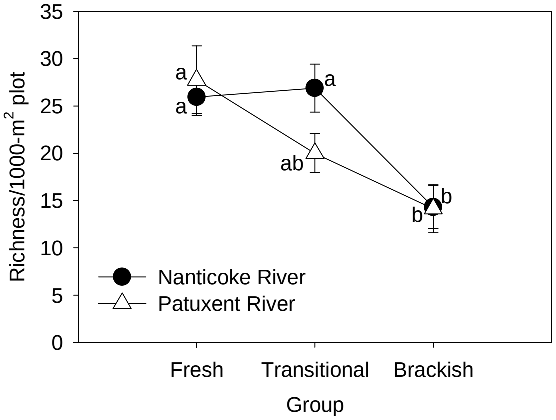

Figure 7. Results of the repeated measures ANOVA analysis for the Nanticoke and Patuxent River plant species richness data. Means comparisons between the Nanticoke and Patuxent Rivers were not made, so the differences between means are meant to be interpreted within each river separately. Means with different letters are significantly different.

significantly from each other, which supports a non-linear type of plant species richness/diversity pattern. On the other hand, the Patuxent River repeated measures ANOVA results showed a significant decline in plant species richness between Fresh and Transitional groups and between Transitional and Brackish groups. The main effects of time and the interaction between time and group membership were not significant for either river (P >> 0.05). Figure 6 shows the results of the repeated measures ANOVA analysis for the diversity data. As with the richness data the main effect of group membership had a significant effect on average plant species richness in both the Nanticoke ($F_{2,26} = 5.51$, P = 0.010) and Patuxent Rivers ($F_{2,18} = 12.29$, P = 0.0004) (Figure 8). As was the case with the richness data, the Shannon-Wiener diversity data on the Nanticoke River did not show a significant difference between the fresh and transitional marsh groups, but significantly higher diversity was observed on average in both areas compared to the brackish marshes.

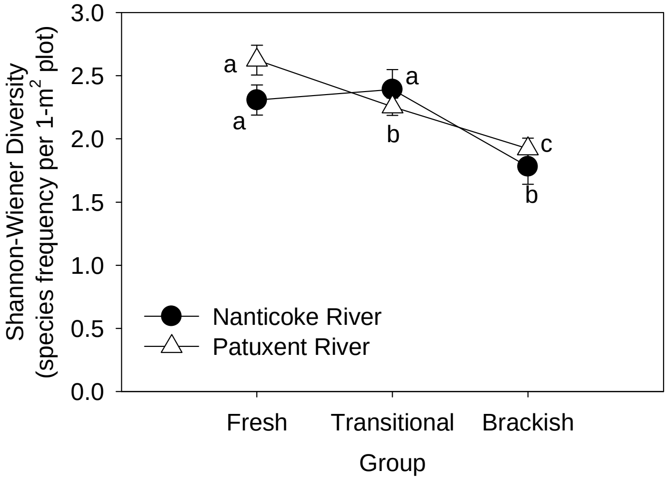

Figure 8. Results of the repeated measures ANOVA analysis for the Nanticoke and Patuxent River plant species Shannon-Wiener Diversity data. Means comparisons between the Nanticoke and Patuxent Rivers were not made, so the differences between means are meant to be interpreted within each river separately. Means with different letters are significantly different.

The results of the Nanticoke River the diversity data lend support to the curve fitting results of a general sigmoidal pattern of plant species diversity/richness. The Patuxent River ANOVA analysis of the diversity data appear to strongly support a linear relationship of plant species richness/diversity as significant differences were found between all three groups at the 0.05 level in Figure 8.

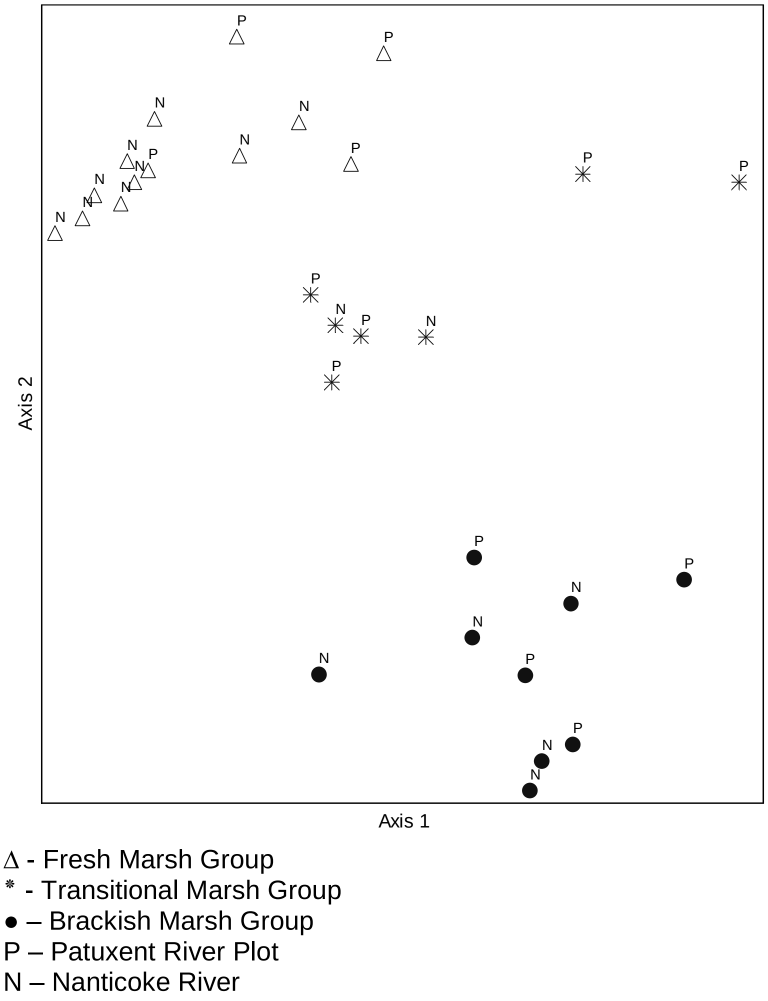

Figure 9. Non-Metric Multidimensional Scaling analysis of the Patuxent and Nanticoke River 1000-m^2 plots showing the separation of plots between Fresh, Transitional, and Brackish group plots.

Distances between points within the NMS ordination space are related to dissimilarities in species composition between the plots in response to salinity and between rivers (Figure 9). NMS provides a quantitative means of examing the similarities or dissimilarities in the plant species data. The axes of the ordination diagram reflect plant species responses to our measured salinity and environmental variable trends as one moves from the Fresh group plots (upper left portion of the graph) to the Transitional group plots (center) to the Brackish group plots (lower right portion of the graph). Within groups the Patuxent River plots tend to be displaced toward the lower right direction from the Nanticoke plots, indicating differences in species composition between the two rivers. However, the difference between the rivers was less than the difference among groups.

Many of the principal group indicator species were also considered the most important within our study gradients on the Nanticoke and Patuxent Rivers based on their average cover (Figure 10). Within the Nanticoke River, dominant fresh marsh species such as *Acorus calamus* and *Polygonum arifolium* showed general trends of maximum abundance in the fresh-oligohaline portions of the river (river-km 0–30). The dominant Transitional group marsh species, such as *Spartina cynosuroides, Phragmites australis*, and *Mikania scandens*, tended to peak closer to the middle to lower portions of the gradient (river-km 30-40), i.e., the oligohaline-mesohaline zones. Brackish group marsh species like *Spartina alterniflora*, *Spartina patens*, and *Iva frutescens* tended to dominate within the saltiest portions of the Nanticoke River gradient (river-km 40–60).

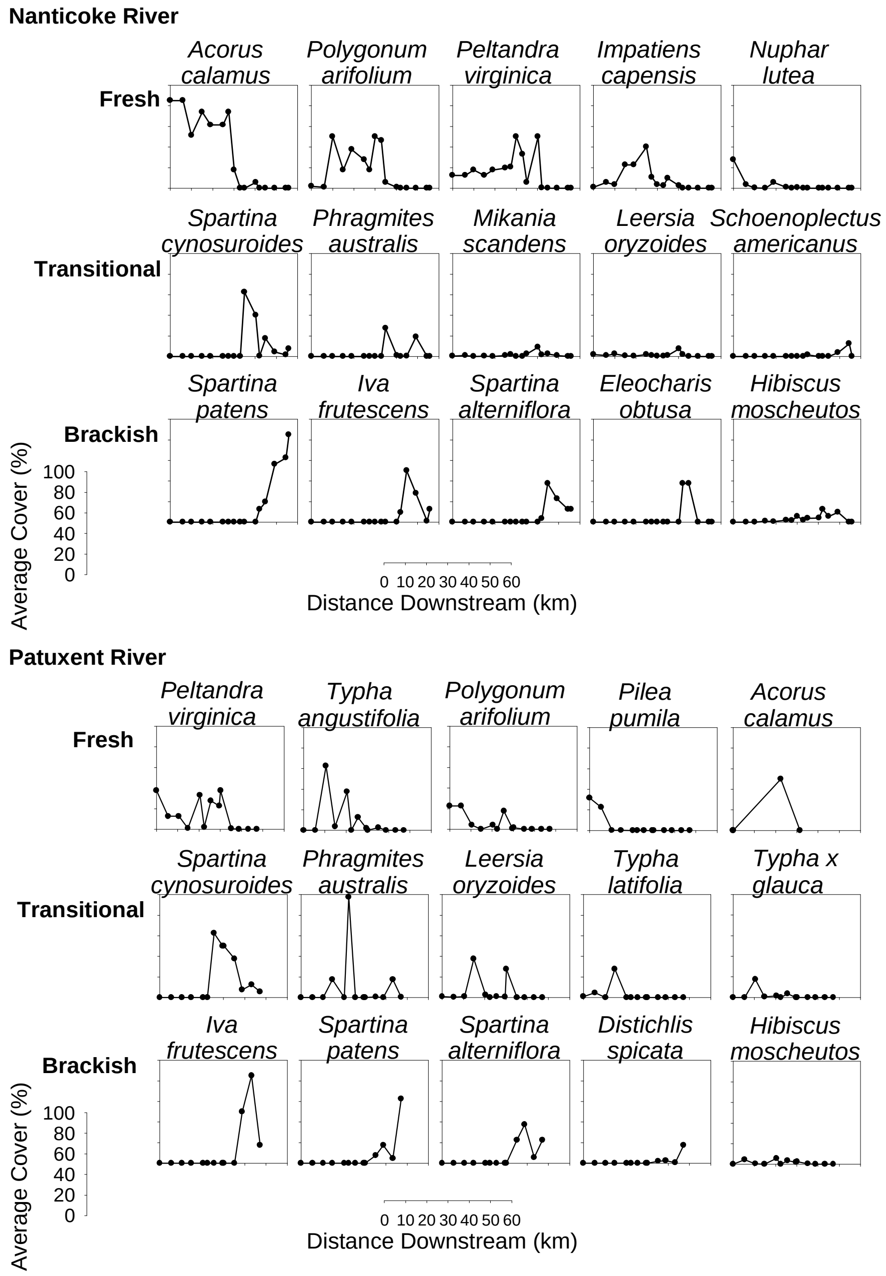

Figure 10. Average percent cover versus distance downstream (May-August 2006) for the five most abundant plant species within each group and river based on relative cover. Plant species are arranged in their respective groups (Fresh, Transitional, Brackish) based on the results of the Indicator Species Analysis from greatest average cover to lowest average cover within each group. Plant community groups were established from Cluster and NMS analysis.

Similar dominant plant species patterns were observed on the Patuxent River over the course of the study. *Polygonum arifolium, Acorus calamus*, *Typha angustifolia* L., *Pilea pumila* (L.) A. Gray, and *Peltandra virginica* all showed high abundances or at least a presence within the upper portions of the river gradient. Dominant transitional marsh species such as *Spartina cynosuroides* and *Phragmites australis* displayed peak abundances within the middle course of the Patuxent River gradient (river-km 30–40). Brackish marsh plants including *Iva frutescens, Spartina patens*, and *Spartina alterniflora* tended to be most abundant near the lower end of the gradient with some representation between river-km 40–50.

Discussion

The results of this study do not conclusively support our hypothesis of a non-linear gradient in wetland plant species richness/diversity. However, at the Nanticoke River there was a distinctly non-linear (sigmoidal) relationship between plant species richness/diversity and distance across the estuary, with richness/diversity in the transitional/oligohaline marshes having no significant differences from the tidal freshwater zone, despite higher salinity (supported by both curve fitting and ANOVA analyses). In contrast, at the Patuxent River richness declined in approximately linear fashion proceeding downstream across the estuary, based on both curve fitting and ANOVA, in concordance with the general pattern reported by others. Two questions arise. First, what mechanisms might explain the high richness observed in oligohaline (transitional) marshes at the Nanticoke River? And second, why was the pattern not observed at the Patuxent River? Answering these questions has implications for understanding richness patterns and how anthropogenic or natural change may influence them, not only in coastal wetlands but in any ecosystem characterized by stressor gradients that influence species composition.

Salinity Disturbance and Species Coexistence

Ecology has a rich history of efforts to understand factors controlling species richness. A groundbreaking theory that many subsequent theories essentially elaborated upon is the Intermediate Disturbance Hypothesis of Connell (1978), which postulates that richness is highest at intermediate levels of disturbance frequency, disturbance size, or time since disturbance. High levels of disturbance prevent occurrence of most species, preventing coexistence and reducing richness, while low levels of disturbance allow competitive elimination of species by a few strong competitors, similarly reducing coexistence.

In estuarine wetlands, salinity can be viewed as a stress that reduces growth and thus competitive ability of freshwater plants, or alternatively as a disturbance when it occurs in pulses that kill freshwater plants. Thus, salinity pulses during droughts may promote coexistence of salt-tolerant and salt-intolerant species in fresh-brackish transition zone marshes. Competitive limitations on brackish plant distributions within tidal freshwater marshes have been well documented in the literature (Hacker and Bertness 1999, Crain et al. 2004, Pennings et al. 2005). In the absence of competition from neighboring freshwater marsh species, many brackish plants thrive and can actually grow best under freshwater conditions (Crain et al. 2004). Other research I are conducting on emergent plants collected from habitats of the Patuxent River confirm these findings. Plant species such as *Pluchea purpurascens* and *Eleocharis parvula* (Roem. & Schult.) Link ex Bluff, Nees & Schauer, two seemingly obligate brackish species based on their distribution in the estuary, grew exceptionally well in pure freshwater conditions in the absence of competition from other plants (unpublished data).

The transitional zone marsh areas I studied exhibited soil porewater salinities ranging from 0 ppt to more than 5 ppt during dry periods when river discharge was low, allowing intrusion of saline water. These periodic intrusions of saline water may be the principal mechanism driving observed high plant species richness observed in marshes in the fresh-brackish transition zone of the Nanticoke River. The periodic salinity pulses may suppress growth of salt-intolerant freshwater plant species such as *Polygonum arifolium*, *Impatiens capensis*, and *Acorus calamus*, thereby allowing colonization by and co-existence with more salt-tolerant plant species such as *Spartina cynosuroides* and *Pluchea purpurascens*.

A Human Effect on Richness?

While coexistence of freshwater and salt-tolerant species was observed in fresh-brackish transition zone marshes at both rivers, richness at the Patuxent River was nonetheless lower in the transition zone than in the tidal freshwater zone. I hypothesize that this is due in part to differences in land use in the two watersheds resulting from human activities. The Nanticoke River watershed has less urban land development (2% urban lands) than the Patuxent River watershed (20% urban lands), which is much closer to major cities (Washington, DC and Baltimore, MD). Furthermore, the Patuxent River is dammed in two locations to create large reservoirs, which may have altered estuarine hydrology and salinity regimes. Urbanization in the Patuxent watershed carried over into the coastal wetlands themselves, historically in the form of ferry and barge landings and railroad beds built across the river through the wetlands, and more recently as highways that were built through the wetlands. For example, an abandoned road and ferry crossing from the late 1800's exists at one of our middle-gradient marsh sites (river km 22.5), where the plant community is now dominated by a large monotypic stand of the non-native genotype of *Phragmites australis*. The negative effect of *Phragmites australis* on local plant species richness has been well documented in the literature (Chambers et al. 1999, Chambers et al. 2002, Silliman and Bertness 2004).

The presence of *Phragmites australis*-dominated marsh communities within the regions of the Patuxent River salinity gradient where I expected to observe high plant species richness may partially explain why the pattern was linear in nature, in contrast with that of the Nanticoke where historic human activity in the wetlands was much lower. Therefore the non-linear pattern of plant species richness observed across the relatively undisturbed Nanticoke River may represent the true normal pattern of plant species richness.

Alternative Explanations

The shape of coastal plain estuaries result in an exponentially increasing cross-sectional area of the river (Savenije 2005), resulting in an exponential increase in salinity proceeding from freshwater into brackish zones of the estuary (with salinity then eventually leveling off at the ocean). This pattern of salinity increase across the estuary is visible for both rivers in Figure 3. Thus, it could be argued that a curvilinear decrease in richness that mirrors the exponential increase in salinity across the estuary would be expected if the relationship between number of species and salinity was linear. However, log-log plots of richness versus distance (not presented) created a straight, increasing line for salinity across the Nanticoke River, while species richness continued to exhibit a curvilinear decrease. This suggests that the pattern of richness across the Nanticoke River is not solely a linear response to salinity stress. Furthermore, it suggests that the Patuxent should exhibit at least a weak curvilinear relationship due to the exponential increase in salinity across its estuary.

In addition to environmental variables, the mid-domain effect may explain part of the observed distribution of richness across the Nanticoke estuary. The mid-domain effect has been portrayed as a null model of species richness across ecosystems or even continents in the absence of environmental factors (Colwell and Lees 2000). The idea essentially is that if random species ranges in a system bounded on either side overlap at all, which is typically in the middle of the system, higher species richness results. Mid-domain analyses have been applied to both plants and animals along rivers (Dunn et al. 2006), up mountainsides (Cardelius et al. 2006), and across large islands (Kerr et al. 2006) and latitudes (Jetz and Rahbek 2001). Assuming that tidal marshes can be considered a system bounded by the ocean and by the non-tidal portion of the river, then the mid-domain effect may explain in part the presence of species-rich transition zone marshes.

Implications

Our research suggests that the general trend of decreasing richness with increasing salinity noted widely elsewhere (Anderson et al. 1968, Odum 1988, Mitsch and Gosselink 2000, Greenberg et al. 2006) may be more complex than previously thought. As tidal marshes face increasing threat from anthropogenic forces, sea level rise, and invasive plant species, understanding the principal mechanisms affecting species richness has become increasingly important. Resource managers intent on maintaining maximum tidal marsh plant species diversity with the goal of providing ecosystem services such as wildlife and plant biodiversity support should focus their efforts on marshes that fall within these transitional zones as well as on tidal freshwater marshes. Tidal marshes such as these within the Chesapeake Bay are under immediate threat from global sea level rise and invasive plant species such as *Phragmites australis*. As water levels and the salt front continue to move deeper into these estuarine systems, transitional marsh zones are likely to shift inland until topographical limitations or human structures prohibit any further inland migration. This research provides baseline information that resource managers and researchers can use to predict tidal marsh community changes over time and develop controlled experiments examining plant community responses to altered physical and biotic conditions, such as those caused by rising sea levels or eutrophication. The results of this study also contribute to a growing body of ecological research aimed at understanding the importance of environmental stressors such as salinity, temperature, and elevation relative to ecological models like the mid-domain effect on the distribution of plant and animal species along spatial gradients.

Chapter 3: Mechanisms Explaining Patterns of Plant Species Richness In Tidal Marshes of Chesapeake Bay

Abstract

In many coastline river systems, such as those draining into Chesapeake Bay, an increase in plant species richness, i.e., the number of species within an area, can be observed as one moves upstream from saline to freshwater portions of the estuary. This general pattern of plant species richness is a dominant paradigm in tidal marsh plant ecology. However, middle-gradient peaks in plant species richness along estuarine gradients have been observed in Europe and the U.S. contrary to this general pattern. One potential explanation for why these mid-gradient peaks may occur is the Mid-Domain Effect (MDE). MDE theory relies on simple geometric constraints on species range boundaries in the absence of any environmental or historical gradients to predict the pattern in species richness along any gradient, be it estuarine, elevation, or latitudinal. In this study I collected tidal marsh plant species data along two estuarine gradients in Chesapeake Bay, MD (Nanticoke and Patuxent Rivers). The data and observed patterns of plant species richness were input into RangeModel 5.0, an MDE testing tool, and analyzed the importance of MDE relative to environmental variables using a modified stepwise multiple regression analysis. The results of the regression analysis found that the MDE effect was not as strong of an individual predictor of observed plant species richness as more generally recognized environmental variables, namely porewater salinity, inundation frequency, and soil nitrogen level. The MDE model did accurately predict the general location of the plant species richness peak along the Nanticoke River,

but due to historical anthropogenic disturbances was not able to accurately predict the plant species peak along the Patuxent River. Understanding the key mechanisms affecting plant species distributions along estuarine gradients is critical when attempting to develop policies and restoration goals for these sensitive ecosystems in the face of sea level rise.

Introduction

Tidal brackish, oligohaline, and freshwater marshes have similar distributions along estuarine river gradients, where tidal freshwater marshes occur at the head of estuaries with more saline systems occurring further downriver (Odum 1988). In Chesapeake Bay, many of the estuarine rivers exhibit a pattern of increasing plant species richness, i.e., the number of species within an area in the freshest portions of the river are higher compared to the less species richness rich saline portions of the estuary. The general pattern that plant species richness increases as salinity decreases along the estuarine gradient is widely accepted (Anderson et al. 1968, Odum 1988, Tiner and Burke 1995, Greenberg et al. 2006). However, in contrast to this general view, middle-course peaks in plant species richness have been reported along the Kalix and Torne Rivers in Northern Sweden (Dunn et al. 2006) and the Adour and MacKenzie Rivers located in SW France and NW United States respectively (Tabacchi and Tabacchi 1996). Research conducted by Sharpe and Baldwin on the Nanticoke and Patuxent Rivers, MD and DE also detected a non-linear plant species richness pattern along the Nanticoke River (Sharpe and Baldwin 2009, Chapter 2).

Mid-gradient richness peaks have also been reported for non-wetland systems, including along elevational gradients for some vascular plant species in Borneo (Grytnes et al. 2006), breeding birds along longitudinal gradients in Africa (Jetz and Rahbek 2001), and elevational and latitudinal gradients for butterflies in Madagascar (Lees et al. 1999). In addition to the influence of environmental stressors, geometric constraints and overlap of species ranges may result in species richness maxima in the middle of bounded systems, a phenomenon termed the Mid-Domain Effect (MDE) (Colwell and Lees 2000, Colwell et al. 2004, Cardelús et al. 2006, Dunn et al. 2006, but see Zapata et al. 2003, 2005).

MDE theory seeks to explain species richness gradients through simple geometric constraints on species range boundaries in the absence of any environmental or historical gradients (Grytnes 2003, Colwell et al. 2004, Colwell et al. 2005, and Dunn et al. 2006). In essence, MDE states that if species geographic ranges are placed on a bounded map in either one or two dimensional space, a peak in species richness will occur near the center (Colwell and Lees 2000, Zapata et al. 2003, and Colwell et al. 2004). This is in direct contrast to the implicit null model many river ecologists traditionally assume when examining species richness along the entire length of a river course (i.e., that species richness will remain constant along the entire river course in the absence of environmental, historical, or biological gradients) (Tabacchi et al. 1996 and Dunn et al. 2006). MDE theory challenges this underlying null model and asserts that a more appropriate null condition for species richness patterns along river courses is a bell shaped curve representing a species richness peak (due to range overlap) at a mid-point along the river course.

My study seeks to test the explanatory power of the Mid-Domain Effect on plant species richness versus environmental factors believed to have the greatest impact on estuarine plant communities (i.e., salinity and flood frequency). These factors, along with other factors such as interspecific competition, disturbance, and facilitation have been widely examined over the last four decades as a means of characterizing plant community richness within tidal marsh ecosystems (Ferren et al. 1981, Latham et al. 1994, Tabacchi et al. 1996, Baldwin and Mendelssohn 1998, Hacker and Bertness 1999, Zedler et al. 2001, Crain et al. 2004, Pennings et al. 2005, and Dunn et al. 2006). Using multiple regression analysis, I explore the explanatory power of MDE richness predictions, using the aforementioned environmental factors as predictor variables and observed (empirical richness) as the response variable. The underlying hypothesis of this study is that the observed plant species richness patterns along the fresh-brackish salinity gradient of the Nanticoke and Patuxent Rivers can be largely explained through the mid-domain effect (MDE). The Null hypothesis for this research is that the MDE model will not be a strong predictor of plant species richness along the

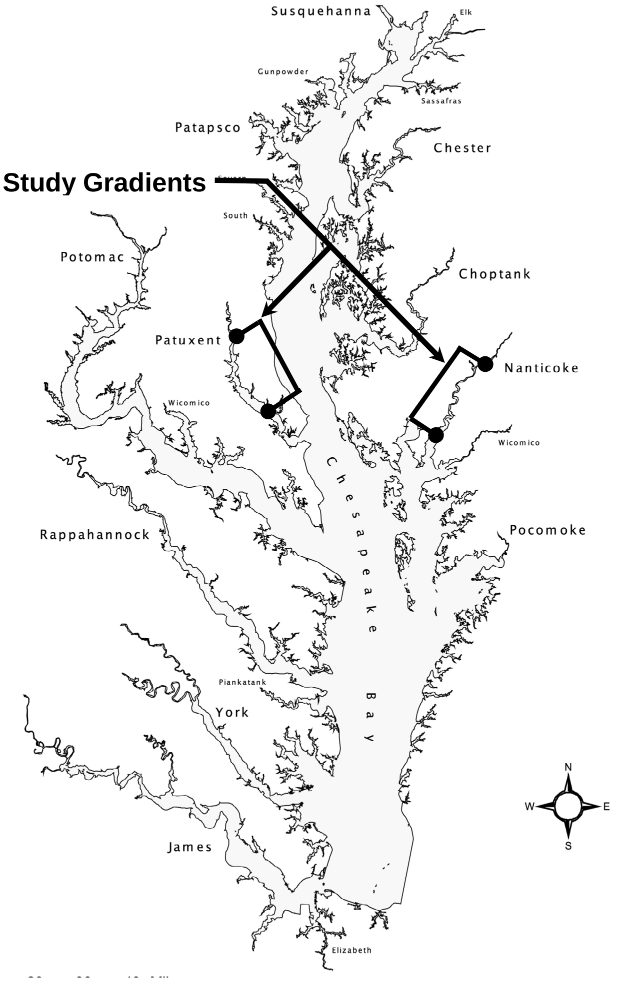

Figure 11. Chesapeake Bay and its major tributaries showing the Patuxent and Nanticoke Rivers and general study gradient locations. Source of base map: The Chesapeake Bay Foundation (http://www.cbf.org)

Nanticoke and Patuxent River salinity gradients.

Methods

Vegetation was described in 16 1000-m^2 plots (20 m x 50 m) along a 56 km salinity gradient in the Nanticoke River and 13 1000-m^2 plots along a similar 46 km gradient in the Patuxent River (Figure 11). Sampling of each plot was conducted once in May/June and once in August 2006 (Chapter 2). To capture within-season variation, plots were sampled non-destructively during both surveys using the North Carolina Vegetation Survey protocol. This “module” method combines larger scale sampling (1000 m^2) with smaller scale nested plots (Peet et al. 1998). The large (1000 m^2) plot size is well suited for capturing dominant plant species richness within fresh-brackish tidal marsh areas because of the patchiness often observed in these habitats. The five nested sample plots ensured that I captured small, less frequent marsh plants within the plot (Peet et al. 1998); only data from the 1000-m^2 plots are reported in this paper as the 1000-m^2 plot size best represented the full range of plant species observed at each location.

Salinity, temperature, and electrical conductivity were measured in each plot at the time of sampling (May/June and August 2006) by measuring substrate porewater at two fixed locations within the plot in holes where PVC marker poles were removed and at one location within the river near the plot with a hand-held salinity-conductivity-temperature meter. Four 10 x 10 m modules were selected for “intensive” nested plot examinations (Peet et al. 1998) at each plot and soil samples were randomly collected from one location within each intensive module of every plot using a Dutch auger with a 25-cm blade. Soil samples were collected from each of the four intensive modules and composited into one aggregate sample per plot in June 2006. The soil samples were tested for macro-nutrients and organic matter content at the University of Delaware Soil Testing Lab and the results were incorporated into the non-metric multidimensional scaling analysis (see Data Analysis below). Specific soil analytes tested from the composited soil samples included: organic matter content (by loss on ignition); phosphorus, potassium, calcium, magnesium, manganese, zinc, iron, boron, sulfate, and aluminum content (Mehlich 3 Extraction); total nitrogen and carbon, ammonia-nitrogen, and nitrate-nitrogen (2M KCI Extraction); total phosphorus and sulfate (microwave digestion (EPA3051-P and EPA3051-S); and pH.

RangeModel Version 5.0 was utilized to determine whether MDE is a significant explanatory factor for observed patterns of plant species richness along the Nanticoke and Patuxent Rivers. RangeModel is an animated, graphical, freeware application designed to examine the MDE.

Model Set-up

A "bin" represents one unit within the model. The empirical sampling point data (i.e., plant species richness / 1000 m^2) from the Patuxent and Nanticoke Rivers were treated as ordered, evenly spaced, discrete bins. Each species' "occupancy" and "range" was then determined. As described in Dunn et al. (2006), plant species occupancy was determined as the total number of plots (or bins) at which a species occurred, including any plots with extreme distances. The range of a plant species was determined by the number of bins between the most upriver site at which a species occurred and the most downriver site at which a species occurred, regardless of how many unoccupied (gaps) or occupied plots occurred within the range. For example, if a plant species were to occur along the Nanticoke River in plots 1, 2, and 4, but not at plot 3, then its range was four plots and its occupancy was three plots.

The purpose of the RangeModel software was to generate the pattern of plant species richness over the ordered bins created previously and imported into the model. This pattern is what the model would expect to observe if plant species ranges were placed at random within a one dimensional space and maintaining each species' observed range size and occupancy under the geometric constraint that no range may extend beyond domain limits (Dunn et. al. 2006). In this case, our domain limits were the maximum extent to tidal freshwater marsh (upper end) and the mesohaline marshes near the mouth of each river (lower end). For a more detailed description regarding the range model algorithm functions please see (Dunn et al. 2006).

Simulations for the observational data from both the Patuxent and Nanticoke Rivers were conducted according to the methods outlined in Dunn et al. (2006). The full dataset (all species) was run for both rivers, followed by subsequent runs where the plant species data were divided for each river into the 50% of plant species with the largest ranges and the 50% of plant species with the smallest ranges (range-size subsets). Repeated simulations for both range-size subsets for each river were also conducted to ensure accuracy and included in the statistical analysis.

Data Analysis

The full dataset and the range-size subsets were resampled and run a total of 5,000 times to generate means and 95% confidence intervals for the predicted pattern of plant species richness along each river. The model approximates the pattern of plant species richness in a scenario in which the position of plants species' ranges along the river is random with respect to any biological, environmental, or historic gradient that the river may exhibit (Dunn et al. 2006).

The explanatory potential of the RangeModel predictions were examined by comparing the observed species richness based on raw species counts to the mean species richness and 95% confidence intervals produced through multiple model runs for plant species richness as a function of distance along the river domain. I also used stepwise regression in SAS to select the best model based on input from other possible influences on plant species richness (besides MDE), namely mean soil salinity (MSS), flooding frequency (%Inun), soil pH, Log nitrate-nitrogen (Log NO_3-N), and the calcium-to-magnesium ratio (CA/MG). The dependent variable for the regression analysis was observed plant species richness. The initial stage of the regression analysis involved running the regression on all single variable (i.e. linear) models followed by selection of the single variable model with the combination of the highest R^2, lowest Akaike Information Criterion (AIC), and lowest Mallow's C(p) ratio using SAS 9.1 (SAS Institute, Cary, NC). The second stage of the regression analysis involved an examination of the best two-variable models that included the variable(s) selected in the initial stepwise regression analysis and models with the best combination of R^2, AIC, and C(p) scores. This process was repeated with increasing levels of model complexity until the initial variables selected by the algorithm were removed by SAS. This method was employed as a means of keeping the models simple and to reduce the chances of producing complex models with overinflated R^2 values caused by colinear predictors.

Results

The results of the stepwise regression analyses for single and multi-variable models as predictors of plant species richness support our null hypothesis that the MDE model does not explain a significant portion of the variance regardless of whether all species, short-ranged species, or long-ranged species are used. Interestingly, RangeModel did appear to predict the approximate location of the plant species richness peak fairly well for the Nanticoke River. The MDE model did not appear to fit the observed plant species richness data well for the full model when it included both large- and short-range species for either the Nanticoke or Patuxent Rivers (Figure 12). The MDE model did appear to fit the empirical data better when our data set was parsed into large-ranged species only based on placement of empirical data points within the confidence interval bands.

The improved MDE model fit was verified in the single variable stepwise regression analysis, which showed a significant improvement in the amount of variance explained by MDE as a single variable model from $R^2=0.23$ (full model) to $R^2=0.98$ (large ranged species only) for the Nanticoke River. The poor fit of the empirical data to MDE predictions when parsed into the small-ranged species subset for the Nanticoke River was verified in the regression analysis by an $R^2<0.01$.

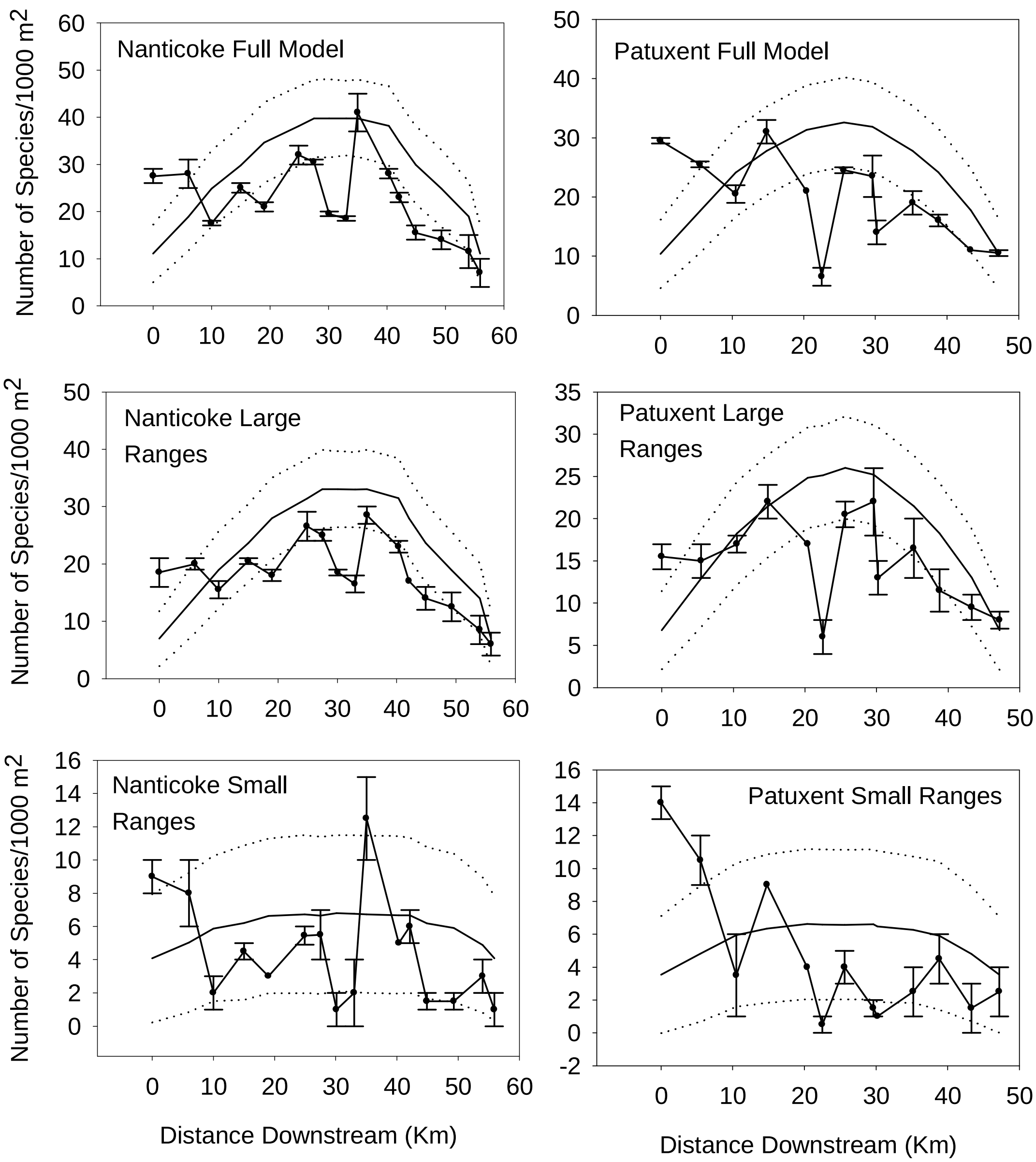

Figure 12. Richness versus distance graphs for the Nanticoke and Patuxent Rivers showing average empirical richness (with standard error bars) and the RangeModel predicted richness at each location along the two gradients (solid line). The graphs also include 95% confidence interval bands based on 5,000 runs of the model (dotted lines).

The Patuxent River results were similar to the Nanticoke in that the MDE model did not appear to fit the observed pattern of plant species richness well for any scenario (full data set, large-range only, and small-range only). When examined as a single-variable model the MDE model explained <0.01, 0.14, and 0.23 proportion of the variance for the full data set, large range subset, and small range subset respectively. Site variables such as porewater salinity (R^2=0.37), soil nitrate-nitrogen (R^2=0.58), and percent inundation (R^2=0.18) all explained a greater proportion of the total variance compared to the RangeModel output as single-variable models for the full plant species dataset.

Salinity explained more of the model variance along the Nanticoke River then MDE predictions when viewed as a single-variable model predicting plant species richness for the full data set (R^2 = 0.49). When plant species richness was plotted against mean porewater salinity (see Figure 13) the data within the lower-salinity portions of the gradient did not appear to show a clear pattern.

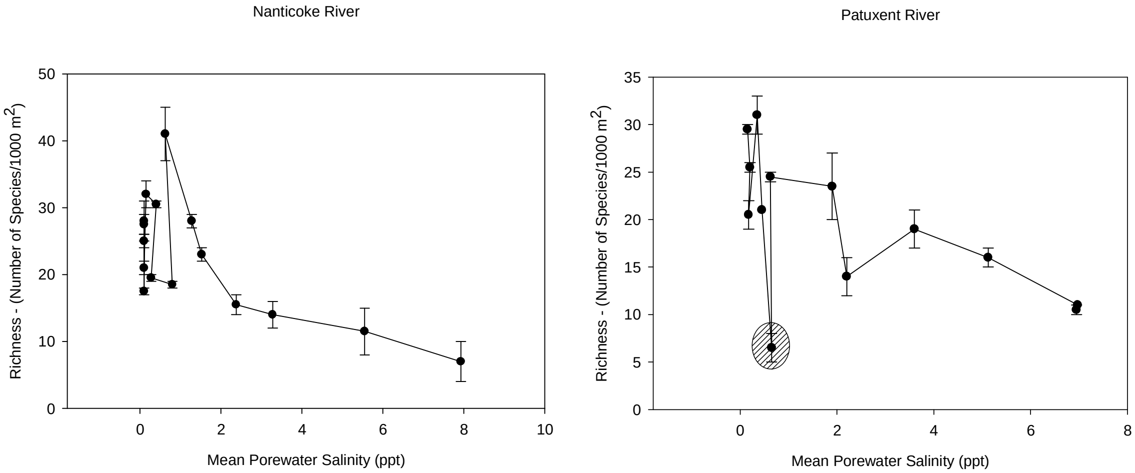

Figure 13. Mean Plant Species Richness (with standard error bars) versus Mean Porewater Salinity for the Nanticoke and Patuxent Rivers during the sampling year 2006. The hatched ellipse identifies the outlier point which was removed from the full dataset to examine if Log NO_3-N was still the principal driver of richness on the Patuxent River.

Once the mean salinity increased to an average of 1-2 ppt, the plant species richness appeared to follow the null plant species richness distribution (linear pattern). At salinities lower than 1.0 ppt plant species richness peaked on both the Nanticoke and

Patuxent Rivers and no general pattern of plant species richness (linear or quadratic) could be determined.

The results of the stepwise regression analysis (Table 2) show that soil Log nitrate-nitrogen levels and mean porewater salinity explained the greatest proportion of the variance in the data for the Patuxent and Nanticoke Rivers, respectively. Interestingly, the RangeModel results for plant species richness were not considered a good predictor of plant species richness along the Nanticoke River, which showed a non-linear pattern in plant species richness along the gradient (Sharpe and Baldwin 2009, Chapter 2). Conversely, RangeModel did improve R^2, AIC, and C(p) scores for the two- and three-variable models on the Patuxent River, which showed no clear mid-gradient peak in plant species richness. The MDE model did appear to predict a significant proportion of the variance when the data sets for both rivers were separated into large-range species only, particularly on the Nanticoke River (Table 2). When the data set was separated into small-range species only and modeled, RangeModel did not explain a significant proportion of the variance for either river.

The relative importance of nitrate nitrogen as a driver of richness was somewhat unexpected and the possibility existed that the extreme low richness plot at the upper end of the gradient was affecting the stepwise regression algorithm. When the extreme low richness plot was removed (See Figure 3) from the data set, mean porewater salinity was the best single variable predictor ($R^2 = 0.70$, C(p) = 4.55, AIC = 33.98) of plant species richness along the Patuxent River gradient (Full-Data set). This result was much more consistent with the trend of decreasing richness with increasing salinity observed in 2006 on the Patuxent River (Figure 12).

RangeModel predicted a plant species richness peak in an area of the Patuxent River where mean plant species richness was lowest (mean richness 6.5 ± 2.12). This tidal marsh area has experienced historic disturbances in the form of a river ferry and associated roadbed in the late 1800s and is now dominated by a monoculture of *Phragmites australis*. However, assuming the MDE model predictions are accurate, it is possible that the low diversity marshes at these locations along the Patuxent River gradient could be good candidates for restoration with at least one goal being to maximize plant species richness/diversity.

Table 2. Table of models selected using SAS stepwise regression methodology. Models with the best combination of R^2, AIC, and C(p) scores were selected with the best one variable model. Subsequent models are summarized here which included the initial variables from previous model runs. RMRich is code for predicted RangeModel richness.

Dataset	**River**	**Model**	**R^2**	**C(p)**	**AIC**	**P-Value**
Full Dataset	Patuxent	1. Log NO_3-N 2. Log NO_3-N, RMRich 3. Log NO_3-N, RMRich, pH	0.57 0.64 0.73	17.09 14.43 10.89	44.37 43.82 41.93	0.0028 0.0054 0.0054
	Patuxent (No Outlier)	1. MSS	0.70	4.55	33.98	0.0006
	Nanticoke	1. MSS 2. %Inun, MSS 3. %Inun,MSS,CA/MG 4. %Inun,MSS,CA/MG,DisDown	0.49 0.59 0.64 0.76	12.83 9.66 9.65 5.44	61.12 59.38 59.65 54.71	0.0024 0.0026 0.0053 0.0017
Large Ranges	Patuxent	1. MSS	0.29	37.05	40.91	0.0555
	Nanticoke	1. RMRich 2. RMRich, MSS	0.98 0.99	13.84 9.04	1.65 -1.22	<0.0001 <0.0001
Small Ranges	Patuxent	1. Log NO_3-N 2. Log NO_3-N, pH 3. Log NO_3-N, pH, RMRich	0.74 0.82 0.82	-0.95 -1.24 0.69	21.68 19.33 21.20	0.0001 0.0002 0.0010
	Nanticoke	1. MSS	0.16	11.75	37.94	0.1159

Discussion

Nanticoke River

Generally speaking mean porewater salinity (MSS) was deemed a better individual predictor of plant species richness within the Nanticoke River gradient compared to any other factor including the MDE. Another variable included in the data analysis that is most commonly considered to be a driver of tidal marsh plant community structure was the flooding frequency (% Inun). These two factors together accounted for almost 60% of the total variance explained by the model along the Nanticoke River. These results do not support the research hypothesis of the MDE as the primary driver of plant species richness along the Nanticoke River when considering all plant species range types within the data set.

When splitting the dataset into large-range and short-range species and re-running the model, I received similar results as Dunn et al. (2006). The MDE model predicted a substantial proportion of the variance ($R^2 = 0.98$) in plant species richness along the gradient for large-range species (single variable model), but was a poor predictor of richness when looking solely at the small-ranged species ($R^2 < 0.16$). This seems to make sense when considering that the MDE model relies upon range overlaps to occur along the gradient to generate a mid-gradient peak. When considering the Nanticoke River, the combined effect of the large- and small-ranged species caused a low to moderate proportion of the variance to be explained by MDE.

While mean porewater salinity and the percentage of inundation explained the greatest proportions of the variance, when plant species richness was graphed versus salinity no clear pattern could be discerned within the freshwater – oligohaline (0 - 2 ppt) salinity ranges (Figure 3) for either river system. This suggests that while salinity did appear to be the most important factor governing plant species richness along the freshwater to brackish marsh gradient, other factors may also play a role, particularly near the top end of the gradient where salinities can vary in some areas from fresh to oligohaline (0 – 2 ppt).

Patuxent River

The Patuxent River pattern of plant species richness was generally linear in nature (Chapter 2). Due to this linear pattern, MDE theory was not the optimal “single variable” model that explained empirical richness. Instead, nitrate-nitrogen levels were the best predictor of the observed pattern of plant species richness. Given that wetland ecosystems can be nitrogen limited through plant uptake and high rates of soil denitrification (Bedford et al. 1999, Batzer and Sharitz 2006, Tiner and Gosselink 2007), this result was plausible though still unexpected given the usual nutrient rich conditions in Chesapeake Bay waters. The pattern of plant species richness dropped dramatically when graphed against mean porewater salinity from 0 – 1 ppt. This extreme dropoff in plant species richness affected the predictive power of mean soil salinity in the regression analysis. When the extreme low richness plot was removed from the data set, mean porewater salinity was the best single variable predictor ($R^2 = 0.70$, C(p) = 4.55, AIC = 33.98) of plant species richness along the Patuxent River gradient. Additionally, though not considered as significant as MSS or nitrates, the MDE effect did account for 40% of the variance explained by the model (as a single variable) in the large range dataset once the outlier was removed.

When the Patuxent River data were separated into large- and small-range species groups and the MDE model was rerun, mean soil salinity was the principle variable explaining plant species richness for the large-range species and nitrate-nitrogen concentrations was the principal explanatory variable for the small-range species. This was not unexpected, given that the data set did not display a quadratic distribution of plant species richness versus distance downstream. Instead, plant species richness seems to follow a inverse linear pattern most commonly associated with tidal marsh plant community gradients along estuarine systems (Anderson et al. 1968, Odum 1988, Tiner and Burke 1995, Greenberg et al. 2006). Additionally, Dunn et al. (2006) found that the MDE model was not a good predictor of empirical richness for small-range species on the Kalix and Torne Rivers in Sweden. This result was similar to our findings for the Nanticoke and Patuxent River small range datasets.

Implications

Of note was that the MDE predicted a peak in plant species richness along the Patuxent River at the location of our lowest diversity site, dominated by a monotypic stand of *Phragmites australis*. *Phragmites australis* is a common invasive plant throughout the tidal marsh systems of the Nanticoke and Patuxent Rivers and tends to occupy and thrive in areas that have or are currently undergoing some form of disturbance. In this case, the *Phragmites* community was occupying land that was formerly part of a ferry and roadway system in the late 1800s. Though the infrastructure from this disturbance is gone, I hypothesize that it was the original disturbance allowing *Phragmites* to establish itself and eventually dominate the marsh at this location. Since the MDE model does not account for geomorphological, biological, or historic context when determining the distribution of high and low diversity areas along a given gradient, it would not have been able to predict this particular pattern. Conversely, the MDE model results did accurately predict the general location of the highest richness plant community along the Nanticoke River (Figure 2 – Full Model). This suggests that anthropogenic disturbances to the low salinity tidal marshes along the Patuxent River may not only have had direct impacts on the affected marsh itself, but indirect effects on the plant species richness patterns along the entire salinity gradient.

The results of this study did not conclusively support the research hypothesis that the MDE model would be a primary predictor of plant species richness patterns along the Nanticoke and Patuxent Rivers. The data analysis seems to indicate that on a single-variable basis, soil porewater salinity explains greater than 50% of the variation in empirical plant species richness data for both rivers. It is likely that periodic intrusions of salt water into the low salinity marshes of the Nanticoke and Patuxent Rivers stress the competitively dominant fresh marsh plants, allowing the less competitive salt tolerators room to survive and grow (Chapter 2). The fact that the MDE explained a high proportion of the variance on the Nanticoke River for the large range dataset ($R^2 = 0.93$) and over a third of the variance on the Patuxent River with the outlier removed ($R^2 = 0.40$) suggests that it is a contributor to our observed patterns.

This combination of abiotic (salt stress) and biotic (plant competition) factors seem to be more important in determining the observed patterns of plant species richness compared to MDE. Past and present anthropogenic disturbance also seem to be a significant factor, as historic disturbances to the low salinity marshes along the Patuxent River in the predicted area of peak plant diversity likely contributed to the linear pattern of plant species richness observed in that location. The MDE model provides an interesting and testable null condition for plant species distributions along estuarine salinity gradients, however, in this case, it appears that the combination of historic disturbance, environmental (porewater salinity), and biotic (i.e. competition) factors are more important in determining observed patterns in plant species richness along the Patuxent and Nanticoke River gradients. The strong explanatory power of the model for the large ranged species datasets should not be ignored however, and suggests that the MDE does contribute to our observed patterns along these two river gradients.

Chapter 4: Separating Environmental Variables From The Mid-Domain Effect: A Tidal Wetland Mesocosm Experiment

Abstract

Tidal low-salinity marshes in Chesapeake Bay are at risk from sea-level rise and associated salt intrusions into estuarine rivers. To quantify the impacts of increased salinity and flooding frequency on tidal marsh species richness, composition, and biomass, a greenhouse experiment, utilizing mesocosm in a randomized complete block, split-plot design with 8 planted species and a mixed seedbank from wetlands spanning the 0 ppt to 12 ppt salinity gradient was conducted. I hypothesized that increases in salinity would reduce plant species richness, diversity, and plant biomass, but maximum richness would occur at low-salinity rather than in fresh water (0 ppt). Average plant species richness was greatest ($\alpha = 0.05$) in the low-salinity mesocosms (0 ppt and 1.5 ppt), with a distinct shift from fresh marsh species to more salt tolerant species over time. The mixed seedbank community also exhibited the highest average richness even compared to the two fresh marsh locations and was significantly higher than the brackish and one of the fresh marsh seed banks ($p < 0.05$). These findings suggest that marshes that have sufficient numbers of salt-tolerant seeds/propagules are able to adjust to increased salinity and flooding conditions at least in the short term without a significant reduction in biomass production. Flooding frequency differences did not have significant impacts on plant species richness or diversity and did not have a significant interactive effect with salinity on richness, biomass, or Shannon-Wiener diversity. Interestingly, average plant species richness was in the low-salinity oligohaline mesocosms (1.5 ppt)

was not significantly different then the pure fresh marsh mesocosms which was similar to the observed pattern on the Nanticoke River (Chapter 2). These results suggest that salinity is the critical factor affecting tidal marsh plant community structure and biomass production across estuarine gradients. Furthermore, alterations to the salinity regimes of low-salinity tidal marshes (i.e. longer durations of salt exposure events and increased upstream movement of the salt wedge) caused by climate change will likely result in diminished marsh biomass and richness unless the ecosystem has an adequate supply of salt/flood-tolerant seeds and propagules.

Introduction

Increases in the rate of sea-level rise associated with global climate change is threatening coastal wetlands worldwide. Increases in sea level may cause shoreward movement of salt-tolerant species such as *Spartina alterniflora* (Donnelly and Bertness 2001) or conversion of coastal wetlands to open water (Baumann et al. 1984). In the Chesapeake Bay, where the relative rate of sea-level rise since 1900 has been 2.5-3.6 mm/year (Lyles et al. 1988; Stevenson and Kearney 1996), extensive marshes such as those at Blackwater National Wildlife Refuge on Maryland’s eastern shore have been lost (Stevenson et al. 1985; Kearney et al. 1988). Much of the research on effects of sea-level rise on coastal wetlands has focused on brackish and salt marshes, where increases in relative water level due the combined effects of land subsidence and eustatic (background) sea-level rise have been implicated as a dominant factor in loss of these wetlands (Stevenson et al. 1985, 1986; Morris et al. 2002). However, little is known about the effects of sea-level rise on low-salinity tidal wetlands, which include the species-rich, high-productivity tidal freshwater and intermediate (oligohaline) marshes (Tiner and Burke 1995). In addition to increases in water level, the salt-sensitive vegetation of low-salinity wetlands also is likely to exhibit stress or mortality due to saltwater intrusion from sea-level rise (McKee and Mendelssohn 1989; Baldwin and Mendelssohn 1998). Therefore, sea-level rise arguably poses a greater risk to low-salinity wetlands than to salt and brackish marshes.

The Chesapeake Bay contains one of the greatest concentrations of tidal low-salinity marshes in the United States, covering about 16,000 hectares in Maryland alone (Tiner and Burke 1995; Mitsch and Gosselink 2000). Tides and river flooding supply abundant nutrients, generating primary productivity as high as any ecosystem on earth, including agroecosystems (Tiner 1993; Mitsch and Gosselink 2000). The combination of high plant diversity and productivity and low-salinity stress supports diverse and abundant fish and wildlife populations.

Therefore, the loss of tidal low-salinity marshes, or their conversion to brackish or salt marshes, in the Chesapeake Bay due to sea-level rise would have dramatic socioeconomic and ecological consequences. While sea-level rise itself cannot be readily controlled, measures can be taken to stabilize or restore coastal wetlands. These include addition of sediment to increase elevation, a technique that has been used in coastal Louisiana to mitigate wetland loss due to sea-level rise (Ford et al. 1999), and which is being considered for restoration of wetlands at Blackwater National Wildlife Refuge on Maryland’s eastern shore.

While the broad responses of vegetation to increases in salinity and tidal inundation are understood, the potential for vegetation dieback or changes in species composition in tidal low-salinity marshes of the Chesapeake Bay and other Atlantic Coast estuaries in response to changes in salinity and waterlogging acting together has not been studied. Because of their position in the estuary, these marshes may experience increases in salinity, but not waterlogging if sedimentation patterns continue to provide adequate accretion to keep pace with increases in water level (Kearney et al. 1988). Alternatively, salinity and water level both may increase. Currently little quantitative information exists upon which to base predictions of changes in species diversity or composition in tidal low-salinity marshes, or even whether vegetation will die back under different projected sea-level rise scenarios (IPCC 2007). Because of the ecological and socioeconomic significance of tidal low-salinity marshes of the Bay and elsewhere, quantitative information is an invaluable tool for understanding how coastal wetlands will respond to increases in sea level and in designing mitigative measures or wetland restoration projects in the face of sea-level rise.

Preliminary Research

During 2006 I studied patterns of plant diversity and composition across low-salinity tidal marshes in the upper estuaries of the Patuxent and Nanticoke Rivers in Maryland (Chapter 2). Vegetation cover was described in 1000-m^2 plots located across an approximately 50-km gradient at roughly 5-km intervals, extending across tidal freshwater and oligohaline marshes into the brackish marsh zone in both estuaries.

Our results (Sharpe and Baldwin 2009, Chapter 2) showed a non-linear pattern of plant richness/diversity along the Nanticoke River in low-salinity oligohaline/fresh marsh areas. In these reaches salinity periodically increases to 2-5 ppt (mddnr.chesapeakebay.net) during periods of low river discharge and in late summer during drought years; our springtime 2006 measurements also detected salinity intrusion (Figure 14). These observed patterns plant species richness (especially on the Nanticoke) was in contrast with the general pattern that plant species richness decreases proceeding downstream across estuaries (Anderson et al. 1968; Tiner 1995; Odum 1988). I theorized that the principal abiotic mechanisms controlling the observed sigmoidal pattern of plant species richness/diversity is periodic salinity stress, which reduces the competitive advantages afforded many freshwater plant species and allows less competitive brackish marsh plants to survive in this transition zone. My previous research (Chapter 3) had identified salinity and flood frequency as two key drivers of marsh plant community structure from the observational study and this research sought to test these two factors in a controlled environment using a mesocosm approach.

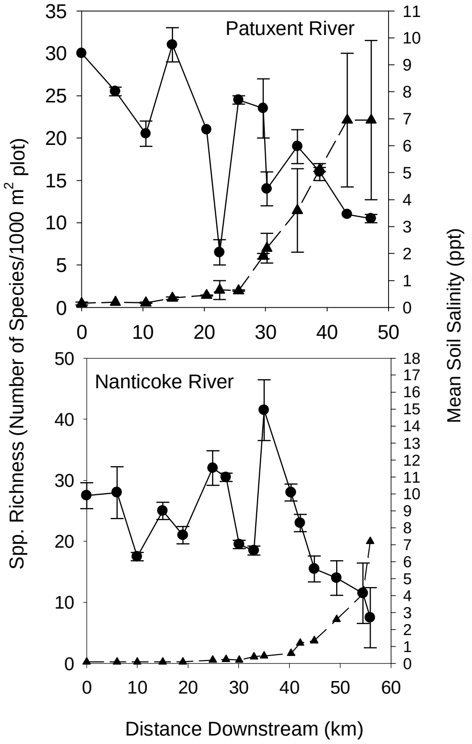

Figure 14. Plant species richness in 1000 m^2 plots (solid lines, left axis) and porewater salinity (dashed lines, right axis) in tidal marshes in the upper Nanticoke and Patuxent Rivers, Maryland (May/June 2006).

My observations from the Patuxent and Nanticoke Rivers (Chapter 2) document the higher plant richness in low-salinity tidal marshes than in brackish marshes and even fresh water marshes in some cases and suggests that increases in salinity associated with sea-level rise will reduce the diversity of these wetlands. Furthermore, if marshes are unable to migrate landward, as is expected in many regions due to coastal steepening, the low-salinity marshes may succumb to the so-called “coastal squeeze” between saline marshes and uplands (Taylor et al. 2004).

While these preliminary findings demonstrate correlation between salinity and plant diversity in coastal wetlands, stronger cause-and-effect relationships needed to be examined using a manipulative experiment in a controlled greenhouse environment. The research questions at the heart of this study were: 1) how do increases in salinity concentration alter species richness and composition in marsh mesocosms? and 2) does soil waterlogging (percentage of time the soil surface is inundated), also predicted to increase due to sea-level rise; affect species richness in marsh mesocosms? Additionally I wanted to assess the potential seed bank variability in collected marsh surface soils from brackish, transitional, and fresh marsh sites. My primary research hypothesis was that increases in salinity will tend to reduce plant diversity (species richness and Shannon-Wiener diversity index) and indices of ecosystem function (i.e. biomass), but maximum diversity will occur at low-salinity rather than in fresh water. I also predict a concurrent shift in the plant community to more salt-tolerant species under conditions of increased salinity, and that salinity and waterlogging will interact in a synergistic manner to reduce diversity and ecosystem function (i.e. plant productivity).

Methods

To examine the potential future responses of low-salinity marsh vegetation to sea-level rise, I developed a greenhouse experiment subjecting marsh mesocosms (the experimental unit) to a range of salinity and soil flooding conditions. The experiment tested the effects of various salinity and flooding regimes on species richness, species composition, and indices of ecosystem function (i.e. above and below ground biomass). Specifically, I subjected synthetic plant communities to three levels of soil flooding and five levels of salinity (0, 1.5, 3, 6, and 12 parts per thousand or ppt) in a 3 x 5 factorial treatment arrangement. For reference, the salinity of ocean water is about 35 ppt, and the salinity classification of coastal marshes is <0.5 ppt for freshwater, 0.5-5 ppt for oligohaline or intermediate marshes, 5-18 for mesohaline or brackish marshes, and >18 for polyhaline or salt marshes (Cowardin et al. 1979).

Mesocosm Configuration

Because of possible gradients in light, temperature, or humidity across greenhouse benches, as well as greenhouse space limitations, experimental units were arranged in a split-plot randomized complete block design (Figure 15). Each block represented a replicate for salinity (i.e. two replicates for salinity) this represented the whole-plot effect, with the sub-plot factor being flooding frequency and having three replicates per trough (Figure 15).

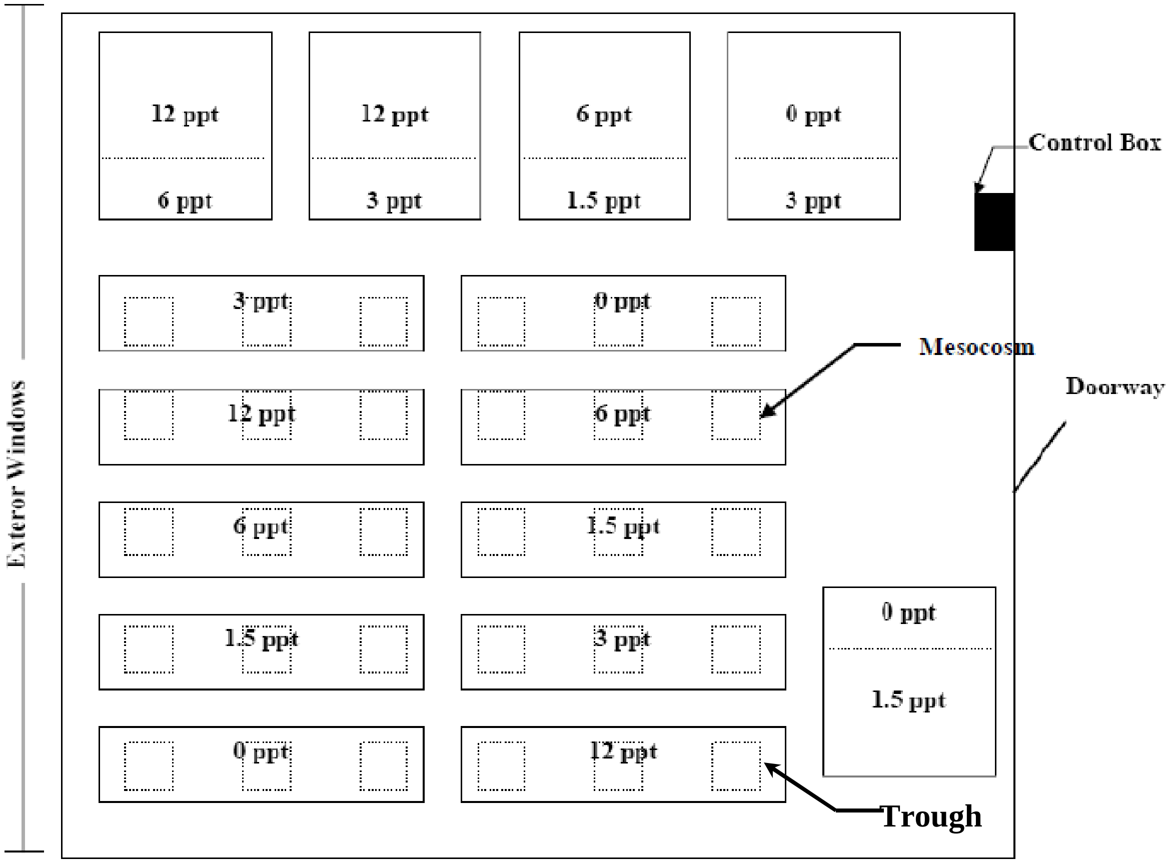

Figure 15. Plan view of experimental treatments and layout for the greenhouse mesocosm study (total experimental units = 30, salinity replicates = 2, and flooding frequency replicates = 10).

The mesocosms consisted of a container design that allowed control of water level and supply of salinity and nutrients. The mesocosm itself was a 56 x 44 x 44 cm (h x l x w; 151.4 L), Rubbermaid® Square Brute container Atlanta, GA with 16, 1.3-cm diameter perforations along the bottom to allow for exchange of water within the watering trough. Each mesocosm also had mesh screens installed at the bottom of each mesocosm over the drainage holes to prevent soil loss. The screens were made from plastic and had a 4 mm^2 mesh size. The watering troughs were made from pressure treated lumber and were (61 x 196 x 56 cm, 666 L). The troughs were designed to house three mesocosms each and were fed by a dedicated reservoir randomly assigned to that particular trough (Figure 2).

The reservoirs were also constructed from pressure treated lumber and were (56 x 117 x 117 cm, 767 L) and were randomly located within the greenhouse. To prevent leaking, the troughs and reservoirs were lined with 45-mil thick black Firestone Pond liners Nashville, TN (Figures 16 and 17). Submersible pumps (Little Giant 115 Volt, Franklin Electric, Blufton, IN) were placed in the reservoirs and troughs to move water into and out of the system. The pumps were attached to a circuit board and timing mechanism set to a six hour interval rate. The circuit controller activated the pumps and allowed the reservoirs to fill over a period of 6 hours, at the end of the 6 hour cycle the system activated a second set of pumps and drained the system over a another 6 hour period. This 6 hour pumping cycle was established to simulate the natural tidal cycles of marshes within the Chesapeake Bay. Target salinity levels were achieved through the addition of Instant Ocean Sea Salt to our targeted treatment level and verified through the use of a handheld YSI-30 SCT meter.

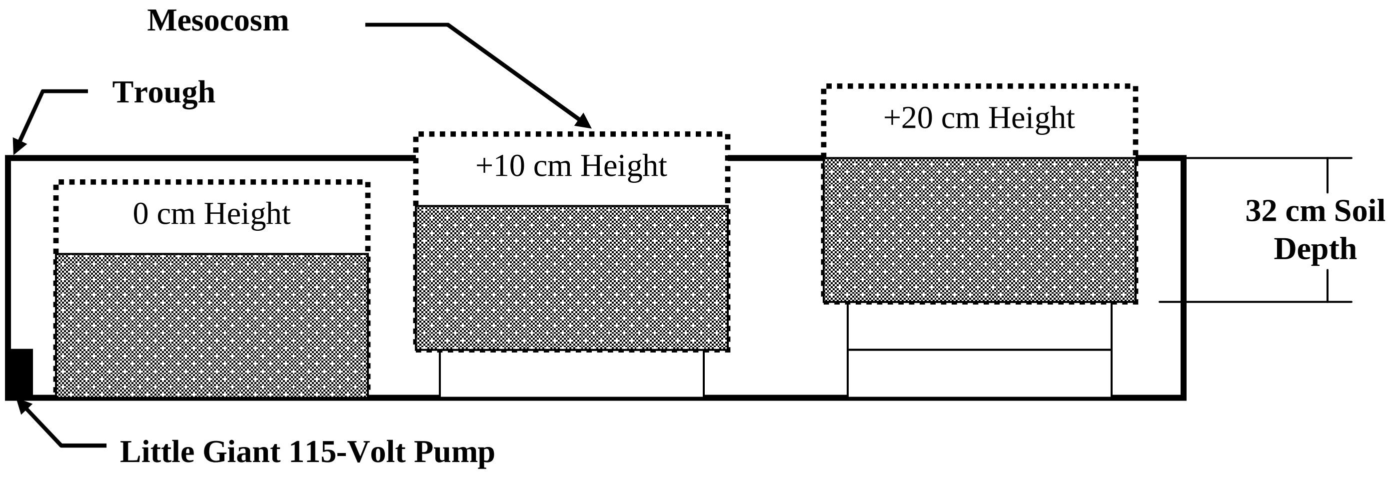

Figure 16. Profile drawing showing a conceptual layout of the marsh mesocosms within a trough.

Flooding frequencies were altered by elevating the mesocosms on concrete blocks; each mesocosm was randomly assigned a height of + 0 cm, +10 cm, or +20 cm

Figure 17. The lined trough and mesocosms in July 2007.

above the trough bottom. These heights corresponded to a flood frequency (percent of hours in a 24 tidal cycle) that the soil surface was inundated with water 23%, (+20 cm), 44% (+10 cm), and 62% (+0 cm). Flooding frequencies were verified using an automatic water level (WL-15 Global Water, Inc Gold River, CA) recording device placed inside a representative trough and measured over a period of 24 hours. For reference, flooding durations measured from 29 marsh plots along the Nanticoke and Patuxent Rivers averaged 35% in 2006.

Experimental Plant Community – Mesocosm and Seedbank Studies

The goal of this experiment was to create a diverse assemblage of plant species representative of conditions across one of my previously surveyed river gradients. This goal was accomplished by inoculating the mesocosms with homogenized soils containing seeds collected along the Patuxent River marsh gradient and supplementing the seed bank with some dominant planted perennials identified previously (Chapter 2), and representative of the entire fresh-brackish salinity gradient. The rationale for including some species of brackish marsh plants was to provide a source of vegetative material that would allow plant communities to potentially shift from salt-intolerant to salt-tolerant communities if environmental conditions became appropriate, as occurs in coastal wetlands experiencing high rates of relative sea-level rise that do not convert directly to open water (Boesch et al. 1994; Perry and Hershner 1999). Previous research has used sections of marsh soil and vegetation collected intact from wetlands rather than synthetic plant communities proposed here (Baldwin and Mendelssohn 1998; Baldwin et al. 2001). However, I decided to use synthetic plant communities because I wished to assemble a diverse suite of propagules and vegetative material from a range of coastal wetland types to better understand how the diversity and composition of wetland vegetation would respond to different combinations of salinity and flooding treatments. Synthetic plant communities also have the added benefit of reducing variation between experimental units, allowing reduced numbers of replicates, and therefore greater numbers of treatment factor levels, than would be possible with more variable soil-vegetation sections.

Marsh surface soils were collected from four marsh locations (two freshwater sites, one transitional site, and one brackish site) along the Patuxent River on March 19-21, 2007. Marsh soils were collected by hand using 5 x 4.75 cm (h x d) corers. A total volume of 38 L (of the top five centimeters of topsoil) was collected from each of the four sites. An additional freshwater marsh site was needed due to concern that a sufficient number of freshwater annual plants would not germinate from a single site. As commercially grown wetland annuals are difficult to obtain, the additional fresh marsh site was included to ensure adequate representation of each salinity class in our mesocosms. The collected marsh topsoil was stored in 19 L buckets and placed in refrigerated conditions until April 17, 2007 when the soils were homogenized.

Marsh surface soil samples from each location were homogenized in a cement mixer and five (284 cm^3) samples from the homogenized soil from each site were extracted, and spread in a uniform 1-cm thick layer on top of a 2-cm thick layer of Sunshine LC1 potting soil mix within 4 x 14 x 20.3 cm (H x W x L) aluminum pans.

Next the collected topsoil across all four marsh locations was homogenized by placing one bucket of topsoil from each marsh type into a cleaned and rinsed cement mixer. The cement mixer was run for seven minutes and the resulting mixture was placed back into the four empty buckets. This process was repeated for the remaining four topsoil sample buckets. Next, two buckets from each of the mixed sets were chosen haphazardly (four buckets total) and mixed again for five minutes and poured back into the empty buckets. This process was repeated for the remaining four buckets. This process of mixing and re-mixing of the collected topsoil samples was utilized to achieve a homogeneous soil mixture.

Five 284-cm^3 volumes of soil were then extracted from the homogenous mix and placed in the aluminum pans as part of the seed bank variability component of this study. This process allowed me to characterize the seed banks of the individual collection sites, as well as the homogenized seedbank that was used in all the mesocosms.

The seedbank trays were randomly placed on a misting bench in the University of Maryland Research Greenhouse Complex and emerging seedlings counted by species. Soil seed banks contain seeds of several dominant annual species in low-salinity marshes, including *Polygonum* spp., *Impatiens capensis, Bidens* spp., and *Pilea pumila* (Baldwin and DeRico 1999; Peterson and Baldwin 2004). Application of a homogeneous soil sample is an effective way to introduce these species, many of which cannot be purchased from nurseries and for which seed collection would be necessary throughout the year. I anticipated that between the planted perennials and plants recruited from the seed bank I would approach stem densities similar to those of natural marshes (e.g., 250 stems/m^2 in July and 150 stems/m^2 in August; Darke and Megonigal 2003).

Upon completion of topsoil homogenization and seedbank study set-up, mesocosm containers were filled with 30 cm of SUNGRO Professional Blend potting soil and inoculated with a 2-cm thick layer of collected marsh topsoil. The resulting mesocosms were put on a freshwater drip-line irrigation system, placed outside 4 April 2007 and then moved into the greenhouse (5 May 2007) and allowed to acclimate to greenhouse conditions until 11 July 2007 when the mesocosms were placed into my tidal system. Perennial wetland plants (two inch plugs) purchased from Environmental Concern, Inc. (St. Michaels, MD) were randomly planted at each of 16 positions (2 of each) within each marsh mesocosm on May 31, 2007. The perennial plants were selected based on availability and relative indicator value from a previous study (Chapter 2). The plant species were: *Acorus calamus, Distichlis spicata, Leersia oryzoides, Spartina alterniflora, Typha angustifolia, Spartina patens, Phragmites australis, and Spartina cynosuroides*. *P. australis* and *S. cynosuroides* were grown in the greenhouse from rhizomes harvested along the Patuxent River as these two species were not commercially available. All of the aforementioned perennial species were from Maryland ecotypes and two of each species were randomly placed into each mesocosm with the exception of *S. cynosuroides*. The *S. cynosuroides* rhizomes did not successfully generate enough viable plants for more than one of that particular species to be planted per mesocosm.

Mesocosm Operation

After the May 31, 2007 perennial planting event the mesocosms were maintained on a freshwater drip line system, the planted perennials were censused and dead planted perennials were removed and replaced prior to salinity treatment initialization on July 27, 2007. Salinity was altered by creating solutions of reconstituted sea water using Instant Ocean® sea water mix. After salinity treatments began for all reservoirs (except for the two fresh water troughs), final reservoir salinities were gradually ramped up over a period of twelve days. The initial salinity treatment brought reservoir salinity concentrations up to 0.75 ppt initially; followed by increases every other day, to the final levels of 1.5, 3.0, 6.0, 9.0 and 12.0 ppt. For those treatments whose target salinities were less than 12.0 ppt, no further salts were added to the system once the target salinity level was reached, except where necessary to maintain the treatment salinity level. The salinity levels were raised gradually to avoid shocking the plant communities with high salt concentrations. Historic salinity data from the Nanticoke and Patuxent River (Figures 18 and 19) also show that salt concentrations tend to spike in late July and August, so this procedure was employed to mimic field conditions on these two river

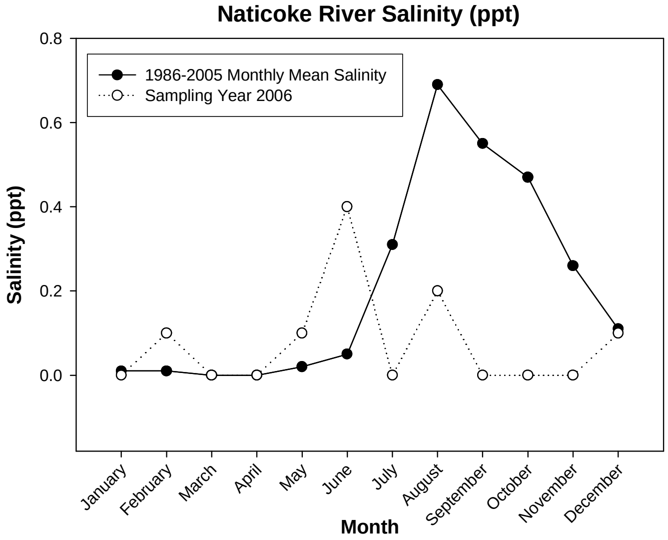

Figure 18. Nanticoke River Salinities Measured at Maryland DNR surface water quality station ET6.1 – Sharpetown, Maryland (near plot N35W) showing the mean monthly salinities measured from 1986-2005 and the mean monthly salinities from the 2006 sampling effort.

systems (Maryland DNR “Eyes On The Bay Program, 2007). Apart from simulating natural salinity increases, this procedure also prevented inhibition of early season germination due to salinity (Odum et al. 1984 and Baldwin et al. 1996)

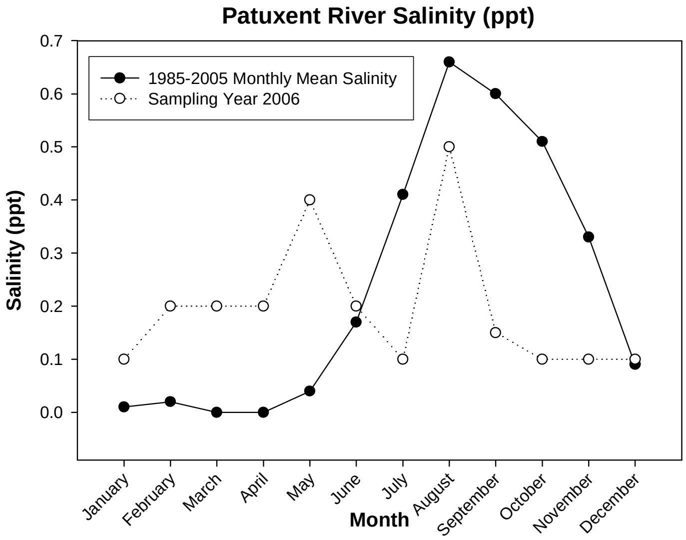

Figure 19. Patuxent River Salinities Measured at Maryland DNR surface water quality station TF1.5 at Nottingham, MD (near plot X30E) showing the mean monthly salinities measured from 1985-2005 and the mean monthly salinities from the 2006 sampling effort.

The mesocosms were operated from the middle of the growing season (July 2007) to the end of July 2008. The salinities in all tanks above 0 ppt were reduced by 50% from 9 October 2007 until 1 May 2008 to simulate the seasonal retreat of the salt front from the fall through early summer. Due to evapo-transpiration losses the water within each mesocosm system was replaced, on average, once per week. Flooding regimes in the mesocosms were maintained 10 cm below the soil surface for 2 weeks so that plants could acclimate, after which water levels were adjusted to their appropriate experimental treatment condition (0cm, +10 cm, and +20 cm). This occurred concurrently with the salinity exposure.

Vegetation and Environmental Measurements

Vegetation in mesocosms was censused non-destructively by using species presence/absence determinations and by estimating percent cover of each plant type using cover class from the North Carolina Vegetative Survey protocol (Peet et al. 1998). This census was performed at the beginning of the salinity/flooding treatments in June 2007, September 2007, and July 2008. The purpose of the initial monitoring was to describe variation in the initial structure of plant communities between mesocosms and track potential treatment effects within and between the mesocosms. Experimental treatment water was also periodically analyzed for salinity, pH, and temperature using YSI portable meters. Treatment water samples were also analyzed periodically for nitrate-nitrogen levels using a portable spectrophotometer (Hach 2000). Study mesocosm soils were also collected dried at room temperature, ground, and analyzed for water soluble-P (USDA 2000), Mehlich-3 extractable aluminum (Al), potassium (K), iron (Fe), calcium (Ca), and phosphorus (P). The purpose of the water and soil chemistry data collection was to identify any potential covariates that might affect the hypothesized outcomes.

At the conclusion of the experiment in July 2008, the aboveground biomass was harvested, separated by species, dried to a constant mass at 70^{o}C, and weighed. The below ground biomass was harvested by using a high pressure water hose and sieve system to separate the roots from the soil matrix. Plant roots were dried to a constant mass at 70^{o}C, and weighed.

Data Analysis

Species richness was calculated using July/September 2007 and July 2008 species count data. Shannon-Wiener diversity values were calculated using the July 2008 data. Above and below ground biomass values were analyzed separately as dependent variables using a two-way analysis of variance (ANOVA) using SAS version 9.1. Additionally, average plant species richness from 2007 and 2008 were analyzed in an ANOVA analysis against salinity and flood frequency independent variables. In instances where no significant block effects were found in the initial ANOVA analysis, the blocking factor was removed and the analysis was rerun to improve statistical power.

The environmental variables such as trough water pH, nitrate-nitrogen, and temperature were analyzed using repeated measures ANOVA analysis (proc mixed procedure) in SAS version 9.1. All soil chemistry data was analyzed using the split-plot ANOVA analysis in SAS described previously.

Non-metric multidimensional scaling (NMS) was also employed as a multivariate analysis tool for determining the relative strength of relationships between vegetation, salinity, and flooding frequency variables. The NMS analysis used a Sorenson (Bray-Curtis) distance measure with a 0.0000001 stability criterion and a maximum of 500 iterations (McCune and Grace 2002). In the NMS analysis plots were identified as Group 1-5 based on the salinity treatment for that set of mesocosms (Group 1 = 0 ppt, Group 2 = 1.5 ppt, Group 3 = 3.00 ppt, Group 4 = 6 ppt, and Group 5 = 12 ppt). NMS analysis was completed using PC-ORD Version 5.0 (MjM Software Design, Gleneden Beach, OR).

Results

Seedbank Observational Study

The results of the seedbank community study showed some significant variation in plant species richness and dominant plants between collection sites. The upper most fresh marsh community (Fresh 2) differed significantly from the brackish marsh seedbank ($p = 0.01$, Tukey adjusted) and there were no significant differences between the fresh and oligohaline seedbanks (Figure 20). As was expected the mixed seedbank, which was an amalgamation of seeds from all four sites, displayed the highest average richness, and was significantly higher than the brackish ($p < 0.01$) and lower fresh marsh site (Fresh 1) ($p < 0.01$). *Eleocharis parvula* and *Pluchea purpurascens* were the most frequently observed plant species from the brackish seedbank ($\overline{x} = 662 \pm 83$ and $\overline{x} = 42 \pm 4$ seeds/sample respectively) and the mixed community seedbank ($\overline{x} = 43 \pm 36$ and $\overline{x} = 12 \pm 1.5$ seeds/sample respectively). A total of 36 species were observed across all seedbank communities (Table 1) average frequencies for most seedbank species ranged from 1 to 20 individuals.

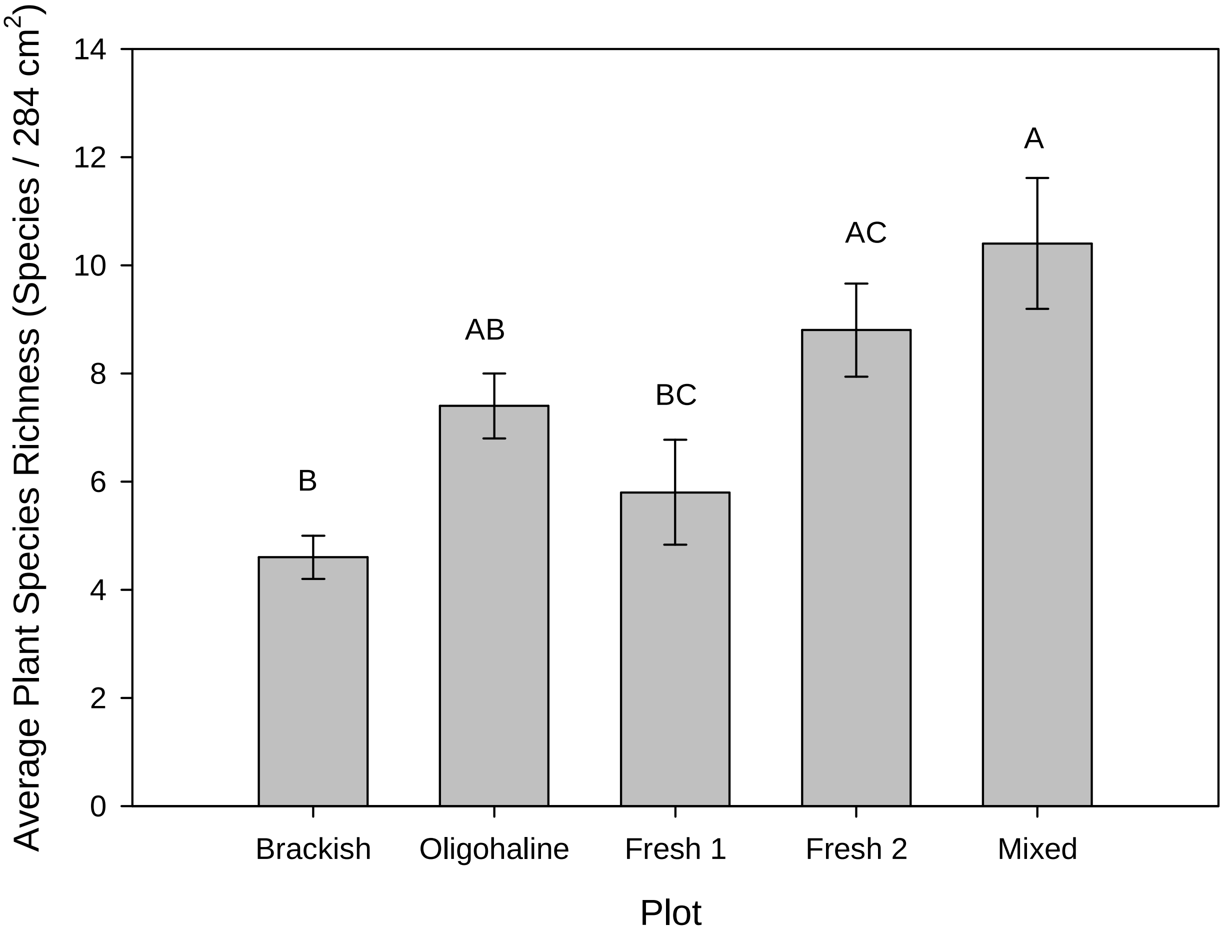

Figure 20. Average plant species richness (± standard error) from seedbanks collected from four locations along the Patuxent River, MD (n = 5). Means that do not share any letters are significantly different (Tukey's HSD, $p < 0.05$).

Table 1. Plant species observed within collected tidal marsh seedbanks along the Patuxent River (values are means, SE is the standard error).

	Fresh 2		**Fresh 1**		**Oligohaline**		**Brackish**		**Mixed**	
Species	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE
Alnus rugosa (du Roi) Spreng.			0.20	0.20						
Amaranthus cannabinus (L.) Sauer	0.60	0.24	0.20	0.20	0.20	0.20			0.60	0.24
Aster puniceus L.	1.60	0.68	0.80	0.37					0.20	0.20
Aster simplex Willd.	1.00	1.00								
Atriplex sp.							0.20	0.20		
Boehmeria cylindrica (L.) Sw.	0.80	0.49	0.60	0.24					0.80	0.37
Cardamine pensylvanica Muhl. Ex Willd.					4.60	2.60	0.60	0.40		
Cinna sp.									0.20	0.20
Cuscuta gronovii Willd. Ex Schult.	0.20	0.20	0.20	0.20						
Cyperus erythrorhizos Muhl.	4.20	0.58	0.20	0.20					2.00	0.32
Cyperus odoratus L.							0.20	0.20		
Cyperus spp.	0.20	0.20	0.20	0.20						
Echinocloa sp.	0.20	0.20					0.20	0.20	0.20	0.20
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer	0.40	0.40	8.60	8.60			662.80	82.58	43.60	36.28
Hibiscus moscheutos L.					0.40	0.24				
Iva frutescens L.							3.00	1.95	0.40	0.24
Juncus effusus L.	0.20	0.20								
Kosteletzkya virginica (L.) Presl			0.20	0.20						
Leersia oryzoides (L.) Sw.	2.40	0.60			5.20	0.80			1.40	0.24
Lobelia cardinalis L.									0.20	0.20
Lythrum salicaria L.					0.80	0.49				
Mentha arvensis L.									0.20	0.20

	Fresh 2		**Fresh 1**		**Oligohaline**		**Brackish**		**Mixed**	
Species	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE	Mean Frequency	SE
Pilea pumila (L.) A. Gray	7.00	1.38	6.20	1.36	0.40	0.24			3.40	1.30
Pluchea purpurascens (Sw.) DC.	0.20	0.20			0.80	0.37	42.20	4.44	12.00	1.58
Polygonum arifolium L.	0.20	0.20			0.20	0.20			0.40	0.24
Polygonum punctatum Elliot					1.40	0.40				
Polygonum sagittatum L.			0.20	0.20						
Sagittaria latifolia Willd.	0.20	0.20								
Schoenplectus fluviatillis (Torr.) M.T. Strong									0.20	0.20
Schoenplectus robustus (Pursh) M.T. Strong							1.00	1.00		
Schoenplectus tabernamontani (C.C. Gmel.) Palla	1.00	1.00	1.40	1.40	2.00	2.00				
Spartina cynosuroides (L.) Roth					0.60	0.40	0.20	0.20	0.80	0.80
Spartina patens (Aiton) Muhl.							4.80	4.55		
Teucrium sp.					0.40	0.40				
Typha angustifolia L.			0.20	0.20						
Typha spp.	0.80	0.37	1.40	0.60	1.40	2.59			2.40	0.93

Mesocosm Study

Data were originally analyzed as a block design, but the block effect was not significant, therefore it was removed from the model. The results of the overall split plot ANOVA supported our initial hypothesis regarding the impact of salinity on plant species richness, specifically that salinity would create significant differences in low versus high salinity treatment mesocosms (Table 3). This is also supported by the clear trend observed in the July 2008 mesocosm richness data that show a clear downward trend in richness between the low-salinity oligohaline mesocosms (1.5 ppt) and the most saline treatment mesocosms (12 ppt) (Figure 21). Flooding frequency and the interaction between flooding frequency and salinity effects were also not significant, which was contrary to our original hypothesis that flooding has a strong influence on tidal marsh plant diversity.

Table 3. Overall Type III Test of Fixed Effects using plant species richness (July 2008) as the response variable and salinity, flooding frequency, and salinity*flooding frequency as independent variables. Richness values are from species counts per mesocosm.

Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Salinity	4	15	6.01	0.0043
Inun (Flooding Frequency)	2	15	1.79	0.2016
Salinity*Inun	8	15	0.54	0.8057

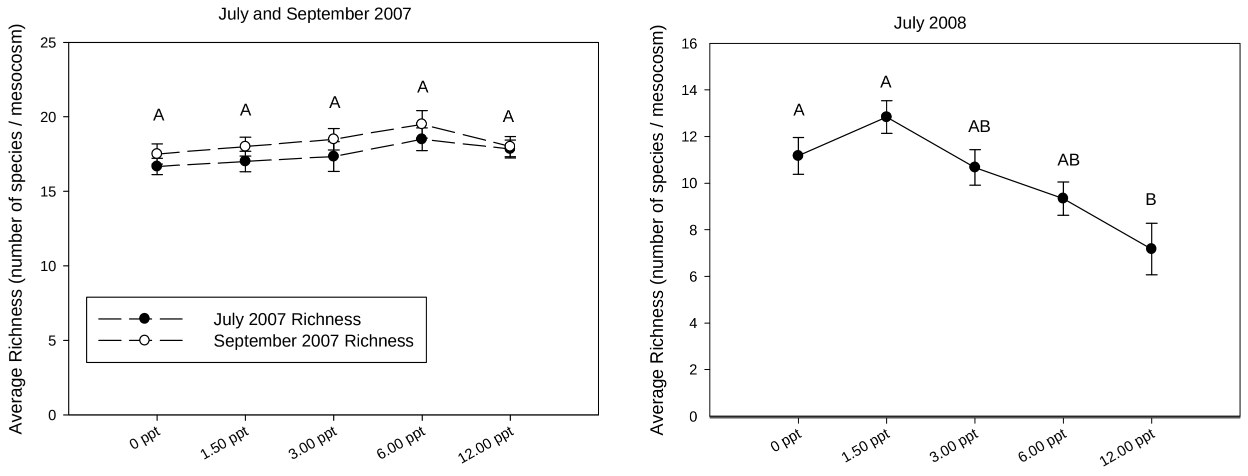

Figure 21. Mesocosm plant species richness during the initial portion of the experiment (2007) and following one entire year of salinity treatments (July 2008). Bars depict mean plant species richness based on salinity treatment group with standard error bars and significant differences depicted. Means with different letters are significantly different with each date (Tukey's HSD, $p < 0.05$). Richness values are from species counts per mesocosm.

These results of the July 2008 richness data differ from the preliminary findings of this study in 2007 which found no significant differences in plant species richness between salinity treatments at either the initial (June 2007) or late growing season (September 2007) plant surveys. Additionally, mean plant species richness within all of the mesocosms showed a marked decline between 2007 and 2008 (Figure 11). This was likely due to little or no influx of seeds from 2007 to 2008 and no cold stratification within the greenhouse environment between growing seasons. However, exposure of seedlings to elevated salinity levels early in the growing season of 2008 produced trends in the low-salinity oligohaline (1.50 ppt) mesocosms similar to those observed along the Nanticoke River in 2006 (see Figures 5 and 6, Chapter 2). The observed trend in the July 2008 data in Figure 11 was also the same as the

Nanticoke River data in that the low-salinity (1.5 ppt) mesocosm community had a average richness values comparable (not significantly different) to the fresh marsh community. As in Chapter 2 this difference was not significant at the 0.05 level. Additionally, average Shannon-Wiener indices of plant species diversity across all salinity treatments yielded no significant differences (Figure 22).

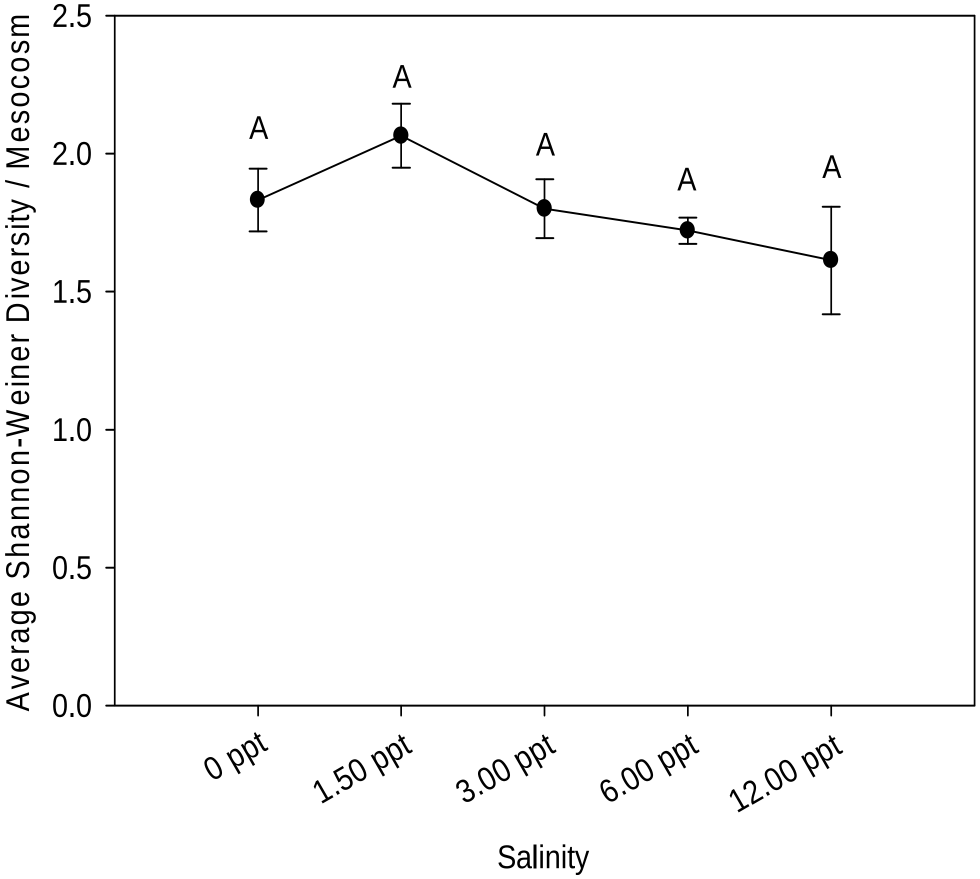

Figure 22. Average Shannon-Wiener Diversity (± SE) based on the July 2008 biomass data. Means with different letters are significantly different (Tukey's HSD, $p < 0.05$)

No significant differences with regards to plant species richness were observed between flooding frequency treatments (Figure 23).

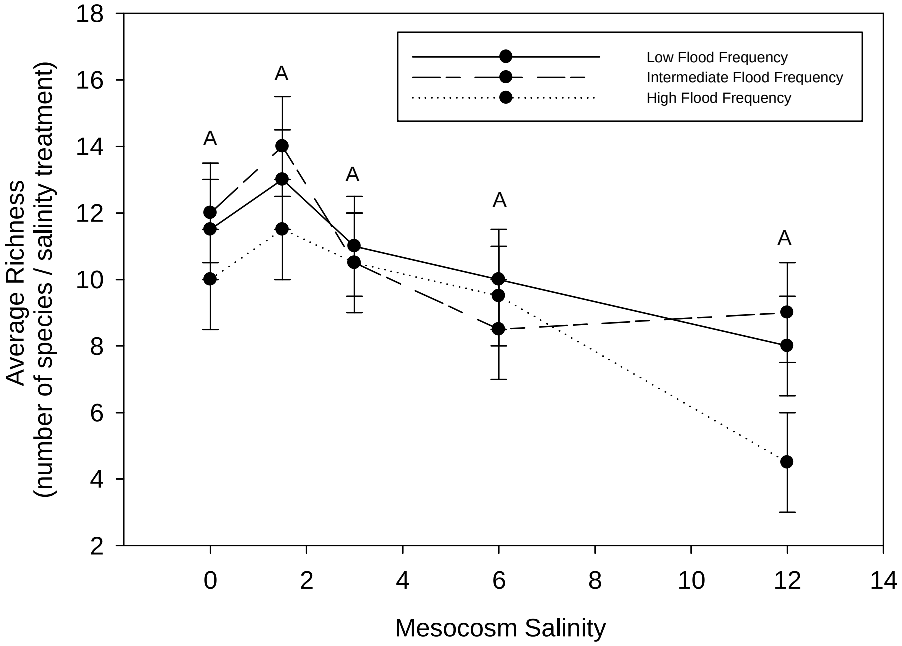

Figure 23 Average mesocosm plant species richness values based on the July 2008 biomass data and separated out by flood frequency to show potential interactions and trends. Means with different letters are significantly different (Tukey's HSD, p <0.05)

Several species of plants did not regerminate and grow between the 2007 and 2008 sampling years, some of these species included *Apios americana, Bidens laevis, Cyperus esculentus,* and *Zizania aquatica* (Table 3). Additionally, species such as *Amaranthus cannabinus,* which was a dominant plant throughout many of the marsh mesocosms in 2007 based on aerial cover ($\bar{x}$ = 45 - 35% from 29 mesocosms), was present for final sampling in July 2008, but had a much lower presence and cover value ($\bar{x}$ = 15% from 5 mesocosms). Species such as *Iva Frutescens, Rumex* sp., and *Samolus parviflorus* were not observed in 2007 but volunteered in 2008. Of the plant species observed in the mesocosms in September 2007 80% (31 species) of them grew from the seed bank of the mesocosms, with the remaining 20% (8 species) being species which I planted randomly within each mesocosm. The July 2008 plant species list shows a 75% recruitment of plant species from the seedbank (24 species), there was also a slight drop in the total number of species between September 2007 (39 species) and July 2008 (32 species), as well as a minor drop in total cover following treatments (Table 4).

Table 4. Mesocosm mean plant species cover and standard errors for June and September 2007, and July 2008. Mean species cover was averaged across all 30 mesocosms.

Species	**Mean Cover June 2007**	**Mean Cover September 2007**	**Mean Cover July 2008**
Acorus calamus L.	1.76 +/- 0.21	3.65 +/- 0.79	1.63 +/- 0.43
Amaranthus cannabinus L.	44.82 +/- 4.32	35.36 +/- 3.63	16.88 +/- 3.71
Apios americana Medic.	1.5 +/- 0.00		
Aster puniceus L.	0.5 +/- 0.00	3 +/- 0.46	9.9 +/- 1.30
Atriplex sp.			
Bidens laevis L.	17.5 +/- 0.00	29.17 +/- 5.35	
Bidens sp.		0.50 +/- 0.00	
Bidens coronata (L.) Britt.	24.17 +/- 2.11		
Boehmeria cylindrica (L.) Sw.	0.50 +/- 0.00	3 +/- 0.55	8.83 +/- 1.48
Cinna sp.		0.5 +/- 0.00	1.17 +/- 0.11
Cuscuta gronovii Willd.	2.93 +/- 1.48	3.21 +/- 0.48	
Cyperus sp.		1.83 +/- 0.28	
Cyperus strigosus L.		1.5 +/- 0.00	13.11 +/- 2.59
Cyperus esculentus L.	0.5 +/- 0.00	1.83 +/- 0.28	
Cyperus filicinus Vahl		1.5 +/- 0.00	
Decodon verticillatus (L.) Ell.		0.5 +/- 0.00	
Distichlis spicata (L.) Greene	7.5 +/- 0.00	2.27 +/- 0.69	4.07 +/- 1.36
Echinochloa muricata (Pursh) Nash			9.43 +/- 2.80
Echinochloa walteri (Pursh) Nash	17.39 +/- 2.40	28.77 +/- 3.75	
Eleocharis parvula (R.&S.) Link			1.8 +/- 0.44
Galium tinctorium L.	0.5 +/- 0.00	0.75 +/- 0.09	2 +/- 0.39
Galium palustre L.	0.5 +/- 0.00	0.5 +/- 0.00	
Hibiscus moscheutos L.		7.5 +/- 0.00	
Hibiscus sp.	2 +/- 0.39	5.5 +/- 0.52	
Impatiens capensis Meerb.	7.5 +/- 0.00		
Iva frutescens L.			1.5 +/- 0.00
Juncus effusus L.			0.5 +/- 0.00
Juncus sp.		0.5 +/- 0.00	
Kosteletzkya virginica (L.) Presl		1.5 +/- 0.00	13.5 +/- 1.15
Leersia oryzoides (L.) Sw.	16.03 +/- 0.70	28.2 +/- 3.15	26.99 +/- 4.50

Lythrum salicaria L.	0.5 +/- 0.00	3.5 +/- 0.00	8.5 +/- 1.21
Mikania scandens (L.) Willd.	0.74 +/- 0.14	19.07 +/- 2.06	40.85 +/- 4.55
Murdannia keisak (Hasskarl) Hand.-Mazz	0.5 +/- 0.00	2.5 +/- 0.51	2.15 +/- 0.47
Nasturtium offiicinale R. Br.	7.3 +/- 1.03		
Peltandra virginica (L.) Schott & Endl.	1.86 +/- 0.82	1.33 +/- 0.21	0.23 +/- 0.04
Phragmites australis (Gav.) Trin.	3.1 +/- 0.67	9.35 +/- 1.43	27.47 +/- 3.10
Pilea pumila (L.) Gray	28.05 +/- 2.65	16.95 +/- 2.24	0.55 +/- 0.12
Pluchea purpurascens (Sw.) DC.	33.5 +/- 2.72	8.73 +/- 1.16	14.69 +/- 3,14
Poaceae sp.			7.5 +/- 0.00
Polygonum arifolium L.	41.39 +/- 3.70	19.75 +/- 2.80	0.5 +/- 0.00
Polygonum punctatum Ell.	16.34 +/- 2.00	18.83 +/- 2.25	
Polygonum sagittatum L.	5.23 +/- 0.73	4.5 +/- 0.37	
Polygonum sp.	7.5 +/- 0.00		
Rorippa islandica (Oeder) Borbas	0.5 +/- 0.00	0.5 +/- 0.00	
Rumex sp.			8.17 +/- 1.48
Samolus parviflorus Raf.			8.42 +/- 1.53
Schoenplectus sp.	0.5 +/- 0.00		3.13 +/- 0.59
Senecio sp.	0.5 +/- 0.00		
Sonchus sp.	17.5 +/- 0.00		
Spartina alterniflora Loisel.	7.5 +/- 0.00	2.23 +/- 0.65	0.06 +/- 0.05
Spartina cynosuroides (L.) Roth	1.3 +/- 0.26	2.5 +/- 0.38	5.05 +/- 0.90
Spartina patens (Ait.) Muhl.	7.5 +/- 0.00	6.3 +/- 1.04	19.75 +/- 4.00
Typha angustifolia L.	0.5 +/- 0.00	0.68 +/- 0.07	1.34 +/- 0.37
Zizania aquatica L.	12.5 +/- 1.29	7.5 +/- 0.00	
Unidentified Dicot		0.5 +/- 0.00	0.1 +/- 0.00
Unidentified Dicot 2			0.1 +/- 0.00
Total Species Count	**37**	**39**	**32**
Total Cover	**339.91**	**285.77**	**259.84**

Not only were there observed changes in individual plant species occurrence and abundance between 2007 and 2008, but there was also a strong shift in the plant species communities themselves in response to the salinity treatments. Figure 24 shows an NMS graph of the mesocosm species biomass from July 2008 relative to salinity and flooding. Clear patterns in the plant communities shown by distinct clustering of mesocosms arranged by salinity treatment can be readily observed. These results suggest that over the course of the 2007-2008 year the plant communities began to shift in response to the treatments, with fresh water marsh species dominating in low-

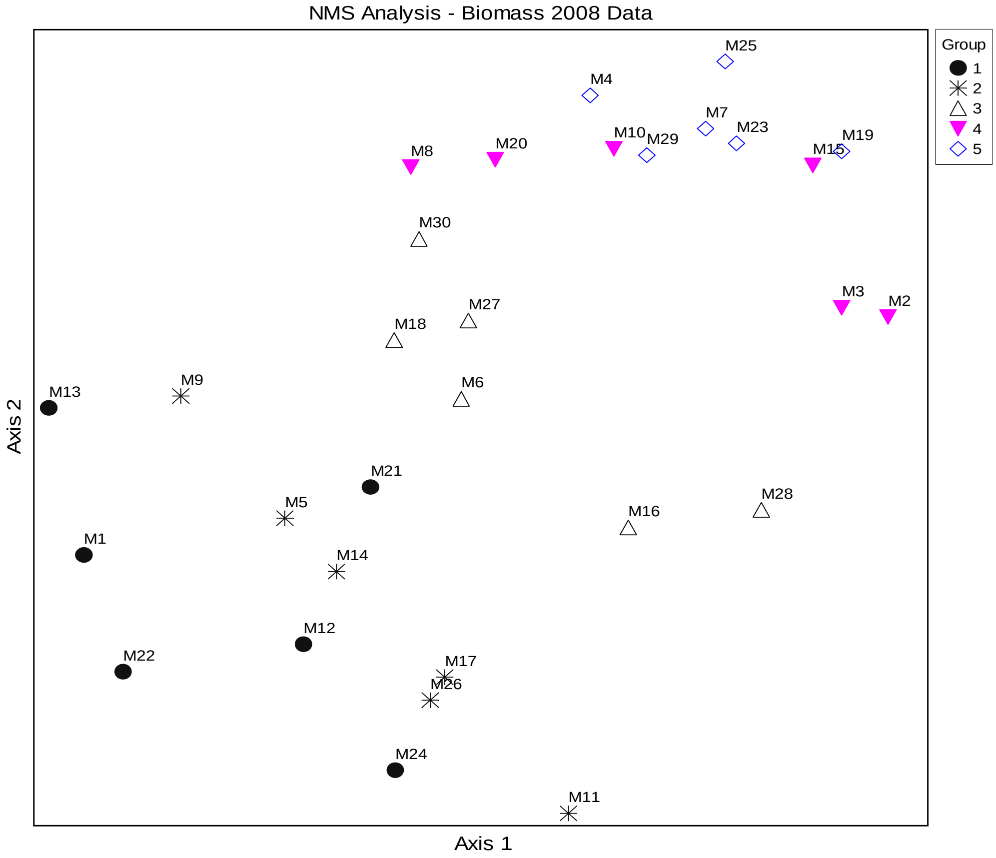

Figure 24. NMS two dimensional graph showing the mesocosm biomass data, individual points are mesocosms from the final harvest in July 2008. The groups are arranged by salinity treatment with Group 1 = 0 ppt, Group 2 = 1.5 ppt, Group 3 = 3 ppt, Group 4 = 6 ppt, and Group 5 = 12 ppt. Points are individual mesocosms.

salinity ranges and salt tolerant species dominating in the high salinity mesocosms. This outcome supports the hypothesis of plant community shifts in response to the salinity treatments. Differences in the above ground biomass of the ten most abundant plant species based on biomass and frequency of occurrence within study mesocosms also varied as a function of salinity. Brackish marsh species such as *Distichlis spicata* and ranging from 6-12 ppt in 2008. Fresh marsh plant species such as *Mikania scandens*, *Cyperus* sp.1, and *Leersia oryzoides* displayed higher biomass in the low-salinity ranges of the experiment (0-1.5 ppt) and a general decline in biomass as salinity increased. *Phragmites australis* and *Spartina cynosuroides*, two species common in oligohaline-brackish marshes along the Patuxent and Nanticoke Rivers, showed no pattern of biomass differences across the salinity range (0-12 ppt) (Figure 15).*Spartina patens* had higher average biomass in mesocosms exposed to salinity treatments ranging from 6-12 ppt in 2008. Fresh marsh plant species such as *Mikania scandens, Cyperus* sp.1, and *Leersia oryzoides* displayed higher biomass in the low-salinity ranges of the experiment (0-1.5 ppt) and a general decline in biomass as salinity increased.

Phragmites australis and *Spartina cynosuroides*, two species common in oligohaline-brackish marshes along the Patuxent and Nanticoke Rivers, showed no pattern of biomass differences across the salinity range (0-12 ppt) (Figure 25). *Pluchea purpurascens and Kosteletzkya virginica,* two species also found in oligohaline-mesohaline marshes showed distinct peaks at 3 and 6 ppt respectively. As the graphs in Figure 25 only show the average plant biomass/salinity treatment, it’s possible that at extreme fresh water and salt water conditions the combination of salinity and flooding frequency at one end, versus competition and flooding at the other imparted restrictions on these species distributions and caused their peak biomass to occur near the middle of the salinity range.

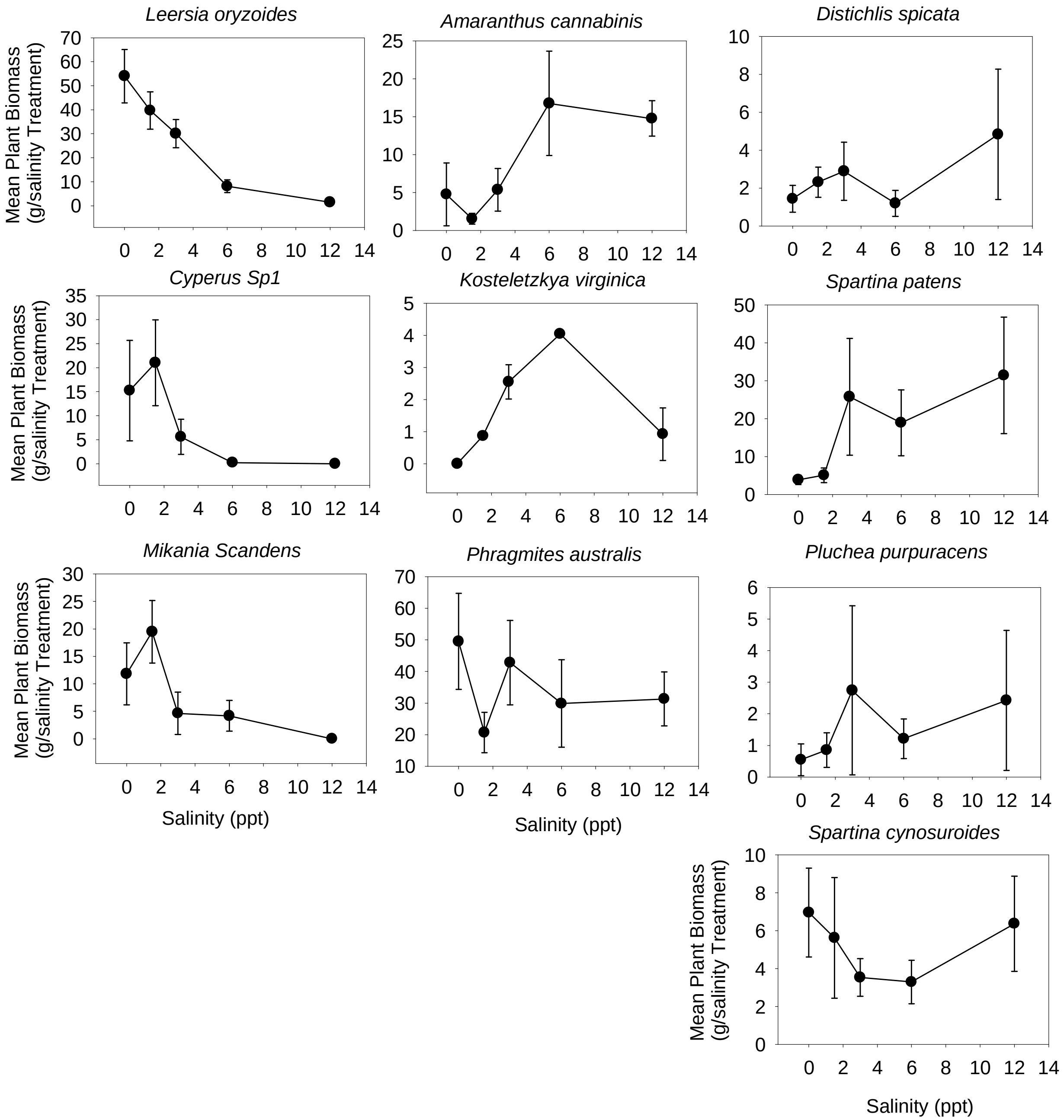

Figure 25. Graphs showing the above ground biomass (g/salinity treatment) of the ten most abundant plant species from the July 2008 biomass data from all 30 mesocosms. Individual points represent mean species biomass per salinity treatment ± SE.

Mesocosm Chemistry

No significant differences in the water soluble-P or in water nitrate-nitrogen levels were observed between treatment groups. Significant differences in average Mehlich-3 extractable magnesium, potassium, and calcium levels were observed with the high salinity mesocosms (12 ppt) having higher magnesium and potassium concentrations in the soil compared to the 0 ppt and 1.5 ppt mesocosms. Mean calcium levels were significantly higher in the purely fresh water (0 ppt) mesocosms compared to the higher salinity level treatments which was likely due to calcium precipitating out in the high salinity mesocosms as $CaSO_4$. These elemental differences were not unexpected as the Instant Ocean mix contains these micronutrients and was added to the water supply of all the salt treated tanks. There were no significant differences in average mesocosm porewater pH which ranged from 6.08 to 6.97. A significant overall difference ($p = 0.0002$, $F_{9,306}=3.69$) was observed between trough water temperatures (Figure 26).

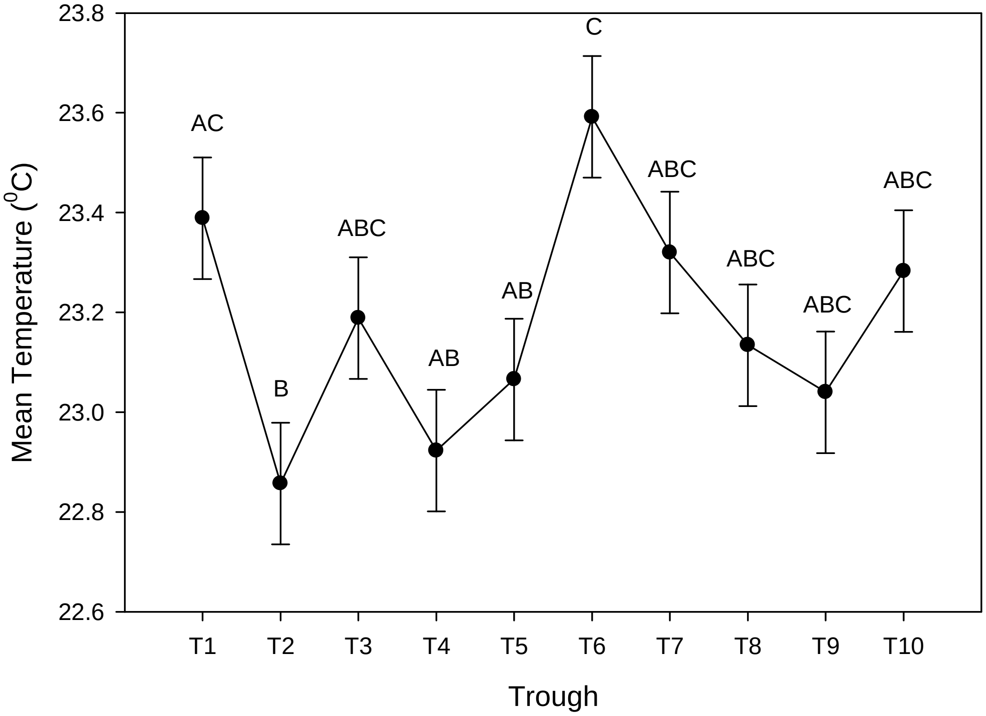

Figure 26. Average trough water temperatures measured at 35 different times over the course of the experiment (2007-2008). Means which share a letter are not significant at the 0.05 level.

Though these data show significant differences between some of the experimental trough water temperatures, it’s unlikely that these differences are significant at a biological level as the difference between the highest mean temperatures (Trough 6 – 23.59 ^{0}C) and the lowest mean temperatures (Trough 2 – 22.85^{0}C) was less than 1^{0}C during the growing season.

Biomass

My initial hypothesis was that above and below ground plant biomass would be significantly higher in the marsh mesocosms subjected to lower salinity and flood frequency disturbances. The results of the ANOVA analysis found no significant differences in mean above ground biomass across salinity and flood frequency treatment levels for the study mesocosms at the 0.05 level (Figure 27). These results coupled with the NMS output (Figure 24) and individual species biomass graphs (Figure 25) suggest that as some species are eliminated with increasing salinity they are replaced by salt tolerant species

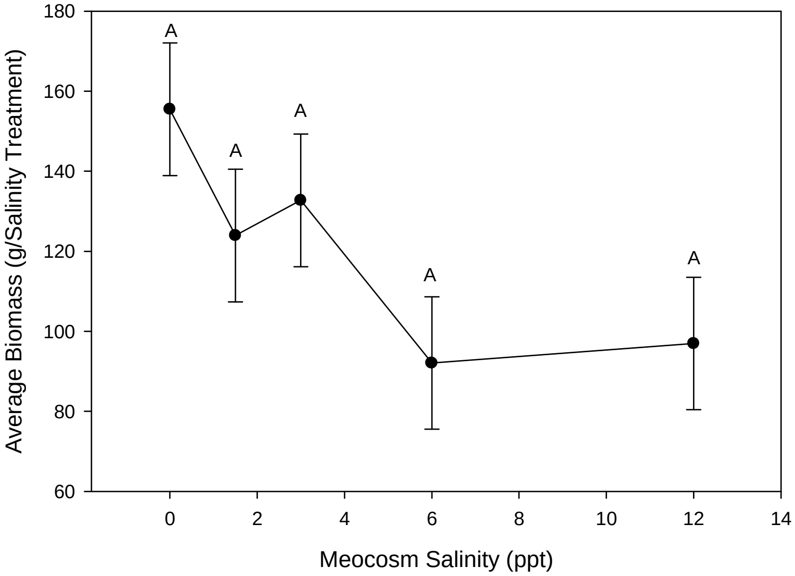

Figure 27. Mean above ground biomass versus salinity for the five salinity groups. Different letters designate significant differences values are salinity group means (n=6) ± SE.

(assuming seed or propagule material is available). This replacement of species helps offset the loss of biomass in the marsh mesocosms. Mean above ground biomass among salinity treatments separated out by flooding frequency shown in Figure 28 also show no significant differences between salinity treatments.

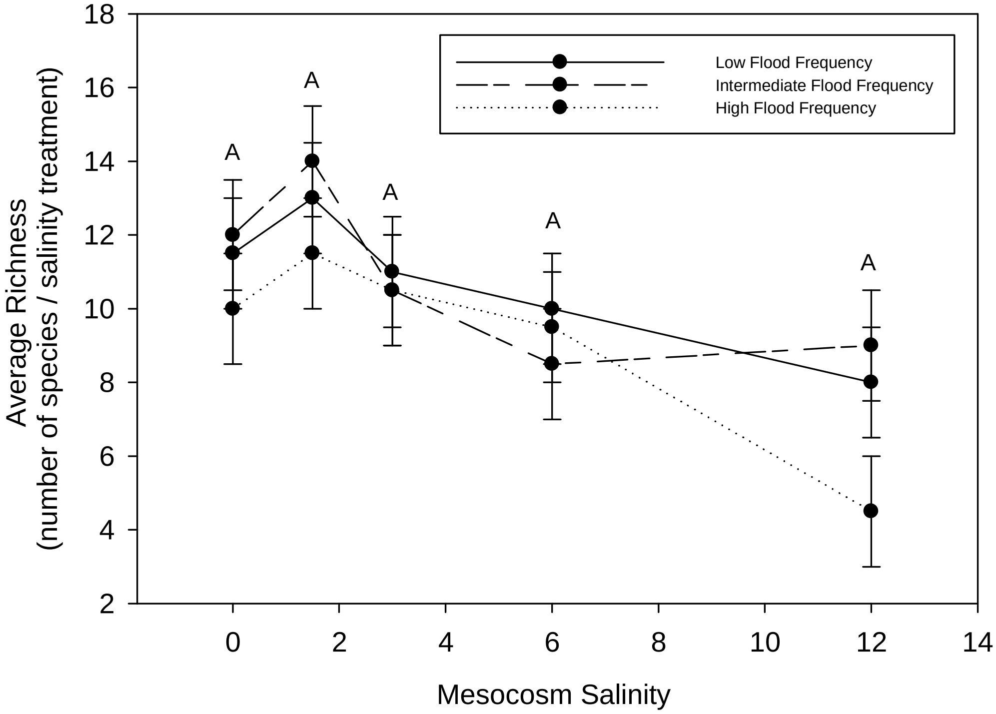

Figure 28. Mean above ground biomass versus salinity group for the three flooding treatments using July 2008 mesocosm biomass data.

Mean below ground biomass (July 2008) versus salinity treatment for the three flooding treatments displayed no significant statistical differences between these means that is consistent with the above ground biomass data in Figure 27 and suggests that the more saline tolerant species were able to minimize the impacts of increased salinity and flood frequency on the marsh mesocosms.

Discussion

Considerable research has been conducted on how salt and brackish marshes will respond to sea-level rise (Mitsch and Gosselink 2000; Morris et al. 2002; Turner et al. 2004). Much of this research has focused on the ability of salt marshes to accrete vertically at sufficient rates to keep pace with sea-level rise and the role of macrophytes in marsh stability or loss (Kearney et al. 1994; Roman et al. 1997; Day et al. 1999), or on the responses of marsh vegetation to increases in salinity and water level or soil waterlogging (Mendelssohn et al. 1981; Pezeshki et al. 1993; Broome et al. 1995; Naidoo et al. 1997; Gough and Grace 1998). These and other studies have demonstrated the importance of mineral sediment and organic matter deposition, which are critical to maintaining elevation (Reed 1995), and tolerance of marsh vegetation to increases in salinity and water logging (Kozlowski 1997). In general, growth and survival of salt and brackish marsh vegetation is reduced by increases in soil waterlogging, such as those that may occur due to sea-level rise (e.g., Webb et al. 1995; Mendelssohn and Batzer 2006). Loss of salt and brackish marshes in areas such as the Mississippi River delta plain (Louisiana) and the Chesapeake Bay is believed to primarily be the result of an inability of marsh elevation to keep up with relative sea level, which increases soil waterlogging and anoxia, stressing or killing salt marsh plants (Stevenson et al. 1985; Boesch et al. 1994).

In contrast to salt and brackish marshes, responses of tidal low-salinity marshes to sea-level rise have received little attention, with the exception of those in the Louisiana delta plain. Research in Louisiana has shown that increases in salinity, as well as soil waterlogging, due to high rates of relative sea-level rise result in vegetation dieback and wetland loss (McKee and Mendelssohn 1989; Boesch et al. 1994; Flynn et al. 1995; Webb and Mendelssohn 1996). These findings suggest that low-salinity marshes in other estuaries are similarly sensitive to increases in both relative water level and salinity. In the Chesapeake Bay, Kearney et al. (1988) found that marsh losses in the Nanticoke River estuary since the 1920s had occurred primarily in the lower portions of the estuary; tidal freshwater marshes remained relatively stable, probably because they occur in the sediment-trapping portion of the estuary. However, it is likely that as sea level rates continue to accelerate, the salt wedge and the zone of major sediment deposition will move farther upstream (Meade 1972; Officer 1981), resulting in vegetation dieback or conversion to salt-tolerant species.

The overall goal of this research was to understand how changes in salinity and water level influenced diversity and ecosystem function of tidal marsh communities grown in a controlled greenhouse environment. My preliminary research hypothesis was that marsh mesocosms subjected to increased salinities and flood frequencies would display diminished plant species richness, diversity, and productivity with an associated shift to fresh marsh plants at low salinities and brackish marsh plants at the high end of the spectrum. Additionally, I was curious as to whether or not average plant species richness would be highest in mesocosms subjected to low oligohaline (0.75-1.50 ppt) salinity conditions similar to the pattern observed in the Nanticoke River (Chapter 2).

Salinity and Tidal Marsh Plant Species Richness

The preliminary species richness and plant community data collected in June and September 2007 showed no significant differences based on the main effects of salinity and flood frequency. Additionally no significant shifts in the plant communities from the initial mixtures were observed between June and September 2007. The results in 2007 were contrary to my research hypothesis, however, this was likely due to salinity and flooding treatments not being initiated until July of 2007 which allowed the plants to establish themselves and grow undisturbed for three months prior to treatment. Changes to the salinity and flooding regimes within the mesocosms are likely to have less of an effect on vegetation that has already become established and thus more resistant to environmental perturbation.

Plant species community data from the second year (2008) following seedling exposure to salinity and flooding treatments yielded results more consistent with my research hypothesis. However while average plant species richness was highest in the low-salinity oligohaline marsh mesocosms (0.75 – 1.50 ppt), it was not significantly different than purely fresh marsh mesocosms. This finding supports the results from Chapter 2 regarding the similarity in pattern between the low salinity mesocosms in the experiment and my observed findings from the Nanticoke River in 2006. It would appear from my observations and this experiment that plant species richness/diversity along some estuarine systems can be more accurately described by a sigmoidal response to salinity rather than a simple linear relationship.

Ecological modeling determined that salinity and inundation frequency were more important overall than the MDE (Chapter 3). Therefore, I hypothesized that the observed pattern in plant species richness was the result of periodic salt water intrusions into low-salinity marshes, which suppressed the more competitively dominant fresh marsh plants, and allowed the salt tolerant species to survive and grow promoting high plant species richness/diversity. The results of this experiment which removes the influence of the MDE by mixing all short and large range species together, support this hypothesis and suggest that low-salinity oligohaline marshes may have plant species richness and diversity values equal to or sometimes even higher than purely tidal fresh water marshes. These findings lend further support to the theory of a more complex pattern of plant species richness along estuarine gradients which is contrary to the general trend of decreasing richness with increasing salinity noted widely elsewhere (Anderson et al. 1968, Odum 1988, Mitsch and Gosselink 2000, Greenberg et al. 2006).

Elevated Flooding and Salinity Effects on Tidal Low-Salinity Marshes

This research suggests that tidal marsh plant communities continuously exposed to salinities as high as 12 ppt with a concurrent increase in flooding frequency midway through the growing season are somewhat resilient to perturbation, provided the plant community is well established prior to disturbance. However, continued exposure to elevated salinity and flooding frequencies (particularly early in the growing season) caused a shift in the plant community types from more fresh-marsh plants to more brackish-marsh plants. Based on direct observation and statistical analysis of the harvested biomass it appears that the plant communities were able to convert to more mesohaline systems without a significant diminishment in biomass, provided that a source of seed/propagules of salt/flood tolerant species were available.

Implications

These findings suggest that low-salinity tidal marshes subjected to increases in flooding and salinity can maintain vegetation albeit with reduced plant biomass (at least initially), provided that they have a diverse enough assemblage of salt and flood-tolerant species in the seedbank or as available rhizome material. One plant species that seemed particularly adept at surviving and growing under our range of salinity and flooding treatments was *Phragmites australis*. In general this plant did not show a significant diminishment in biomass across the salinity range, except under extreme flooding and salinity treatments. Given that *Phragmites australis* is a C3 plant, can propagate from seed or rhizome material, and can tolerate high flooding and salinity conditions it is already well adapted for marsh growth under elevated atmospheric carbon dioxide, salinity, and flooding conditions. Additionally, despite many efforts to remove or limit this plant species from tidal marshes within Chesapeake Bay, it still remains prevalent throughout much of the Bay ecosystem. I suggest that natural resource managers and agencies interested in restoring and protecting tidal marsh ecosystems without using invasive plants such as *Phragmites australis* focus on selecting species with similar physiological traits, as current climate model trends in Chesapeake Bay suggest an increase in salt intrusions into estuarine river systems and continual increases in relative sea-level rise (Hayhoe et al. 2007, Pyke et al. 2008).

As tidal marshes face increasing threat from anthropogenic forces, sea-level rise, and invasive plant species, understanding the principal mechanisms affecting species richness has become increasingly important. Resource managers intent on maintaining tidal marsh plant species diversity with the goal of providing ecosystem services such as high habitat diversity for wildlife should focus their efforts on low-salinity oligohaline marshes as well as on tidal freshwater systems. Invasive species such as *Phragmites australis*, though viewed by many in the natural resource community as undesirable, may be able to offer insights regarding plant selection and management of restored tidal marsh ecosystems. My hope is that this research can be utilized to predict tidal marsh community changes over time and develop additional controlled experiments examining plant community responses to altered physical and biotic conditions, such as those caused by global climate changes.

Chapter 5: Synthesis and Conclusions of Research

This research program sought to examine the existing (observed) patterns in tidal marsh plant species diversity along estuarine river systems in Chesapeake Bay (Chapter 2). The outcomes of those observations were tested against Mid-Domain Effect (MDE) predictions of plant species richness along those same gradients to determine the importance of abiotic factors versus MDE modeled outcomes (Chapter 3). In essence I sought to identify the appropriate null expectation of plant species richness patterns and examine the possibility that observed patterns of plant species richness could be explained by an underlying Mid-Domain Effect which functions independently of environmental factors such as soil salinity, flooding duration, and competition. Lastly, through a controlled greenhouse experiment subjecting synthetic marsh mesocosm communities to varied salinity and flood durations I sought to quantify the importance of those abiotic factors on plant community composition and richness/diversity in the absence of the MDE (Chapter 4). The mesocosm greenhouse experiment also sought to quantity the impacts of increased salinity and flooding on low-salinity marshes under increased flooding and salinity conditions.

Research Questions and Hypotheses

Through these efforts I attempted to answer the following research questions:

1. Are tidal marsh plant species richness patterns along estuarine river gradients more complex than a simple linear relationship?

2. What are the key factors influencing observed plant species richness patterns along the Nanticoke and Patuxent Rivers?

3. What is the relative importance of non-environmental factors (i.e. MDE) in shaping observed patterns of plant species richness in estuarine systems like the Nanticoke and Patuxent Rivers?

4. How would high diversity, low salinity marshes respond to elevated salinity and flooding frequencies and would they shift in response if seeds/propagules were available?

5. Could the observed patterns of plant species richness observed from the Nanticoke and Patuxent Rivers be duplicated under controlled conditions manipulating salinity and flood frequency?

This research utilized a combination of field observational study, computer modeling, and controlled experimentation in order to answer my research questions. The principal research hypotheses for each phase (chapter) of this research are summarized below:

*Primary Research Hypothesis 1***:** The pattern of observed plant species richness for both river systems will follow a non-linear relationship with increasing salinity.

*Primary Research Hypothesis 2***:** The observed patterns of plant species richness observed on the Nanticoke and Patuxent Rivers will be accurately predicted by the MDE model independent of measured abiotic factors.

*Primary Research Hypothesis 3***:** Marsh mesocosms subjected to intermediate salinity and flooding frequencies will exhibit significantly higher biomass and plant species richness compared to mesocosms subjected to extreme salt/fresh and flooding regimes.

Synthesis and Conclusions

The results of the observational study of the plant species richness patterns along the Nanticoke and Patuxent Rivers in 2006 showed a clear non-linear pattern in richness for the Nanticoke River and a general linear pattern of richness for the Patuxent River. Two questions arose following the completion of this portion of the study. Firstly, what were the key mechanisms affecting plant species richness along the

Nanticoke and Patuxent Rivers, and second, why did I not observe the same pattern of plant species richness along the Patuxent River?

I theorized that the principal environmental mechanisms behind the observed patterns of plant species richness included salinity, anthropogenic disturbance, and possibly the Mid-Domain Effect (MDE). Salinity is a known plant stressor, causing reduced growth and competitive ability of freshwater plants, or alternatively as a disturbance when it occurs in pulses that kill freshwater plants. Thus, dry conditions in either the Nanticoke or Patuxent Rivers may promote coexistence of salt-tolerant and salt-intolerant species in fresh-brackish transition zone marshes (i.e. low-salinity oligohaline marshes). Simply stated, periodic salinity pulses reduce the competitive advantage of freshwater plant species allowing for less competitive salt tolerant plants to survive and grow. However, the contrasting linear pattern of richness on the Patuxent River was more difficult to explain. Given that there was a significantly higher instance of urban land use within the watershed and direct evidence of historic and current human induced disturbances to some of the marsh lands along the Patuxent River, it seemed likely that the non-linear pattern of plant species richness observed across the relatively undisturbed Nanticoke River may represent the true normal pattern of plant species richness.

Another alternative explanation behind the patterns observed in both estuarine river systems was MDE. The MDE model was run using plant species occurrence and range data from both rivers against a range of environmental variables including salinity and flood frequency. The MDE model was not as strong of an individual predictor of plant species richness compared to soil salinity, flooding frequency, and nitrate-nitrogen when all plant species were included in the analysis. However, MDE theory was a strong predictor of plant species richness when only large-range species were included, suggesting that there is a possibility of an underlying Mid-Domain Effect along these gradients independent of environmental factors and anthropogenic influences.

Interestingly, the MDE model accurately predicted the general location of the peak area of plant species richness along the Nanticoke River and predicted a similar peak in the low salinity regions of the Patuxent River. The Patuxent River marsh at the MDE predicted peak location was dominated by a monotypic stand of *Phragmites australis* likely caused by ferry construction and operation at this location in the late 1800s. As a practical application for this model, resource managers and environmental agencies looking to restore marsh land in areas likely to promote high plant diversity could utilize the MDE model as a tool for identifying candidate sites along these types of gradients.

Knowing that salinity and flood frequency are two of the dominant environmental factors affecting plant species richness along estuarine gradients and most likely too significantly change due to global and regional climate changes, I developed a controlled greenhouse experiment. The experimental units were marsh mesocosms constructed from seedbank material collected from fresh, oligohaline, and brackish marsh sites, and included planted perennials representative of these habitats as well. The overlap of large-range and short-range plant species eliminated the possibly of an MDE and the mixture of species allowed for potential plant community shifts from low to high salinity plant species following implementation of salinity treatments. The data showed an overall treatment effect of salinity on plant species richness, with low salinity (0 ppt and 1.5 ppt) having significantly higher richness than the 12 ppt treatments. The pattern of plant species richness observed in the mesocosm experiment seemed to approximate the sigmoidal pattern observed on the Nanticoke River in 2006 (Chapter 2). Mean plant species richness in the low salinity oligohaline treatments was not significantly different from the 0 ppt control group. These results did not support my hypothesis of highest plant species richness in the intermediate salinity treatment group, but did lend quantitative support to my hypothesis of a non-linear pattern in plant species richness with increasing salinity in Chapter 2.

Peak standing crop (g/mesocosm) was not significantly different across salinity or flood frequency treatments. However, the NMS analysis and individual species graphs displayed a clear separation of the mesocosms into distinct communities, the shift from fresh to brackish plant conditions allowed for the above and below ground biomass to remain similar. This work shows that if sources of saline/flood tolerant plant propagules are available in natural systems a shift to a more saline and/or flood tolerant plant communities will emerge, however, this shift may come at a loss of total biomass (at least initially) and thus adversely affect marsh productivity.

The implications for of this research are four-fold. First, the null expectation of a linear reduction in plant species richness with increasing salinity in estuarine rivers of Chesapeake Bay is more complex than originally assumed. Second, the non-linear pattern of richness observed on the Nanticoke River was primarily explained by salinity and flooding frequency, however, there was also an underlying MDE which did explain some of the observed pattern (particularly for large ranged species). Therefore when assessing the mechanisms driving plant species richness patterns along relatively undisturbed estuarine gradients one should consider the MDE as a potential factor. Third, though the MDE was not a strong a predictor of the plant species richness patterns along either river system compared to other environmental variables, the model was able to identify areas along both gradients where plant richness was expected to peak based on the empirical data input into the model. The MDE model could be used as a tool for identifying locations along similar estuarine gradients where the goal is to restore tidal marshes for maximum plant species richness/diversity. Lastly, tidal low salinity marshes are likely to see a shift in their plant communities from salt-intolerant to salt-tolerant species, assuming that the marshes can accrete at a rate equal to or greater than current sea level rise scenarios, but with a reduction in total biomass. Species of plants such as *Phragmites australis* deemed by many in the natural resource community as a nuisance species responded well to increases in both salinity and flooding frequencies, suggesting that they are pre-adapted for these climate change effects. If Chesapeake Bay continues to experience climate change impacts such as sea level rise and alterations to the timing and intensity of salt intrusions into estuarine rivers, then restoration ecologists and resource managers should consider including species with similar physiological traits such as *Spartina cynosuroides* in their restoration strategies.

Appendices

Appendix A. Raw Chemistry and Richness Data, Nanticoke and Patuxent Rivers

Patuxent River

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/25/2006	AX00W	Mean Soil Salinity (ppt)	4	3.7	4.3	7.3
6/12/2006	AX00W	Mean Soil Salinity (ppt)	9.9	9.6	10.2	11.9
8/25/2006	AX00W	River Salinity (ppt)	7.3			
6/12/2006	AX00W	River Salinity (ppt)	11.9			
8/25/2006	AX00W	Mean Specific Conductance (µS)	7095	6.4	7.79	
6/12/2006	AX00W	Mean Specific Conductance (µS)	16870	16.37	17.37	
8/25/2006	AX00W	Mean Raw Conductivity (µS)	6995	6.32	7.67	
6/12/2006	AX00W	Mean Raw Conductivity (µS)	14915	14.41	15.42	
8/25/2006	AX00W	Mean Temperature C	24.5	24.6	24.4	
6/12/2006	AX00W	Mean Temperature C	18.85	18.8	18.9	
8/25/2006	AX00W	River Specific Conductance (µS)	12780			
6/12/2006	AX00W	River Specific Conductance (µS)	19880			
8/25/2006	AX00W	River Conductivity Raw (µS)	14220			
6/12/2006	AX00W	River Conductivity Raw (µS)	18580			
8/25/2006	AX00W	River Temperature C	30.8			
6/12/2006	AX00W	River Temperature C	11.9			
6/12/2006	AX00W	pH	3.9			
6/12/2006	AX00W	Buffer pH	7.17			
6/12/2006	AX00W	OM%	27.4			
6/12/2006	AX00W	M3-P	49.31			
6/12/2006	AX00W	M3-K	918.72			
6/12/2006	AX00W	M3-Ca	1469.60			
6/12/2006	AX00W	M3-Mg	1932.11			
6/12/2006	AX00W	M3-Mn	66.33			
6/12/2006	AX00W	M3-Zn	19.83			
6/12/2006	AX00W	M3-Cu	1.64			
6/12/2006	AX00W	M3-Fe	1125.69			
6/12/2006	AX00W	M3-B	11.40			
6/12/2006	AX00W	M3-S	2792.66			
6/12/2006	AX00W	M3-Al	1047.43			
6/12/2006	AX00W	TN%	1.078			
6/12/2006	AX00W	TC%	12.83			
6/12/2006	AX00W	NH4-N	20.56			
6/12/2006	AX00W	NO3-N	0.00			
6/12/2006	AX00W	EPA-P	824.5			
6/12/2006	AX00W	EPA-S	12468.0			
6/12/2006	AX00W	CA/Mg	7.82E-06			
6/12/2006	AX00W	N/P	1331220			
	AX00W	% Inundation	35.54			
	AX00W	Distance Downstream	47.2			
	AX00W	Richness (1000m2) May-June	11			
	AX00W	Richness (1000m2) August	10			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/24/2006	AX05W	Mean Soil Salinity (ppt)	4.5	5.2	3.8	5.2
6/17/2006	AX05W	Mean Soil Salinity (ppt)	9.45	10.2	8.7	9.7
8/24/2006	AX05W	River Salinity (ppt)	5.2			
6/17/2006	AX05W	River Salinity (ppt)	9.7			
8/24/2006	AX05W	Mean Specific Conductance (µS)	8185	9.44	6.93	
6/17/2006	AX05W	Mean Specific Conductance (µS)	15915	16.87	14.96	
8/24/2006	AX05W	Mean Raw Conductivity (µS)	8900	10.22	7.58	
6/17/2006	AX05W	Mean Raw Conductivity (µS)	15345	17.06	13.63	
8/24/2006	AX05W	Mean Temperature C	29.55	29.3	29.8	
6/17/2006	AX05W	Mean Temperature C	21.9	23.5	20.3	
8/24/2006	AX05W	River Specific Conductance (µS)	9340			
6/17/2006	AX05W	River Specific Conductance (µS)	17090			
8/24/2006	AX05W	River Conductivity Raw (µS)	10220			
6/17/2006	AX05W	River Conductivity Raw (µS)	18010			
8/24/2006	AX05W	River Temperature C	30			
6/17/2006	AX05W	River Temperature C	25.9			
6/17/2006	AX05W	pH	3.8			
6/17/2006	AX05W	Buffer pH	7.14			
6/17/2006	AX05W	OM%	32.2			
6/17/2006	AX05W	M3-P	67.15			
6/17/2006	AX05W	M3-K	1209.44			
6/17/2006	AX05W	M3-Ca	2039.11			
6/17/2006	AX05W	M3-Mg	3044.74			
6/17/2006	AX05W	M3-Mn	90.38			
6/17/2006	AX05W	M3-Zn	14.36			
6/17/2006	AX05W	M3-Cu	2.21			
6/17/2006	AX05W	M3-Fe	1169.91			
6/17/2006	AX05W	M3-B	11.01			
6/17/2006	AX05W	M3-S	3111.86			
6/17/2006	AX05W	M3-Al	1104.81			
6/17/2006	AX05W	TN%	1.416			
6/17/2006	AX05W	TC%	18.54			
6/17/2006	AX05W	NH4-N	30.72			
6/17/2006	AX05W	NO3-N	0.00			
6/17/2006	AX05W	EPA-P	1026.0			
6/17/2006	AX05W	EPA-S	12676.0			
6/17/2006	AX05W	CA/Mg	0.669716			
6/17/2006	AX05W	N/P	13.80117			
	AX05W	% Inundation	33.6			
	AX05W	Distance Downstream	43.3			
	AX05W	Richness (1000m2) May-June	11			
	AX05W	Richness (1000m2) August	11			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/24/2006	AX10E	Mean Soil Salinity (ppt)	5.05	4.9	5.2	5.9
6/15/2006	AX10E	Mean Soil Salinity (ppt)	5.2	8.1	2.3	9
8/24/2006	AX10E	River Salinity (ppt)	5.9			
6/15/2006	AX10E	River Salinity (ppt)	9			
8/24/2006	AX10E	Mean Specific Conductance (µS)	9085	8.82	9.35	
6/15/2006	AX10E	Mean Specific Conductance (µS)	11681.5	9293	14070	
8/24/2006	AX10E	Mean Raw Conductivity (µS)	9085	8.82	9.35	
6/15/2006	AX10E	Mean Raw Conductivity (µS)	8910.5	4281	13540	
8/24/2006	AX10E	Mean Temperature C	29.15	30	28.3	
6/15/2006	AX10E	Mean Temperature C	22	21	23	
8/24/2006	AX10E	River Specific Conductance (µS)	10480			
6/15/2006	AX10E	River Specific Conductance (µS)	15460			
8/24/2006	AX10E	River Conductivity Raw (µS)	11510			
6/15/2006	AX10E	River Conductivity Raw (µS)	16310			
8/24/2006	AX10E	River Temperature C	30.1			
6/15/2006	AX10E	River Temperature C	27.9			
6/15/2006	AX10E	pH	4.0			
6/15/2006	AX10E	Buffer pH	7.12			
6/15/2006	AX10E	OM%	26.2			
6/15/2006	AX10E	M3-P	54.00			
6/15/2006	AX10E	M3-K	1156.78			
6/15/2006	AX10E	M3-Ca	1797.01			
6/15/2006	AX10E	M3-Mg	2708.26			
6/15/2006	AX10E	M3-Mn	220.39			
6/15/2006	AX10E	M3-Zn	14.45			
6/15/2006	AX10E	M3-Cu	1.94			
6/15/2006	AX10E	M3-Fe	968.58			
6/15/2006	AX10E	M3-B	9.86			
6/15/2006	AX10E	M3-S	3024.60			
6/15/2006	AX10E	M3-Al	1103.44			
6/15/2006	AX10E	TN%	1.302			
6/15/2006	AX10E	TC%	14.64			
6/15/2006	AX10E	NH4-N	26.86			
6/15/2006	AX10E	NO3-N	0.00			
6/15/2006	AX10E	EPA-P	1007.2			
6/15/2006	AX10E	EPA-S	14280.0			
6/15/2006	AX10E	CA/Mg	0.663529			
6/15/2006	AX10E	N/P	12.92693			
	AX10E	% Inundation	63.39			
	AX10E	Distance Downstream	38.8			
	AX10E	Richness (1000m2) May-June	15			
	AX10E	Richness (1000m2) August	17			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/24/2006	AX15W	Mean Soil Salinity (ppt)	2.05	2.1	2	4.5
6/16/2006	AX15W	Mean Soil Salinity (ppt)	5.15	5	5.3	2.5
8/24/2006	AX15W	River Salinity (ppt)	4.5			
6/16/2006	AX15W	River Salinity (ppt)	2.5			
8/24/2006	AX15W	Mean Specific Conductance (µS)	3829.5	3850	3809	
6/16/2006	AX15W	Mean Specific Conductance (µS)	9180	8.97	9.39	
8/24/2006	AX15W	Mean Raw Conductivity (µS)	3850	3900	3800	
6/16/2006	AX15W	Mean Raw Conductivity (µS)	8890	8.88	8.9	
8/24/2006	AX15W	Mean Temperature C	25.5	25.9	25.1	
6/16/2006	AX15W	Mean Temperature C	23.35	24.5	22.2	
8/24/2006	AX15W	River Specific Conductance (µS)	8160			
6/16/2006	AX15W	River Specific Conductance (µS)	4780			
8/24/2006	AX15W	River Conductivity Raw (µS)	8950			
6/16/2006	AX15W	River Conductivity Raw (µS)	5080			
8/24/2006	AX15W	River Temperature C	30			
6/16/2006	AX15W	River Temperature C	28.2			
6/16/2006	AX15W	pH	4.2			
6/16/2006	AX15W	Buffer pH	7.05			
6/16/2006	AX15W	OM%	19.5			
6/16/2006	AX15W	M3-P	59.97			
6/16/2006	AX15W	M3-K	1012.93			
6/16/2006	AX15W	M3-Ca	1762.63			
6/16/2006	AX15W	M3-Mg	2158.85			
6/16/2006	AX15W	M3-Mn	295.69			
6/16/2006	AX15W	M3-Zn	25.77			
6/16/2006	AX15W	M3-Cu	1.51			
6/16/2006	AX15W	M3-Fe	895.90			
6/16/2006	AX15W	M3-B	6.84			
6/16/2006	AX15W	M3-S	2579.43			
6/16/2006	AX15W	M3-Al	1099.12			
6/16/2006	AX15W	TN%	1.066			
6/16/2006	AX15W	TC%	11.24			
6/16/2006	AX15W	NH4-N	26.12			
6/16/2006	AX15W	NO3-N	0.00			
6/16/2006	AX15W	EPA-P	1157.4			
6/16/2006	AX15W	EPA-S	13456.0			
6/16/2006	AX15W	CA/Mg	0.816467			
6/16/2006	AX15W	N/P	9.210299			
	AX15W	% Inundation	56.8			
	AX15W	Distance Downstream	35.2			
	AX15W	Richness (1000m2) May-June	17			
	AX15W	Richness (1000m2) August	21			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/18/2006	AX20E	Mean Soil Salinity (ppt)	1.65	1.1	2.2	2.7
6/15/2006	AX20E	Mean Soil Salinity (ppt)	2.75	2.8	2.7	2.7
8/18/2006	AX20E	River Salinity (ppt)	2.7			
6/15/2006	AX20E	River Salinity (ppt)	2.7			
8/18/2006	AX20E	Mean Specific Conductance (µS)	3138.5	2.193	4.084	
6/15/2006	AX20E	Mean Specific Conductance (µS)	5170	5.24	5.1	
8/18/2006	AX20E	Mean Raw Conductivity (µS)	1993.604	2.207	3985	
6/15/2006	AX20E	Mean Raw Conductivity (µS)	4865	4.94	4.79	
8/18/2006	AX20E	Mean Temperature C	25.4	27	23.8	
6/15/2006	AX20E	Mean Temperature C	22	22.2	21.8	
8/18/2006	AX20E	River Specific Conductance (µS)	5130			
6/15/2006	AX20E	River Specific Conductance (µS)	5.05			
8/18/2006	AX20E	River Conductivity Raw (µS)	5610			
6/15/2006	AX20E	River Conductivity Raw (µS)	5020			
8/18/2006	AX20E	River Temperature C	30			
6/15/2006	AX20E	River Temperature C	24.2			
6/15/2006	AX20E	pH	4.4			
6/15/2006	AX20E	Buffer pH	7.12			
6/15/2006	AX20E	OM%	16.1			
6/15/2006	AX20E	M3-P	59.76			
6/15/2006	AX20E	M3-K	540.55			
6/15/2006	AX20E	M3-Ca	1786.25			
6/15/2006	AX20E	M3-Mg	1552.82			
6/15/2006	AX20E	M3-Mn	265.37			
6/15/2006	AX20E	M3-Zn	33.70			
6/15/2006	AX20E	M3-Cu	1.51			
6/15/2006	AX20E	M3-Fe	982.43			
6/15/2006	AX20E	M3-B	4.08			
6/15/2006	AX20E	M3-S	1483.36			
6/15/2006	AX20E	M3-Al	1058.86			
6/15/2006	AX20E	TN%	0.919			
6/15/2006	AX20E	TC%	9.22			
6/15/2006	AX20E	NH4-N	27.63			
6/15/2006	AX20E	NO3-N	0.00			
6/15/2006	AX20E	EPA-P	1629.9			
6/15/2006	AX20E	EPA-S	5864.0			
6/15/2006	AX20E	CA/Mg	1.150327			
6/15/2006	AX20E	N/P	5.638452			
	AX20E	% Inundation	50.11			
	AX20E	Distance Downstream	30.2			
	AX20E	Richness (1000m2) May-June	12			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/18/2006	AX22W	Mean Soil Salinity (ppt)	2	2.2	1.8	3.2
6/17/2006	AX22W	Mean Soil Salinity (ppt)	1.8	1.9	1.7	2.2
8/18/2006	AX22W	River Salinity (ppt)	3.2			
6/17/2006	AX22W	River Salinity (ppt)	2.2			
8/18/2006	AX22W	Mean Specific Conductance (µS)	3791	4083	3499	
6/17/2006	AX22W	Mean Specific Conductance (µS)	3276	3383	3169	
8/18/2006	AX22W	Mean Raw Conductivity (µS)	3863.5	4275	3452	
6/17/2006	AX22W	Mean Raw Conductivity (µS)	3220.5	3620	2821	
8/18/2006	AX22W	Mean Temperature C	25.8	27.4	24.2	
6/17/2006	AX22W	Mean Temperature C	20.35	21.4	19.3	
8/18/2006	AX22W	River Specific Conductance (µS)	6030			
6/17/2006	AX22W	River Specific Conductance (µS)	4177			
8/18/2006	AX22W	River Conductivity Raw (µS)	6370			
6/17/2006	AX22W	River Conductivity Raw (µS)	4310			
8/18/2006	AX22W	River Temperature C	28.1			
6/17/2006	AX22W	River Temperature C	26.4			
6/17/2006	AX22W	pH	4.8			
6/17/2006	AX22W	Buffer pH	7.19			
6/17/2006	AX22W	OM%	16.3			
6/17/2006	AX22W	M3-P	31.04			
6/17/2006	AX22W	M3-K	599.41			
6/17/2006	AX22W	M3-Ca	1481.39			
6/17/2006	AX22W	M3-Mg	1215.80			
6/17/2006	AX22W	M3-Mn	445.34			
6/17/2006	AX22W	M3-Zn	22.07			
6/17/2006	AX22W	M3-Cu	1.54			
6/17/2006	AX22W	M3-Fe	900.94			
6/17/2006	AX22W	M3-B	4.11			
6/17/2006	AX22W	M3-S	566.00			
6/17/2006	AX22W	M3-Al	860.05			
6/17/2006	AX22W	TN%	0.800			
6/17/2006	AX22W	TC%	9.07			
6/17/2006	AX22W	NH4-N	22.80			
6/17/2006	AX22W	NO3-N	0.71			
6/17/2006	AX22W	EPA-P	2381.1			
6/17/2006	AX22W	EPA-S	3528.2			
6/17/2006	AX22W	CA/Mg	1.218449			
6/17/2006	AX22W	N/P	3.35982			
	AX22W	% Inundation	30.11			
	AX22W	Distance Downstream	29.6			
	AX22W	Richness (1000m2) May-June	20			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/17/2006	AX26W	Mean Soil Salinity (ppt)	0.6	0.8	0.4	1.2
6/15/2006	AX26W	Mean Soil Salinity (ppt)	0.65	0.7	0.6	1.3
8/17/2006	AX26W	River Salinity (ppt)	1.2			
6/15/2006	AX26W	River Salinity (ppt)	1.3			
8/17/2006	AX26W	Mean Specific Conductance (µS)	1218.5	1573	864	
6/15/2006	AX26W	Mean Specific Conductance (µS)	1370	1453	1287	
8/17/2006	AX26W	Mean Raw Conductivity (µS)	1187.5	1528	847	
6/15/2006	AX26W	Mean Raw Conductivity (µS)	1180.5	1259	1102	
8/17/2006	AX26W	Mean Temperature C	23.6	23.4	23.8	
6/15/2006	AX26W	Mean Temperature C	17.5	18	17	
8/17/2006	AX26W	River Specific Conductance (µS)	2368			
6/15/2006	AX26W	River Specific Conductance (µS)	2542			
8/17/2006	AX26W	River Conductivity Raw (µS)	2543			
6/15/2006	AX26W	River Conductivity Raw (µS)	2652			
8/17/2006	AX26W	River Temperature C	28.8			
6/15/2006	AX26W	River Temperature C	27			
6/15/2006	AX26W	pH	4.6			
6/15/2006	AX26W	Buffer pH	7.09			
6/15/2006	AX26W	OM%	23.3			
6/15/2006	AX26W	M3-P	54.50			
6/15/2006	AX26W	M3-K	422.84			
6/15/2006	AX26W	M3-Ca	2458.13			
6/15/2006	AX26W	M3-Mg	1322.50			
6/15/2006	AX26W	M3-Mn	385.21			
6/15/2006	AX26W	M3-Zn	23.26			
6/15/2006	AX26W	M3-Cu	1.52			
6/15/2006	AX26W	M3-Fe	963.66			
6/15/2006	AX26W	M3-B	4.72			
6/15/2006	AX26W	M3-S	1006.24			
6/15/2006	AX26W	M3-Al	1240.44			
6/15/2006	AX26W	TN%	1.327			
6/15/2006	AX26W	TC%	13.67			
6/15/2006	AX26W	NH4-N	34.67			
6/15/2006	AX26W	NO3-N	0.72			
6/15/2006	AX26W	EPA-P	1414.4			
6/15/2006	AX26W	EPA-S	4156.0			
6/15/2006	AX26W	CA/Mg	1.858699			
6/15/2006	AX26W	N/P	9.381805			
	AX26W	% Inundation	40.43			
	AX26W	Distance Downstream	25.6			
	AX26W	Richness (1000m2) May-June	25			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/16/2006	AX30E	Mean Soil Salinity (ppt)	0.3	0.3	0.3	0.5
6/14/2006	AX30E	Mean Soil Salinity (ppt)	0.6	0.6	0.6	0.8
8/16/2006	AX30E	River Salinity (ppt)	0.5			
6/14/2006	AX30E	River Salinity (ppt)	0.8			
8/16/2006	AX30E	Mean Specific Conductance (µS)	660	670	650	
6/14/2006	AX30E	Mean Specific Conductance (µS)	1196	1146	1246	
8/16/2006	AX30E	Mean Raw Conductivity (µS)	639	636	642	
6/14/2006	AX30E	Mean Raw Conductivity (µS)	1064.5	1022	1107	
8/16/2006	AX30E	Mean Temperature C	23.75	23.1	24.4	
6/14/2006	AX30E	Mean Temperature C	19.4	19.4	19.4	
8/16/2006	AX30E	River Specific Conductance (µS)	975			
6/14/2006	AX30E	River Specific Conductance (µS)	1658			
8/16/2006	AX30E	River Conductivity Raw (µS)	1019			
6/14/2006	AX30E	River Conductivity Raw (µS)	1574			
8/16/2006	AX30E	River Temperature C	27.5			
6/14/2006	AX30E	River Temperature C	22.4			
6/14/2006	AX30E	pH	4.7			
6/14/2006	AX30E	Buffer pH	7.20			
6/14/2006	AX30E	OM%	26.8			
6/14/2006	AX30E	M3-P	62.84			
6/14/2006	AX30E	M3-K	252.48			
6/14/2006	AX30E	M3-Ca	2605.18			
6/14/2006	AX30E	M3-Mg	814.42			
6/14/2006	AX30E	M3-Mn	370.91			
6/14/2006	AX30E	M3-Zn	27.20			
6/14/2006	AX30E	M3-Cu	1.91			
6/14/2006	AX30E	M3-Fe	1367.30			
6/14/2006	AX30E	M3-B	3.98			
6/14/2006	AX30E	M3-S	556.38			
6/14/2006	AX30E	M3-Al	1181.18			
6/14/2006	AX30E	TN%	1.577			
6/14/2006	AX30E	TC%	15.83			
6/14/2006	AX30E	NH4-N	33.03			
6/14/2006	AX30E	NO3-N	1.24			
6/14/2006	AX30E	EPA-P	1328.6			
6/14/2006	AX30E	EPA-S	3419.6			
6/14/2006	AX30E	CA/Mg	3.198816			
6/14/2006	AX30E	N/P	11.86964			
	AX30E	% Inundation	42.9			
	AX30E	Distance Downstream	20.4			
	AX30E	Richness (1000m2) May-June	8			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/16/2006	AX30W	Mean Soil Salinity (ppt)	0.3	0.3	0.3	0.4
6/18/2006	AX30W	Mean Soil Salinity (ppt)	1	1	1	1.4
8/16/2006	AX30W	River Salinity (ppt)	0.4			
6/18/2006	AX30W	River Salinity (ppt)	1.4			
8/16/2006	AX30W	Mean Specific Conductance (µS)	616	645	587	
6/18/2006	AX30W	Mean Specific Conductance (µS)	1958.5	1926	1991	
8/16/2006	AX30W	Mean Raw Conductivity (µS)	587	597	577	
6/18/2006	AX30W	Mean Raw Conductivity (µS)	1953	1916	1990	
8/16/2006	AX30W	Mean Temperature C	22.9	21.5	24.3	
6/18/2006	AX30W	Mean Temperature C	24.75	24.6	24.9	
8/16/2006	AX30W	River Specific Conductance (µS)	906			
6/18/2006	AX30W	River Specific Conductance (µS)	2648			
8/16/2006	AX30W	River Conductivity Raw (µS)	991			
6/18/2006	AX30W	River Conductivity Raw (µS)	2690			
8/16/2006	AX30W	River Temperature C	29.9			
6/18/2006	AX30W	River Temperature C	26.3			
6/18/2006	AX30W	pH	4.0			
6/18/2006	AX30W	Buffer pH	6.97			
6/18/2006	AX30W	OM%	39.8			
6/18/2006	AX30W	M3-P	68.07			
6/18/2006	AX30W	M3-K	242.95			
6/18/2006	AX30W	M3-Ca	3914.41			
6/18/2006	AX30W	M3-Mg	1486.70			
6/18/2006	AX30W	M3-Mn	256.05			
6/18/2006	AX30W	M3-Zn	22.90			
6/18/2006	AX30W	M3-Cu	1.90			
6/18/2006	AX30W	M3-Fe	1274.30			
6/18/2006	AX30W	M3-B	4.51			
6/18/2006	AX30W	M3-S	3212.86			
6/18/2006	AX30W	M3-Al	1611.18			
6/18/2006	AX30W	TN%	1.708			
6/18/2006	AX30W	TC%	23.39			
6/18/2006	AX30W	NH4-N	24.14			
6/18/2006	AX30W	NO3-N	0.00			
6/18/2006	AX30W	EPA-P	970.0			
6/18/2006	AX30W	EPA-S	14956.0			
6/18/2006	AX30W	CA/Mg	2.632952			
6/18/2006	AX30W	N/P	17.60897			
	AX30W	% Inundation	47.45			
	AX30W	Distance Downstream	22.5			
	AX30W	Richness (1000m2) May-June	21			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/16/2006	AX35W	Mean Soil Salinity (ppt)	0.4	0.5	0.3	0.3
6/14/2006	AX35W	Mean Soil Salinity (ppt)	0.3	0.3	0.3	0.4
8/16/2006	AX35W	River Salinity (ppt)	0.3			
6/14/2006	AX35W	River Salinity (ppt)	0.4			
8/16/2006	AX35W	Mean Specific Conductance (µS)	763	929	597	
6/14/2006	AX35W	Mean Specific Conductance (µS)	589.5	625	554	
8/16/2006	AX35W	Mean Raw Conductivity (µS)	771.5	957	586	
6/14/2006	AX35W	Mean Raw Conductivity (µS)	531	566	496	
8/16/2006	AX35W	Mean Temperature C	24.65	25.7	23.6	
6/14/2006	AX35W	Mean Temperature C	19.6	19.7	19.5	
8/16/2006	AX35W	River Specific Conductance (µS)	581			
6/14/2006	AX35W	River Specific Conductance (µS)	803			
8/16/2006	AX35W	River Conductivity Raw (µS)	605			
6/14/2006	AX35W	River Conductivity Raw (µS)	762			
8/16/2006	AX35W	River Temperature C	27.1			
6/14/2006	AX35W	River Temperature C	22.5			
6/14/2006	AX35W	pH	4.2			
6/14/2006	AX35W	Buffer pH	7.17			
6/14/2006	AX35W	OM%	38.6			
6/14/2006	AX35W	M3-P	124.70			
6/14/2006	AX35W	M3-K	235.14			
6/14/2006	AX35W	M3-Ca	3195.68			
6/14/2006	AX35W	M3-Mg	701.20			
6/14/2006	AX35W	M3-Mn	162.87			
6/14/2006	AX35W	M3-Zn	47.81			
6/14/2006	AX35W	M3-Cu	2.18			
6/14/2006	AX35W	M3-Fe	1309.02			
6/14/2006	AX35W	M3-B	5.07			
6/14/2006	AX35W	M3-S	2111.51			
6/14/2006	AX35W	M3-Al	1697.84			
6/14/2006	AX35W	TN%	2.365			
6/14/2006	AX35W	TC%	24.52			
6/14/2006	AX35W	NH4-N	47.84			
6/14/2006	AX35W	NO3-N	1.42			
6/14/2006	AX35W	EPA-P	1075.0			
6/14/2006	AX35W	EPA-S	8216.0			
6/14/2006	AX35W	CA/Mg	31.29817			
6/14/2006	AX35W	N/P	66423.33			
	AX35W	% Inundation	24.54			
	AX35W	Distance Downstream	14.8			
	AX35W	Richness (1000m2) May-June	33			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/17/2006	AX39W	Mean Soil Salinity (ppt)	0.15	0.2	0.1	0.2
6/18/2006	AX39W	Mean Soil Salinity (ppt)	0.2	0.3	0.1	0.1
8/17/2006	AX39W	River Salinity (ppt)	0.2			
6/18/2006	AX39W	River Salinity (ppt)	0.1			
8/17/2006	AX39W	Mean Specific Conductance (µS)	355.15	436.1	274.2	
6/18/2006	AX39W	Mean Specific Conductance (µS)	444.35	587	301.7	
8/17/2006	AX39W	Mean Raw Conductivity (µS)	341.05	416	266.1	
6/18/2006	AX39W	Mean Raw Conductivity (µS)	422.25	559	285.5	
8/17/2006	AX39W	Mean Temperature C	23.1	23	23.2	
6/18/2006	AX39W	Mean Temperature C	22.35	22.6	22.1	
8/17/2006	AX39W	River Specific Conductance (µS)	370			
6/18/2006	AX39W	River Specific Conductance (µS)	265.1			
8/17/2006	AX39W	River Conductivity Raw (µS)	374.4			
6/18/2006	AX39W	River Conductivity Raw (µS)	271.7			
8/17/2006	AX39W	River Temperature C	25.6			
6/18/2006	AX39W	River Temperature C	26.4			
6/18/2006	AX39W	pH	3.8			
6/18/2006	AX39W	Buffer pH	6.92			
6/18/2006	AX39W	OM%	24.1			
6/18/2006	AX39W	M3-P	122.62			
6/18/2006	AX39W	M3-K	137.06			
6/18/2006	AX39W	M3-Ca	2390.81			
6/18/2006	AX39W	M3-Mg	412.73			
6/18/2006	AX39W	M3-Mn	226.39			
6/18/2006	AX39W	M3-Zn	45.29			
6/18/2006	AX39W	M3-Cu	3.23			
6/18/2006	AX39W	M3-Fe	1568.89			
6/18/2006	AX39W	M3-B	3.41			
6/18/2006	AX39W	M3-S	1776.83			
6/18/2006	AX39W	M3-Al	1353.90			
6/18/2006	AX39W	TN%	1.212			
6/18/2006	AX39W	TC%	14.78			
6/18/2006	AX39W	NH4-N	38.00			
6/18/2006	AX39W	NO3-N	0.80			
6/18/2006	AX39W	EPA-P	1773.0			
6/18/2006	AX39W	EPA-S	9344.0			
6/18/2006	AX39W	CA/Mg	5.792673			
6/18/2006	AX39W	N/P	6.835871			
	AX39W	% Inundation	52.98			
	AX39W	Distance Downstream	10.5			
	AX39W	Richness (1000m2) May-June	19			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/15/2006	AX43W	Mean Soil Salinity (ppt)	0.2	0.2	0.2	0.2
6/13/2006	AX43W	Mean Soil Salinity (ppt)	0.2	0.2	0.2	0.2
8/15/2006	AX43W	River Salinity (ppt)	0.2			
6/13/2006	AX43W	River Salinity (ppt)	0.2			
8/15/2006	AX43W	Mean Specific Conductance (µS)	412.15	423.1	401.2	
6/13/2006	AX43W	Mean Specific Conductance (µS)	352.4	319.5	385.3	
8/15/2006	AX43W	Mean Raw Conductivity (µS)	407.75	421.9	393.6	
6/13/2006	AX43W	Mean Raw Conductivity (µS)	310.65	277.3	344	
8/15/2006	AX43W	Mean Temperature C	24.8	25.3	24.3	
6/13/2006	AX43W	Mean Temperature C	18.75	18	19.5	
8/15/2006	AX43W	River Specific Conductance (µS)	323.7			
6/13/2006	AX43W	River Specific Conductance (µS)	339.4			
8/15/2006	AX43W	River Conductivity Raw (µS)	329.9			
6/13/2006	AX43W	River Conductivity Raw (µS)	322.4			
8/15/2006	AX43W	River Temperature C	25.9			
6/13/2006	AX43W	River Temperature C	22.6			
6/13/2006	AX43W	pH	4.3			
6/13/2006	AX43W	Buffer pH	7.10			
6/13/2006	AX43W	OM%	18.2			
6/13/2006	AX43W	M3-P	168.35			
6/13/2006	AX43W	M3-K	97.37			
6/13/2006	AX43W	M3-Ca	1912.10			
6/13/2006	AX43W	M3-Mg	223.05			
6/13/2006	AX43W	M3-Mn	179.54			
6/13/2006	AX43W	M3-Zn	28.01			
6/13/2006	AX43W	M3-Cu	2.61			
6/13/2006	AX43W	M3-Fe	1559.96			
6/13/2006	AX43W	M3-B	3.42			
6/13/2006	AX43W	M3-S	463.31			
6/13/2006	AX43W	M3-Al	1024.12			
6/13/2006	AX43W	TN%	1.112			
6/13/2006	AX43W	TC%	12.70			
6/13/2006	AX43W	NH4-N	17.49			
6/13/2006	AX43W	NO3-N	1.59			
6/13/2006	AX43W	EPA-P	1226.5			
6/13/2006	AX43W	EPA-S	2470.7			
6/13/2006	AX43W	CA/Mg	8.572517			
6/13/2006	AX43W	N/P	9.066301			
	AX43W	% Inundation	27.36			
	AX43W	Distance Downstream	5.5			
	AX43W	Richness (1000m2) May-June	26			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/15/2006	AX47E	Mean Soil Salinity (ppt)	0.2	0.2	0.2	0.1
6/13/2006	AX47E	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.2
8/15/2006	AX47E	River Salinity (ppt)	0.1			
6/13/2006	AX47E	River Salinity (ppt)	0.2			
8/15/2006	AX47E	Mean Specific Conductance (µS)	408.8	418.6	399	
6/13/2006	AX47E	Mean Specific Conductance (µS)	296	298.6	293.4	
8/15/2006	AX47E	Mean Raw Conductivity (µS)	391.85	403	380.7	
6/13/2006	AX47E	Mean Raw Conductivity (µS)	252.6	255.9	249.3	
8/15/2006	AX47E	Mean Temperature C	22.75	22.9	22.6	
6/13/2006	AX47E	Mean Temperature C	17.2	17.4	17	
8/15/2006	AX47E	River Specific Conductance (µS)	92			
6/13/2006	AX47E	River Specific Conductance (µS)	323.4			
8/15/2006	AX47E	River Conductivity Raw (µS)	87.5			
6/13/2006	AX47E	River Conductivity Raw (µS)	294.5			
8/15/2006	AX47E	River Temperature C	24.3			
6/13/2006	AX47E	River Temperature C	20.6			
6/13/2006	AX47E	pH	4.5			
6/13/2006	AX47E	Buffer pH	6.95			
6/13/2006	AX47E	OM%	34.6			
6/13/2006	AX47E	M3-P	65.39			
6/13/2006	AX47E	M3-K	141.92			
6/13/2006	AX47E	M3-Ca	3448.42			
6/13/2006	AX47E	M3-Mg	340.18			
6/13/2006	AX47E	M3-Mn	498.58			
6/13/2006	AX47E	M3-Zn	46.43			
6/13/2006	AX47E	M3-Cu	2.71			
6/13/2006	AX47E	M3-Fe	1880.41			
6/13/2006	AX47E	M3-B	4.34			
6/13/2006	AX47E	M3-S	481.08			
6/13/2006	AX47E	M3-Al	1377.14			
6/13/2006	AX47E	TN%	1.885			
6/13/2006	AX47E	TC%	19.54			
6/13/2006	AX47E	NH4-N	31.10			
6/13/2006	AX47E	NO3-N	4.81			
6/13/2006	AX47E	EPA-P	1594.9			
6/13/2006	AX47E	EPA-S	2993.7			
6/13/2006	AX47E	CA/Mg	10.13705			
6/13/2006	AX47E	N/P	11.81907			
	AX47E	% Inundation	27.24			
	AX47E	Distance Downstream	0			
	AX47E	Richness (1000m2) May-June	30			

Nanticoke River

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/4/2006	PS00W	Mean Soil Salinity (ppt)	7.2	7.6	6.8	8.7
5/23/2006	PS00W	Mean Soil Salinity (ppt)	8.65	8.8	8.5	
8/4/2006	PS00W	River Salinity (ppt)	8.7			
5/23/2006	PS00W	River Salinity (ppt)				
8/4/2006	PS00W	Mean Specific Conductance (µS)	12745	13.62	11.87	
5/23/2006	PS00W	Mean Specific Conductance (µS)	14775	14.96	14.59	
8/4/2006	PS00W	Mean Raw Conductivity (µS)	12590	13.73	11.45	
5/23/2006	PS00W	Mean Raw Conductivity (µS)	11900	11.9	11.9	
8/4/2006	PS00W	Mean Temperature C	24.1	25	23.2	
5/23/2006	PS00W	Mean Temperature C	14.7	15.2	14.2	
8/4/2006	PS00W	River Specific Conductance (µS)	15180			
5/23/2006	PS00W	River Specific Conductance (µS)				
8/4/2006	PS00W	River Conductivity Raw (µS)	17210			
5/23/2006	PS00W	River Conductivity Raw (µS)				
8/4/2006	PS00W	River Temperature C	31.8			
5/23/2006	PS00W	River Temperature C				
5/23/2006	PS00W	pH	4.0			
5/23/2006	PS00W	Buffer pH	7.33			
5/23/2006	PS00W	OM%	29.8			
5/23/2006	PS00W	M3-P	37.18			
5/23/2006	PS00W	M3-K	908.36			
5/23/2006	PS00W	M3-Ca	1737.19			
5/23/2006	PS00W	M3-Mg	2626.39			
5/23/2006	PS00W	M3-Mn	31.63			
5/23/2006	PS00W	M3-Zn	11.94			
5/23/2006	PS00W	M3-Cu	3.45			
5/23/2006	PS00W	M3-Fe	1322.06			
5/23/2006	PS00W	M3-B	11.18			
5/23/2006	PS00W	M3-S	3475.00			
5/23/2006	PS00W	M3-Al	940.94			
5/23/2006	PS00W	TN%	1.189			
5/23/2006	PS00W	TC%	16.73			
5/23/2006	PS00W	NH4-N	31.91			
5/23/2006	PS00W	NO3-N	0.00			
5/23/2006	PS00W	EPA-P	638.6			
5/23/2006	PS00W	EPA-S	9976.0			
5/23/2006	PS00W	CA/Mg	0.661436			
5/23/2006	PS00W	N/P	18.61769			
	PS00W	% Inundation	4.45			
	PS00W	Distance Downstream	55.9			
	PS00W	Richness (1000m2) May-June	4			
	PS00W	Richness (1000m2) August	11			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/4/2006	PS05W	Mean Soil Salinity (ppt)	4.1	4.7	3.5	6.2
5/24/2006	PS05W	Mean Soil Salinity (ppt)	7	6.5	7.5	
8/4/2006	PS05W	River Salinity (ppt)	6.2			
5/24/2006	PS05W	River Salinity (ppt)				
8/4/2006	PS05W	Mean Specific Conductance (µS)	7470	8.54	6.4	
5/24/2006	PS05W	Mean Specific Conductance (µS)	12270	11.61	12.93	
8/4/2006	PS05W	Mean Raw Conductivity (µS)	7615	8.75	6.48	
5/24/2006	PS05W	Mean Raw Conductivity (µS)	10335	9.77	10.9	
8/4/2006	PS05W	Mean Temperature C	25.9	26.2	25.6	
5/24/2006	PS05W	Mean Temperature C	16.55	16.2	16.9	
8/4/2006	PS05W	River Specific Conductance (µS)	11030			
5/24/2006	PS05W	River Specific Conductance (µS)				
8/4/2006	PS05W	River Conductivity Raw (µS)	12410			
5/24/2006	PS05W	River Conductivity Raw (µS)				
8/4/2006	PS05W	River Temperature C	31.4			
5/24/2006	PS05W	River Temperature C				
5/24/2006	PS05W	pH	4.0			
5/24/2006	PS05W	Buffer pH	7.49			
5/24/2006	PS05W	OM%	28.0			
5/24/2006	PS05W	M3-P	53.89			
5/24/2006	PS05W	M3-K	963.86			
5/24/2006	PS05W	M3-Ca	2265.26			
5/24/2006	PS05W	M3-Mg	2922.18			
5/24/2006	PS05W	M3-Mn	55.59			
5/24/2006	PS05W	M3-Zn	14.00			
5/24/2006	PS05W	M3-Cu	3.43			
5/24/2006	PS05W	M3-Fe	1150.92			
5/24/2006	PS05W	M3-B	9.72			
5/24/2006	PS05W	M3-S	4088.74			
5/24/2006	PS05W	M3-Al	1361.81			
5/24/2006	PS05W	TN%	1.063			
5/24/2006	PS05W	TC%	15.73			
5/24/2006	PS05W	NH4-N	74.58			
5/24/2006	PS05W	NO3-N	0.00			
5/24/2006	PS05W	EPA-P	518.1			
5/24/2006	PS05W	EPA-S	10984.0			
5/24/2006	PS05W	CA/Mg	0.775195			
5/24/2006	PS05W	N/P	20.51648			
	PS05W	% Inundation	11.75			
	PS05W	Distance Downstream	54.5			
	PS05W	Richness (1000m2) May-June	8			
	PS05W	Richness (1000m2) August	15			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/4/2006	PS10E	Mean Soil Salinity (ppt)	2.6	2.7	2.5	2.9
5/24/2006	PS10E	Mean Soil Salinity (ppt)	3.95	3.6	4.3	7.3
8/4/2006	PS10E	River Salinity (ppt)	2.9			
5/24/2006	PS10E	River Salinity (ppt)	7.3			
8/4/2006	PS10E	Mean Specific Conductance (µS)	5000	5.28	4.72	
5/24/2006	PS10E	Mean Specific Conductance (µS)	7125	6.47	7.78	
8/4/2006	PS10E	Mean Raw Conductivity (µS)	5255	5.55	4.96	
5/24/2006	PS10E	Mean Raw Conductivity (µS)	6020	5.36	6.68	
8/4/2006	PS10E	Mean Temperature C	27.4	27.1	27.7	
5/24/2006	PS10E	Mean Temperature C	16.7	16	17.4	
8/4/2006	PS10E	River Specific Conductance (µS)	5490			
5/24/2006	PS10E	River Specific Conductance (µS)	12700			
8/4/2006	PS10E	River Conductivity Raw (µS)	6140			
5/24/2006	PS10E	River Conductivity Raw (µS)	11590			
8/4/2006	PS10E	River Temperature C	31.3			
5/24/2006	PS10E	River Temperature C				
5/24/2006	PS10E	pH	4.3			
5/24/2006	PS10E	Buffer pH	7.38			
5/24/2006	PS10E	OM%	24.0			
5/24/2006	PS10E	M3-P	36.60			
5/24/2006	PS10E	M3-K	808.98			
5/24/2006	PS10E	M3-Ca	1770.51			
5/24/2006	PS10E	M3-Mg	2094.03			
5/24/2006	PS10E	M3-Mn	79.35			
5/24/2006	PS10E	M3-Zn	16.15			
5/24/2006	PS10E	M3-Cu	2.29			
5/24/2006	PS10E	M3-Fe	1062.77			
5/24/2006	PS10E	M3-B	7.74			
5/24/2006	PS10E	M3-S	2387.17			
5/24/2006	PS10E	M3-Al	1167.43			
5/24/2006	PS10E	TN%	1.092			
5/24/2006	PS10E	TC%	14.28			
5/24/2006	PS10E	NH4-N	32.66			
5/24/2006	PS10E	NO3-N	0.00			
5/24/2006	PS10E	EPA-P	594.4			
5/24/2006	PS10E	EPA-S	12176.0			
5/24/2006	PS10E	CA/Mg	0.845504			
5/24/2006	PS10E	N/P	18.37147			
	PS10E	% Inundation	30.71			
	PS10E	Distance Downstream	49.3			
	PS10E	Richness (1000m2) May-June	12			
	PS10E	Richness (1000m2) August	16			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/3/2006	PS15E	Mean Soil Salinity (ppt)	1.35	1.5	1.2	2
5/24/2006	PS15E	Mean Soil Salinity (ppt)	3.4	3.6	3.2	1.4
8/3/2006	PS15E	River Salinity (ppt)	2			
5/24/2006	PS15E	River Salinity (ppt)	1.4			
8/3/2006	PS15E	Mean Specific Conductance (µS)	2571.5	2580	2563	
5/24/2006	PS15E	Mean Specific Conductance (µS)	6130	6.48	5.78	
8/3/2006	PS15E	Mean Raw Conductivity (µS)	2654	2662	2646	
5/24/2006	PS15E	Mean Raw Conductivity (µS)	5230	5.54	4.92	
8/3/2006	PS15E	Mean Temperature C	26.55	26.7	26.4	
5/24/2006	PS15E	Mean Temperature C	17	17.4	16.6	
8/3/2006	PS15E	River Specific Conductance (µS)	3835			
5/24/2006	PS15E	River Specific Conductance (µS)	2729			
8/3/2006	PS15E	River Conductivity Raw (µS)	4227			
5/24/2006	PS15E	River Conductivity Raw (µS)	2486			
8/3/2006	PS15E	River Temperature C	31.4			
5/24/2006	PS15E	River Temperature C	20.5			
5/24/2006	PS15E	pH	4.4			
5/24/2006	PS15E	Buffer pH	7.34			
5/24/2006	PS15E	OM%	20.9			
5/24/2006	PS15E	M3-P	25.14			
5/24/2006	PS15E	M3-K	710.17			
5/24/2006	PS15E	M3-Ca	2012.72			
5/24/2006	PS15E	M3-Mg	2198.46			
5/24/2006	PS15E	M3-Mn	259.94			
5/24/2006	PS15E	M3-Zn	17.92			
5/24/2006	PS15E	M3-Cu	1.46			
5/24/2006	PS15E	M3-Fe	1118.86			
5/24/2006	PS15E	M3-B	7.21			
5/24/2006	PS15E	M3-S	2067.44			
5/24/2006	PS15E	M3-Al	958.17			
5/24/2006	PS15E	TN%	1.088			
5/24/2006	PS15E	TC%	12.52			
5/24/2006	PS15E	NH4-N	31.75			
5/24/2006	PS15E	NO3-N	0.00			
5/24/2006	PS15E	EPA-P	608.4			
5/24/2006	PS15E	EPA-S	11512.0			
5/24/2006	PS15E	CA/Mg	0.915514			
5/24/2006	PS15E	N/P	17.88297			
	PS15E	% Inundation	36.8			
	PS15E	Distance Downstream	44.9			
	PS15E	Richness (1000m2) May-June	14			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/4/2006	PS19E	Mean Soil Salinity (ppt)	1.2	1.4	1	1
5/25/2006	PS19E	Mean Soil Salinity (ppt)	1.85	2.5	1.2	3.7
8/4/2006	PS19E	River Salinity (ppt)	1			
5/25/2006	PS19E	River Salinity (ppt)	3.7			
8/4/2006	PS19E	Mean Specific Conductance (µS)	2559.5	3219	1900	
5/25/2006	PS19E	Mean Specific Conductance (µS)	3466	4607	2325	
8/4/2006	PS19E	Mean Raw Conductivity (µS)	2610.5	3296	1925	
5/25/2006	PS19E	Mean Raw Conductivity (µS)	2885	3862	1908	
8/4/2006	PS19E	Mean Temperature C	26.9	26.3	27.5	
5/25/2006	PS19E	Mean Temperature C	16.25	16.5	16	
8/4/2006	PS19E	River Specific Conductance (µS)	1901			
5/25/2006	PS19E	River Specific Conductance (µS)	6820			
8/4/2006	PS19E	River Conductivity Raw (µS)	2123			
5/25/2006	PS19E	River Conductivity Raw (µS)	6180			
8/4/2006	PS19E	River Temperature C	31.1			
5/25/2006	PS19E	River Temperature C	20.3			
5/25/2006	PS19E	pH	4.2			
5/25/2006	PS19E	Buffer pH	7.27			
5/25/2006	PS19E	OM%	30.6			
5/25/2006	PS19E	M3-P	38.41			
5/25/2006	PS19E	M3-K	591.27			
5/25/2006	PS19E	M3-Ca	2228.36			
5/25/2006	PS19E	M3-Mg	2412.99			
5/25/2006	PS19E	M3-Mn	96.60			
5/25/2006	PS19E	M3-Zn	17.54			
5/25/2006	PS19E	M3-Cu	2.59			
5/25/2006	PS19E	M3-Fe	1261.97			
5/25/2006	PS19E	M3-B	8.75			
5/25/2006	PS19E	M3-S	3106.49			
5/25/2006	PS19E	M3-Al	1204.60			
5/25/2006	PS19E	TN%	1.412			
5/25/2006	PS19E	TC%	18.72			
5/25/2006	PS19E	NH4-N	36.17			
5/25/2006	PS19E	NO3-N	0.31			
5/25/2006	PS19E	EPA-P	692.0			
5/25/2006	PS19E	EPA-S	14488.0			
5/25/2006	PS19E	CA/Mg	0.923485			
5/25/2006	PS19E	N/P	20.40344			
	PS19E	% Inundation	18.9			
	PS19E	Distance Downstream	42.1			
	PS19E	Richness (1000m2) May-June	24			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/3/2006	PS25E	Mean Soil Salinity (ppt)	0.6	0.6	0.6	0.4
5/25/2006	PS25E	Mean Soil Salinity (ppt)	1.95	1.9	2	2.8
8/3/2006	PS25E	River Salinity (ppt)	0.4			
5/25/2006	PS25E	River Salinity (ppt)	2.8			
8/3/2006	PS25E	Mean Specific Conductance (µS)	1151.5	1130	1173	
5/25/2006	PS25E	Mean Specific Conductance (µS)	3641.5	3597	3686	
8/3/2006	PS25E	Mean Raw Conductivity (µS)	1218.5	1215	1222	
5/25/2006	PS25E	Mean Raw Conductivity (µS)	3089	3045	3133	
8/3/2006	PS25E	Mean Temperature C	27.85	28.7	27	
5/25/2006	PS25E	Mean Temperature C	17.1	17	17.2	
8/3/2006	PS25E	River Specific Conductance (µS)	853			
5/25/2006	PS25E	River Specific Conductance (µS)	5130			
8/3/2006	PS25E	River Conductivity Raw (µS)	1014			
5/25/2006	PS25E	River Conductivity Raw (µS)	4640			
8/3/2006	PS25E	River Temperature C	35			
5/25/2006	PS25E	River Temperature C	20.3			
5/25/2006	PS25E	pH	4.8			
5/25/2006	PS25E	Buffer pH	7.24			
5/25/2006	PS25E	OM%	16.1			
5/25/2006	PS25E	M3-P	29.04			
5/25/2006	PS25E	M3-K	349.40			
5/25/2006	PS25E	M3-Ca	1793.87			
5/25/2006	PS25E	M3-Mg	1627.42			
5/25/2006	PS25E	M3-Mn	212.23			
5/25/2006	PS25E	M3-Zn	24.30			
5/25/2006	PS25E	M3-Cu	1.53			
5/25/2006	PS25E	M3-Fe	934.79			
5/25/2006	PS25E	M3-B	4.32			
5/25/2006	PS25E	M3-S	910.65			
5/25/2006	PS25E	M3-Al	903.65			
5/25/2006	PS25E	TN%	0.960			
5/25/2006	PS25E	TC%	10.54			
5/25/2006	PS25E	NH4-N	21.96			
5/25/2006	PS25E	NO3-N	1.12			
5/25/2006	PS25E	EPA-P	761.0			
5/25/2006	PS25E	EPA-S	4232.0			
5/25/2006	PS25E	CA/Mg	1.102278			
5/25/2006	PS25E	N/P	12.61498			
	PS25E	% Inundation	31.07			
	PS25E	Distance Downstream	40.3			
	PS25E	Richness (1000m2) May-June	27			
	PS25E	Richness (1000m2) August	29			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/2/2006	PS27W	Mean Soil Salinity (ppt)	0.45	0.5	0.4	0.3
6/11/2006	PS27W	Mean Soil Salinity (ppt)	0.8	0.6	1	1.5
8/2/2006	PS27W	River Salinity (ppt)	0.3			
6/11/2006	PS27W	River Salinity (ppt)	1.5			
8/2/2006	PS27W	Mean Specific Conductance (µS)	935	960	910	
6/11/2006	PS27W	Mean Specific Conductance (µS)	1564.5	1224	1905	
8/2/2006	PS27W	Mean Raw Conductivity (µS)	985.5	1016	955	
6/11/2006	PS27W	Mean Raw Conductivity (µS)	1394.5	1119	1670	
8/2/2006	PS27W	Mean Temperature C	28.35	28	28.7	
6/11/2006	PS27W	Mean Temperature C	19	19.4	18.6	
8/2/2006	PS27W	River Specific Conductance (µS)	640			
6/11/2006	PS27W	River Specific Conductance (µS)	2919			
8/2/2006	PS27W	River Conductivity Raw (µS)	731			
6/11/2006	PS27W	River Conductivity Raw (µS)	2837			
8/2/2006	PS27W	River Temperature C	33			
6/11/2006	PS27W	River Temperature C	20.1			
6/11/2006	PS27W	pH	4.3			
6/11/2006	PS27W	Buffer pH	7.09			
6/11/2006	PS27W	OM%	28.8			
6/11/2006	PS27W	M3-P	34.05			
6/11/2006	PS27W	M3-K	429.54			
6/11/2006	PS27W	M3-Ca	2132.29			
6/11/2006	PS27W	M3-Mg	1932.08			
6/11/2006	PS27W	M3-Mn	107.42			
6/11/2006	PS27W	M3-Zn	29.60			
6/11/2006	PS27W	M3-Cu	2.00			
6/11/2006	PS27W	M3-Fe	1184.63			
6/11/2006	PS27W	M3-B	5.45			
6/11/2006	PS27W	M3-S	2377.36			
6/11/2006	PS27W	M3-Al	1083.67			
6/11/2006	PS27W	TN%	1.594			
6/11/2006	PS27W	TC%	17.64			
6/11/2006	PS27W	NH4-N	37.51			
6/11/2006	PS27W	NO3-N	0.00			
6/11/2006	PS27W	EPA-P	750.6			
6/11/2006	PS27W	EPA-S	8756.0			
6/11/2006	PS27W	CA/Mg	1.103624			
6/11/2006	PS27W	N/P	21.23634			
	PS27W	% Inundation	28.18			
	PS27W	Distance Downstream	35			
	PS27W	Richness (1000m2) May-June	38			
	PS27W	Richness (1000m2) August	45			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
7/31/2006	PS30E	Mean Soil Salinity (ppt)	0.4	0.6	0.2	0.2
5/25/2006	PS30E	Mean Soil Salinity (ppt)	1.2	1.2	1.2	1.8
7/31/2006	PS30E	River Salinity (ppt)	0.2			
5/25/2006	PS30E	River Salinity (ppt)	1.8			
7/31/2006	PS30E	Mean Specific Conductance (µS)	875	1237	513	
5/25/2006	PS30E	Mean Specific Conductance (µS)	2280	2303	2257	
7/31/2006	PS30E	Mean Raw Conductivity (µS)	915.5	1265	566	
5/25/2006	PS30E	Mean Raw Conductivity (µS)	1981.5	1978	1985	
7/31/2006	PS30E	Mean Temperature C	27.15	25.3	29	
5/25/2006	PS30E	Mean Temperature C	18.3	17.8	18.8	
7/31/2006	PS30E	River Specific Conductance (µS)	362.1			
5/25/2006	PS30E	River Specific Conductance (µS)	3396			
7/31/2006	PS30E	River Conductivity Raw (µS)	416			
5/25/2006	PS30E	River Conductivity Raw (µS)	3103			
7/31/2006	PS30E	River Temperature C	33.3			
5/25/2006	PS30E	River Temperature C	23.2			
5/25/2006	PS30E	pH	3.7			
5/25/2006	PS30E	Buffer pH	7.05			
5/25/2006	PS30E	OM%	26.5			
5/25/2006	PS30E	M3-P	20.29			
5/25/2006	PS30E	M3-K	292.86			
5/25/2006	PS30E	M3-Ca	2095.92			
5/25/2006	PS30E	M3-Mg	2186.61			
5/25/2006	PS30E	M3-Mn	301.27			
5/25/2006	PS30E	M3-Zn	54.97			
5/25/2006	PS30E	M3-Cu	2.86			
5/25/2006	PS30E	M3-Fe	1747.88			
5/25/2006	PS30E	M3-B	4.83			
5/25/2006	PS30E	M3-S	3736.61			
5/25/2006	PS30E	M3-Al	1277.43			
5/25/2006	PS30E	TN%	1.438			
5/25/2006	PS30E	TC%	16.06			
5/25/2006	PS30E	NH4-N	38.46			
5/25/2006	PS30E	NO3-N	0.00			
5/25/2006	PS30E	EPA-P	595.6			
5/25/2006	PS30E	EPA-S	15280.0			
5/25/2006	PS30E	CA/Mg	0.958525			
5/25/2006	PS30E	N/P	24.14534			
	PS30E	% Inundation	58.25			
	PS30E	Distance Downstream	33			
	PS30E	Richness (1000m2) May-June	18			
	PS30E	Richness (1000m2) August	19			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
7/31/2006	PS33W	Mean Soil Salinity (ppt)	0.2	0.2	0.2	0.1
6/11/2006	PS33W	Mean Soil Salinity (ppt)	0.35	0.1	0.6	0.2
7/31/2006	PS33W	River Salinity (ppt)	0.1			
6/11/2006	PS33W	River Salinity (ppt)	0.2			
7/31/2006	PS33W	Mean Specific Conductance (µS)	429.5	524	335	
6/11/2006	PS33W	Mean Specific Conductance (µS)	697.35	216.7	1178	
7/31/2006	PS33W	Mean Raw Conductivity (µS)	446	537	355	
6/11/2006	PS33W	Mean Raw Conductivity (µS)	619.65	197.3	1042	
7/31/2006	PS33W	Mean Temperature C	27.2	26.1	28.3	
6/11/2006	PS33W	Mean Temperature C	18.9	19.1	18.7	
7/31/2006	PS33W	River Specific Conductance (µS)	182.5			
6/11/2006	PS33W	River Specific Conductance (µS)	430.3			
7/31/2006	PS33W	River Conductivity Raw (µS)	203.4			
6/11/2006	PS33W	River Conductivity Raw (µS)	418.8			
7/31/2006	PS33W	River Temperature C	30.9			
6/11/2006	PS33W	River Temperature C	20.4			
6/11/2006	PS33W	pH	4.1			
6/11/2006	PS33W	Buffer pH	7.13			
6/11/2006	PS33W	OM%	30.4			
6/11/2006	PS33W	M3-P	34.28			
6/11/2006	PS33W	M3-K	263.17			
6/11/2006	PS33W	M3-Ca	2528.54			
6/11/2006	PS33W	M3-Mg	1536.69			
6/11/2006	PS33W	M3-Mn	209.08			
6/11/2006	PS33W	M3-Zn	44.97			
6/11/2006	PS33W	M3-Cu	2.21			
6/11/2006	PS33W	M3-Fe	1368.66			
6/11/2006	PS33W	M3-B	5.17			
6/11/2006	PS33W	M3-S	1876.98			
6/11/2006	PS33W	M3-Al	1310.86			
6/11/2006	PS33W	TN%	1.673			
6/11/2006	PS33W	TC%	17.31			
6/11/2006	PS33W	NH4-N	36.74			
6/11/2006	PS33W	NO3-N	0.19			
6/11/2006	PS33W	EPA-P	691.5			
6/11/2006	PS33W	EPA-S	7552.0			
6/11/2006	PS33W	CA/Mg	1.645446			
6/11/2006	PS33W	N/P	24.19308			
	PS33W	% Inundation	32.85			
	PS33W	Distance Downstream	30.1			
	PS33W	Richness (1000m2) May-June	19			
	PS33W	Richness (1000m2) August	20			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/7/2006	PS35W	Mean Soil Salinity (ppt)	0.25	0.2	0.3	0.1
5/26/2006	PS35W	Mean Soil Salinity (ppt)	0.55	0.5	0.6	0.7
8/7/2006	PS35W	River Salinity (ppt)	0.1			
5/26/2006	PS35W	River Salinity (ppt)	0.7			
8/7/2006	PS35W	Mean Specific Conductance (µS)	488.05	437.1	539	
5/26/2006	PS35W	Mean Specific Conductance (µS)	1097	1045	1149	
8/7/2006	PS35W	Mean Raw Conductivity (µS)	495.75	451.5	540	
5/26/2006	PS35W	Mean Raw Conductivity (µS)	936	876	996	
8/7/2006	PS35W	Mean Temperature C	25.75	26.1	25.4	
5/26/2006	PS35W	Mean Temperature C	17.25	16.4	18.1	
8/7/2006	PS35W	River Specific Conductance (µS)	211.6			
5/26/2006	PS35W	River Specific Conductance (µS)	1450			
8/7/2006	PS35W	River Conductivity Raw (µS)	234.3			
5/26/2006	PS35W	River Conductivity Raw (µS)	1328			
8/7/2006	PS35W	River Temperature C	211.6			
5/26/2006	PS35W	River Temperature C	23.5			
5/26/2006	PS35W	pH	4.2			
5/26/2006	PS35W	Buffer pH	7.21			
5/26/2006	PS35W	OM%	45.3			
5/26/2006	PS35W	M3-P	42.75			
5/26/2006	PS35W	M3-K	213.95			
5/26/2006	PS35W	M3-Ca	2619.15			
5/26/2006	PS35W	M3-Mg	1546.92			
5/26/2006	PS35W	M3-Mn	196.50			
5/26/2006	PS35W	M3-Zn	37.91			
5/26/2006	PS35W	M3-Cu	5.33			
5/26/2006	PS35W	M3-Fe	1316.30			
5/26/2006	PS35W	M3-B	5.38			
5/26/2006	PS35W	M3-S	882.70			
5/26/2006	PS35W	M3-Al	1253.67			
5/26/2006	PS35W	TN%	2.463			
5/26/2006	PS35W	TC%	26.35			
5/26/2006	PS35W	NH4-N	31.01			
5/26/2006	PS35W	NO3-N	1.03			
5/26/2006	PS35W	EPA-P	852.7			
5/26/2006	PS35W	EPA-S	6488.0			
5/26/2006	PS35W	CA/Mg	1.693139			
5/26/2006	PS35W	N/P	28.8854			
	PS35W	% Inundation	38.39			
	PS35W	Distance Downstream	27.5			
	PS35W	Richness (1000m2) May-June	31			
	PS35W	Richness (1000m2) August	30			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
7/30/2006	PS40W	Mean Soil Salinity (ppt)	0.2	0.3	0.1	0.1
5/26/2006	PS40W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
7/30/2006	PS40W	River Salinity (ppt)	0.1			
5/26/2006	PS40W	River Salinity (ppt)	0.1			
7/30/2006	PS40W	Mean Specific Conductance (µS)	468.5	645	292	
5/26/2006	PS40W	Mean Specific Conductance (µS)	193.7	172.1	215.3	
7/30/2006	PS40W	Mean Raw Conductivity (µS)	459.2	633	285.4	
5/26/2006	PS40W	Mean Raw Conductivity (µS)	164.65	145.4	183.9	
7/30/2006	PS40W	Mean Temperature C	23.85	24	23.7	
5/26/2006	PS40W	Mean Temperature C	17.05	16.8	17.3	
7/30/2006	PS40W	River Specific Conductance (µS)	125.8			
5/26/2006	PS40W	River Specific Conductance (µS)	191.1			
7/30/2006	PS40W	River Conductivity Raw (µS)	126.5			
5/26/2006	PS40W	River Conductivity Raw (µS)	177.9			
7/30/2006	PS40W	River Temperature C	31.6			
5/26/2006	PS40W	River Temperature C	20.7			
5/26/2006	PS40W	pH	4.5			
5/26/2006	PS40W	Buffer pH	7.25			
5/26/2006	PS40W	OM%	49.0			
5/26/2006	PS40W	M3-P	46.10			
5/26/2006	PS40W	M3-K	213.69			
5/26/2006	PS40W	M3-Ca	3127.13			
5/26/2006	PS40W	M3-Mg	1316.46			
5/26/2006	PS40W	M3-Mn	141.41			
5/26/2006	PS40W	M3-Zn	51.16			
5/26/2006	PS40W	M3-Cu	5.55			
5/26/2006	PS40W	M3-Fe	1179.30			
5/26/2006	PS40W	M3-B	4.03			
5/26/2006	PS40W	M3-S	758.23			
5/26/2006	PS40W	M3-Al	1452.07			
5/26/2006	PS40W	TN%	2.559			
5/26/2006	PS40W	TC%	28.38			
5/26/2006	PS40W	NH4-N	30.05			
5/26/2006	PS40W	NO3-N	2.35			
5/26/2006	PS40W	EPA-P	820.5			
5/26/2006	PS40W	EPA-S	5668.0			
5/26/2006	PS40W	CA/Mg	2.375408			
5/26/2006	PS40W	N/P	31.18906			
	PS40W	% Inundation	17.5			
	PS40W	Distance Downstream	24.9			
	PS40W	Richness (1000m2) May-June	34			
	PS40W	Richness (1000m2) August	30			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/7/2006	PS42E	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
6/9/2006	PS42E	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
8/7/2006	PS42E	River Salinity (ppt)	0.1			
6/9/2006	PS42E	River Salinity (ppt)	0.1			
8/7/2006	PS42E	Mean Specific Conductance (µS)	113.8	108.1	119.5	
6/9/2006	PS42E	Mean Specific Conductance (µS)	155.7	179.1	132.3	
8/7/2006	PS42E	Mean Raw Conductivity (µS)	120.65	107.7	133.6	
6/9/2006	PS42E	Mean Raw Conductivity (µS)	141.15	161.6	120.7	
8/7/2006	PS42E	Mean Temperature C	28.05	25	31.1	
6/9/2006	PS42E	Mean Temperature C	19.85	19.5	20.2	
8/7/2006	PS42E	River Specific Conductance (µS)	120.1			
6/9/2006	PS42E	River Specific Conductance (µS)	127.9			
8/7/2006	PS42E	River Conductivity Raw (µS)	134.5			
6/9/2006	PS42E	River Conductivity Raw (µS)	128.2			
8/7/2006	PS42E	River Temperature C	31.4			
6/9/2006	PS42E	River Temperature C	21.4			
6/9/2006	PS42E	pH	4.8			
6/9/2006	PS42E	Buffer pH	7.22			
6/9/2006	PS42E	OM%	46.5			
6/9/2006	PS42E	M3-P	43.66			
6/9/2006	PS42E	M3-K	237.80			
6/9/2006	PS42E	M3-Ca	3330.34			
6/9/2006	PS42E	M3-Mg	872.14			
6/9/2006	PS42E	M3-Mn	348.36			
6/9/2006	PS42E	M3-Zn	50.88			
6/9/2006	PS42E	M3-Cu	5.04			
6/9/2006	PS42E	M3-Fe	1471.36			
6/9/2006	PS42E	M3-B	4.41			
6/9/2006	PS42E	M3-S	256.91			
6/9/2006	PS42E	M3-Al	1283.50			
6/9/2006	PS42E	TN%	2.574			
6/9/2006	PS42E	TC%	26.42			
6/9/2006	PS42E	NH4-N	43.04			
6/9/2006	PS42E	NO3-N	3.30			
6/9/2006	PS42E	EPA-P	986.4			
6/9/2006	PS42E	EPA-S	3636.9			
6/9/2006	PS42E	CA/Mg	3.818584			
6/9/2006	PS42E	N/P	26.09489			
	PS42E	% Inundation	34.6			
	PS42E	Distance Downstream	19			
	PS42E	Richness (1000m2) May-June	20			
	PS42E	Richness (1000m2) August	22			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/7/2006	PS45E	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
5/27/2006	PS45E	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
8/7/2006	PS45E	River Salinity (ppt)	0.1			
5/27/2006	PS45E	River Salinity (ppt)	0.1			
8/7/2006	PS45E	Mean Specific Conductance (µS)	133.55	142	125.1	
5/27/2006	PS45E	Mean Specific Conductance (µS)	112.8	110.1	115.5	
8/7/2006	PS45E	Mean Raw Conductivity (µS)	149.95	159.1	140.8	
5/27/2006	PS45E	Mean Raw Conductivity (µS)	97.25	91.8	102.7	
8/7/2006	PS45E	Mean Temperature C	31.15	30.9	31.4	
5/27/2006	PS45E	Mean Temperature C	17.95	16.4	19.5	
8/7/2006	PS45E	River Specific Conductance (µS)	122.2			
5/27/2006	PS45E	River Specific Conductance (µS)	119			
8/7/2006	PS45E	River Conductivity Raw (µS)	122.2			
5/27/2006	PS45E	River Conductivity Raw (µS)	111.9			
8/7/2006	PS45E	River Temperature C	31			
5/27/2006	PS45E	River Temperature C	20.9			
5/27/2006	PS45E	pH	4.7			
5/27/2006	PS45E	Buffer pH	7.29			
5/27/2006	PS45E	OM%	61.1			
5/27/2006	PS45E	M3-P	46.95			
5/27/2006	PS45E	M3-K	209.72			
5/27/2006	PS45E	M3-Ca	3720.46			
5/27/2006	PS45E	M3-Mg	1039.16			
5/27/2006	PS45E	M3-Mn	159.22			
5/27/2006	PS45E	M3-Zn	67.59			
5/27/2006	PS45E	M3-Cu	9.45			
5/27/2006	PS45E	M3-Fe	1574.18			
5/27/2006	PS45E	M3-B	5.08			
5/27/2006	PS45E	M3-S	642.97			
5/27/2006	PS45E	M3-Al	1561.03			
5/27/2006	PS45E	TN%	3.216			
5/27/2006	PS45E	TC%	35.62			
5/27/2006	PS45E	NH4-N	32.11			
5/27/2006	PS45E	NO3-N	1.31			
5/27/2006	PS45E	EPA-P	865.2			
5/27/2006	PS45E	EPA-S	6512.0			
5/27/2006	PS45E	CA/Mg	3.580257			
5/27/2006	PS45E	N/P	37.17231			
	PS45E	% Inundation	27.48			
	PS45E	Distance Downstream	15			
	PS45E	Richness (1000m2) May-June	26			
	PS45E	Richness (1000m2) August	24			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/7/2006	PS49W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
6/10/2006	PS49W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	
8/7/2006	PS49W	River Salinity (ppt)	0.1			
6/10/2006	PS49W	River Salinity (ppt)				
8/7/2006	PS49W	Mean Specific Conductance (µS)	125.45	128.9	122	
6/10/2006	PS49W	Mean Specific Conductance (µS)	133.85	137.9	129.8	
8/7/2006	PS49W	Mean Raw Conductivity (µS)	131.2	127.1	135.3	
6/10/2006	PS49W	Mean Raw Conductivity (µS)	117.4	120.9	113.9	
8/7/2006	PS49W	Mean Temperature C	27.35	24	30.7	
6/10/2006	PS49W	Mean Temperature C	18.6	18.5	18.7	
8/7/2006	PS49W	River Specific Conductance (µS)	121			
6/10/2006	PS49W	River Specific Conductance (µS)				
8/7/2006	PS49W	River Conductivity Raw (µS)	134.5			
6/10/2006	PS49W	River Conductivity Raw (µS)				
8/7/2006	PS49W	River Temperature C	30.8			
6/10/2006	PS49W	River Temperature C	21.9			
6/10/2006	PS49W	pH	4.6			
6/10/2006	PS49W	Buffer pH	7.29			
6/10/2006	PS49W	OM%	55.3			
6/10/2006	PS49W	M3-P	64.34			
6/10/2006	PS49W	M3-K	398.26			
6/10/2006	PS49W	M3-Ca	3644.04			
6/10/2006	PS49W	M3-Mg	763.04			
6/10/2006	PS49W	M3-Mn	154.16			
6/10/2006	PS49W	M3-Zn	71.28			
6/10/2006	PS49W	M3-Cu	8.45			
6/10/2006	PS49W	M3-Fe	2081.83			
6/10/2006	PS49W	M3-B	6.41			
6/10/2006	PS49W	M3-S	594.17			
6/10/2006	PS49W	M3-Al	1499.58			
6/10/2006	PS49W	TN%	2.849			
6/10/2006	PS49W	TC%	31.83			
6/10/2006	PS49W	NH4-N	46.20			
6/10/2006	PS49W	NO3-N	1.14			
6/10/2006	PS49W	EPA-P	984.2			
6/10/2006	PS49W	EPA-S	4928.0			
6/10/2006	PS49W	CA/Mg	4.775687			
6/10/2006	PS49W	N/P	28.94619			
	PS49W	% Inundation	42.83			
	PS49W	Distance Downstream	10			
	PS49W	Richness (1000m2) May-June	17			
	PS49W	Richness (1000m2) August	18			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/9/2006	PS55W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
5/27/2006	PS55W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
8/9/2006	PS55W	River Salinity (ppt)	0.1			
5/27/2006	PS55W	River Salinity (ppt)	0.1			
8/9/2006	PS55W	Mean Specific Conductance (µS)	186.8	119.1	254.5	
5/27/2006	PS55W	Mean Specific Conductance (µS)	100.65	104.6	96.7	
8/9/2006	PS55W	Mean Raw Conductivity (µS)	181.8	117.2	246.4	
5/27/2006	PS55W	Mean Raw Conductivity (µS)	88.85	91.6	86.1	
8/9/2006	PS55W	Mean Temperature C	24.1	24.2	24	
5/27/2006	PS55W	Mean Temperature C	18.75	18.4	19.1	
8/9/2006	PS55W	River Specific Conductance (µS)	137.7			
5/27/2006	PS55W	River Specific Conductance (µS)	120.7			
8/9/2006	PS55W	River Conductivity Raw (µS)	145.2			
5/27/2006	PS55W	River Conductivity Raw (µS)	116.2			
8/9/2006	PS55W	River Temperature C	26.9			
5/27/2006	PS55W	River Temperature C	23.2			
5/27/2006	PS55W	pH	4.6			
5/27/2006	PS55W	Buffer pH	7.41			
5/27/2006	PS55W	OM%	51.6			
5/27/2006	PS55W	M3-P	73.80			
5/27/2006	PS55W	M3-K	278.09			
5/27/2006	PS55W	M3-Ca	2370.29			
5/27/2006	PS55W	M3-Mg	498.68			
5/27/2006	PS55W	M3-Mn	159.53			
5/27/2006	PS55W	M3-Zn	109.93			
5/27/2006	PS55W	M3-Cu	8.50			
5/27/2006	PS55W	M3-Fe	1458.11			
5/27/2006	PS55W	M3-B	5.12			
5/27/2006	PS55W	M3-S	327.64			
5/27/2006	PS55W	M3-Al	1615.68			
5/27/2006	PS55W	TN%	2.689			
5/27/2006	PS55W	TC%	29.39			
5/27/2006	PS55W	NH4-N	34.56			
5/27/2006	PS55W	NO3-N	1.51			
5/27/2006	PS55W	EPA-P	827.4			
5/27/2006	PS55W	EPA-S	4100.0			
5/27/2006	PS55W	CA/Mg	4.753128			
5/27/2006	PS55W	N/P	32.4994			
	PS55W	% Inundation	33.42			
	PS55W	Distance Downstream	6			
	PS55W	Richness (1000m2) May-June	25			
	PS55W	Richness (1000m2) August	31			

Date	Plot	Parameter	Value	Salinity S1 (ppt)	Salinity S2 (ppt)	River Salinity (ppt)
8/9/2006	PS56W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
6/10/2006	PS56W	Mean Soil Salinity (ppt)	0.1	0.1	0.1	0.1
8/9/2006	PS56W	River Salinity (ppt)	0.1			
6/10/2006	PS56W	River Salinity (ppt)	0.1			
8/9/2006	PS56W	Mean Specific Conductance (µS)	156.05	179.7	132.4	
6/10/2006	PS56W	Mean Specific Conductance (µS)	109.15	110	108.3	
8/9/2006	PS56W	Mean Raw Conductivity (µS)	159.3	188	130.6	
6/10/2006	PS56W	Mean Raw Conductivity (µS)	101.55	102.2	100.9	
8/9/2006	PS56W	Mean Temperature C	25.75	27.6	23.9	
6/10/2006	PS56W	Mean Temperature C	21.5	21.6	21.4	
8/9/2006	PS56W	River Specific Conductance (µS)	108.9			
6/10/2006	PS56W	River Specific Conductance (µS)	105			
8/9/2006	PS56W	River Conductivity Raw (µS)	112.5			
6/10/2006	PS56W	River Conductivity Raw (µS)	100.3			
8/9/2006	PS56W	River Temperature C	26.8			
6/10/2006	PS56W	River Temperature C	22.5			
6/10/2006	PS56W	pH	4.6			
6/10/2006	PS56W	Buffer pH	7.39			
6/10/2006	PS56W	OM%	36.4			
6/10/2006	PS56W	M3-P	48.21			
6/10/2006	PS56W	M3-K	248.37			
6/10/2006	PS56W	M3-Ca	1801.27			
6/10/2006	PS56W	M3-Mg	400.23			
6/10/2006	PS56W	M3-Mn	273.40			
6/10/2006	PS56W	M3-Zn	116.20			
6/10/2006	PS56W	M3-Cu	3.75			
6/10/2006	PS56W	M3-Fe	1852.13			
6/10/2006	PS56W	M3-B	4.38			
6/10/2006	PS56W	M3-S	315.43			
6/10/2006	PS56W	M3-Al	1603.30			
6/10/2006	PS56W	TN%	2.139			
6/10/2006	PS56W	TC%	22.62			
6/10/2006	PS56W	NH4-N	32.36			
6/10/2006	PS56W	NO3-N	2.53			
6/10/2006	PS56W	EPA-P	821.6			
6/10/2006	PS56W	EPA-S	3443.1			
6/10/2006	PS56W	CA/Mg	4.500587			
6/10/2006	PS56W	N/P	26.03457			
	PS56W	% Inundation	47.32			
	PS56W	Distance Downstream	0			
	PS56W	Richness (1000m2) May-June	26			
	PS56W	Richness (1000m2) August	29			

Appendix B. Raw Species and Plant Cover Data Nanticoke and Patuxent Rivers

Nanticoke May 2006 Plant Species and Cover Data

Date	tributary	plot	Species	cover	MidPoint%
23-May-06	Nan	N00W	SPARPAT	9	85
23-May-06	Nan	N00W	IVA_FRUF	6	17.5
23-May-06	Nan	N00W	SPARALT	5	7.5
23-May-06	Nan	N00W	SPARCYN	5	7.5
24-May-06	Nan	N05W	IVA_FRUF	3	1.5
24-May-06	Nan	N05W	KOSTVIR	1	0.1
24-May-06	Nan	N05W	SPARCYN	3	1.5
24-May-06	Nan	N05W	SCHOROB	2	0.5
24-May-06	Nan	N10E	SPARCYN	2	1
24-May-06	Nan	N10E	SPARPAT	7	50
24-May-06	Nan	N10E	IVA_FRUF	6	18.5
24-May-06	Nan	N10E	SPARALT	7	27.75
24-May-06	Nan	N10E	SCHOROB	2	0.375
24-May-06	Nan	N10E	HIBIMOSM	3	2
24-May-06	Nan	N10E	BACCHAL	2	0.15
24-May-06	Nan	N10E	CARESCOS	2	0.275
24-May-06	Nan	N10E	MIKASCA	2	0.15
24-May-06	Nan	N10E	POLYPEN	2	0.15
24-May-06	Nan	N10E	SCHOAME	4	4.125
24-May-06	Nan	N10E	PHRAAUS	2	0.375
24-May-06	Nan	N15E	SPARCYN	6	17.5
24-May-06	Nan	N15E	SCHOROB	4	3.5
24-May-06	Nan	N15E	HIBIMOSM	5	7.5
24-May-06	Nan	N15E	ELEOOBT	7	37.5
24-May-06	Nan	N15E	POLYHDD	2	0.5
24-May-06	Nan	N15E	MIKASCA	4	3.5
24-May-06	Nan	N15E	PTILCAP	2	0.5
24-May-06	Nan	N15E	CARESCOS	2	0.5
24-May-06	Nan	N15E	SPARPAT	7	37.5
24-May-06	Nan	N15E	IVA_FRUF	7	37.5
24-May-06	Nan	N15E	SPARALT	7	37.5
24-May-06	Nan	N15E	PHRAAUS	1	0.1
24-May-06	Nan	N15E	PELTVIR	1	0.1
24-May-06	Nan	N15E	IMPACPN	1	0.1
24-May-06	Nan	N05W	SPARPAT	8	62.5
24-May-06	Nan	N05W	SCHOAME	5	7.5
24-May-06	Nan	N05W	SPARALT	5	7.5
24-May-06	Nan	N05W	LYTHLIN	2	0.5
25-May-06	Nan	N19E	CARESCOS	6	17.5
25-May-06	Nan	N19E	LEERORY	1	0.1
25-May-06	Nan	N19E	JUNCACU	3	1.5
25-May-06	Nan	N19E	ELEOOBT	7	37.5
25-May-06	Nan	N19E	IVA_FRUF	6	17.5

25-May-06	Nan	N19E	SPARPAT	6	17.5
25-May-06	Nan	N19E	POLYARI	1	0.1
25-May-06	Nan	N19E	SPARALT	4	3.5
25-May-06	Nan	N19E	SCHOROB	2	0.5
25-May-06	Nan	N19E	PTILCAP	1	0.1
25-May-06	Nan	N19E	CARETRBT	1	0.1
25-May-06	Nan	N19E	LYSI1S1	1	0.1
25-May-06	Nan	N19E	AMARCAN	1	0.1
25-May-06	Nan	N19E	EUPA1S1	2	0.5
25-May-06	Nan	N19E	IMPACPN	1	0.1
25-May-06	Nan	N19E	IRIS1S1	1	0.1
25-May-06	Nan	N19E	SPARCYN	1	0.1
25-May-06	Nan	N19E	POLYHDD	1	0.1
25-May-06	Nan	N25E	ACORCAL	5	7.5
25-May-06	Nan	N25E	PELTVIR	8	62.5
25-May-06	Nan	N25E	LEERORY	5	7.5
25-May-06	Nan	N25E	SPARCYN	6	17.5
25-May-06	Nan	N25E	HIBIMOSM	2	0.5
25-May-06	Nan	N25E	IMPACPN	4	3.5
25-May-06	Nan	N25E	POLY1S1	2	0.5
25-May-06	Nan	N25E	POLYARI	2	0.5
25-May-06	Nan	N25E	RUMEVER	5	7.5
25-May-06	Nan	N25E	CALYSEP	1	0.1
25-May-06	Nan	N25E	PTILCAP	1	0.1
25-May-06	Nan	N25E	MIKASCA	2	0.5
25-May-06	Nan	N25E	TYPHXGL	5	7.5
25-May-06	Nan	N25E	ELEOOBT	1	0.1
25-May-06	Nan	N25E	CARESCOS	2	0.5
25-May-06	Nan	N25E	GALITIN	1	0.1
25-May-06	Nan	N25E	DECOVER	1	0.1
25-May-06	Nan	N25E	TYPHANS	2	0.5
25-May-06	Nan	N25E	AMARCAN	1	0.1
25-May-06	Nan	N25E	CUSCGROG	1	0.1
25-May-06	Nan	N25E	PHRAAUS	2	0.5
25-May-06	Nan	N25E	SCIR1S1	3	1.5
25-May-06	Nan	N25E	BIDE1S1	1	0.1
25-May-06	Nan	N25E	SIUMSUA	1	0.1
25-May-06	Nan	N25E	SCHOTAB	2	0.5
25-May-06	Nan	N25E	PONTCOR	1	0.1
25-May-06	Nan	N25E	SCHOPUN	1	0.1
25-May-06	Nan	N30E	PELTVIR	8	62.5
25-May-06	Nan	N30E	IMPACPN	4	3.5
25-May-06	Nan	N30E	POLYARI	5	7.5
25-May-06	Nan	N30E	ZIZAAQU1	4	3.5
25-May-06	Nan	N30E	TYPHANS	6	17.5
25-May-06	Nan	N30E	BIDELAE	2	0.5
25-May-06	Nan	N30E	SCIR1S1	2	0.5
25-May-06	Nan	N30E	HIBIMOSM	2	0.5
25-May-06	Nan	N30E	CUSCGROG	1	0.1
25-May-06	Nan	N30E	BIDE1S1	1	0.1

25-May-06	Nan	N30E	AMARCAN	3	1.5
25-May-06	Nan	N30E	SIUMSUA	1	0.1
25-May-06	Nan	N30E	MENTARV	1	0.1
25-May-06	Nan	N30E	LEERORY	1	0.1
25-May-06	Nan	N30E	NUPHLUT	1	0.1
25-May-06	Nan	N30E	POLYPUN1	1	0.1
25-May-06	Nan	N30E	SPARAME	2	0.5
25-May-06	Nan	N30E	SCHOTAB	2	0.5
25-May-06	Nan	N19E	PANIVIRV	7	37.5
25-May-06	Nan	N19E	MIKASCA	3	1.5
25-May-06	Nan	N19E	SIUMSUA	1	0.1
25-May-06	Nan	N19E	HIBIMOSM	5	7.5
25-May-06	Nan	N19E	PELTVIR	2	0.5
25-May-06	Nan	N19E	PLUCODOO	2	0.5
26-May-06	Nan	N35W	IRIS1S1	1	0.1
26-May-06	Nan	N35W	SCHOPUN	1	0.1
26-May-06	Nan	N35W	TYPHLAT	2	0.5
26-May-06	Nan	N35W	THELPALP	2	0.5
26-May-06	Nan	N35W	MENTSPI	2	0.5
26-May-06	Nan	N35W	MORECER	1	0.1
26-May-06	Nan	N40W	POLYARI	6	17.5
26-May-06	Nan	N40W	ACORCAL	9	85
26-May-06	Nan	N40W	IMPACPN	6	17.5
26-May-06	Nan	N40W	POLYSAG	3	1.5
26-May-06	Nan	N40W	PELTVIR	7	37.5
26-May-06	Nan	N40W	GALITIN	3	1.5
26-May-06	Nan	N40W	CUSCGROG	1	0.1
26-May-06	Nan	N40W	TYPHLAT	2	0.5
26-May-06	Nan	N40W	SCIR1S1	2	0.5
26-May-06	Nan	N40W	SPARAME	2	0.5
26-May-06	Nan	N40W	MIKASCA	1	0.1
26-May-06	Nan	N40W	CINN1S1	4	3.5
26-May-06	Nan	N40W	CICUMACM	4	3.5
26-May-06	Nan	N40W	LEERORY	1	0.1
26-May-06	Nan	N40W	CEPHOCC	2	0.5
26-May-06	Nan	N40W	BIDE1S1	2	0.5
26-May-06	Nan	N40W	NUPHLUT	1	0.1
26-May-06	Nan	N40W	ZIZAAQU1	1	0.1
26-May-06	Nan	N40W	BIDELAE	2	0.5
26-May-06	Nan	N40W	SCHOTAB	2	0.5
26-May-06	Nan	N40W	UNK2	1	0.1
26-May-06	Nan	N40W	CARESCOS	2	0.5
26-May-06	Nan	N40W	CARELUR	2	0.5
26-May-06	Nan	N40W	BOEHCYL	3	1.5
26-May-06	Nan	N40W	CARESTC	2	0.5
26-May-06	Nan	N40W	UNK3	2	0.5
26-May-06	Nan	N40W	ACERRUB	1	0.1
26-May-06	Nan	N40W	VIOLCUC	1	0.1
26-May-06	Nan	N40W	SYMPPUNP	4	3.5
26-May-06	Nan	N40W	CAREKOB	2	0.5

26-May-06	Nan	N40W	HIBIMOSM	2	0.5
26-May-06	Nan	N40W	APIOAME	2	0.5
26-May-06	Nan	N40W	IRIS1S1	1	0.1
26-May-06	Nan	N40W	CARESTP	2	0.5
26-May-06	Nan	N35W	BIDE1S1	2	0.5
26-May-06	Nan	N35W	ACORCAL	9	85
26-May-06	Nan	N35W	POLYSAG	6	17.5
26-May-06	Nan	N35W	POLYARI	6	17.5
26-May-06	Nan	N35W	CUSCGROG	1	0.1
26-May-06	Nan	N35W	CINNARU	5	7.5
26-May-06	Nan	N35W	PELTVIR	7	37.5
26-May-06	Nan	N35W	IMPACPN	6	17.5
26-May-06	Nan	N35W	SCHOTAB	2	0.5
26-May-06	Nan	N35W	GALITIN	4	3.5
26-May-06	Nan	N35W	MIKASCA	1	0.1
26-May-06	Nan	N35W	LEERORY	1	0.1
26-May-06	Nan	N35W	STAC1S1	3	1.5
26-May-06	Nan	N35W	ASTE1S1	3	1.5
26-May-06	Nan	N35W	CARESCOS	2	0.5
26-May-06	Nan	N35W	CICUMACM	2	0.5
26-May-06	Nan	N35W	SIUMSUA	1	0.1
26-May-06	Nan	N35W	CAREVUL	2	0.5
26-May-06	Nan	N35W	BOEHCYL	3	1.5
26-May-06	Nan	N35W	NYSSBIF	2	0.5
26-May-06	Nan	N35W	BIDELAE	1	0.1
26-May-06	Nan	N35W	SPARAME	2	0.5
26-May-06	Nan	N35W	ALNUSER	1	0.1
26-May-06	Nan	N35W	SCIR1S1	3	1.5
26-May-06	Nan	N35W	RUMEVER	3	1.5
27-May-06	Nan	N55W	LEERORY	1	0.1
27-May-06	Nan	N55W	POLYSAG	3	1.5
27-May-06	Nan	N55W	POLYPUN1	1	0.1
27-May-06	Nan	N55W	MIKASCA	1	0.1
27-May-06	Nan	N55W	IRIS1S1	1	0.1
27-May-06	Nan	N55W	CEPHOCC	1	0.1
27-May-06	Nan	N55W	UNK3	1	0.1
27-May-06	Nan	N55W	APIOAME	1	0.1
27-May-06	Nan	N55W	DECOVER	1	0.1
27-May-06	Nan	N55W	CARESTC	2	0.5
27-May-06	Nan	N55W	THALPUB	1	0.1
27-May-06	Nan	N55W	LILISUP	1	0.1
27-May-06	Nan	N55W	STAC1S1	1	0.1
27-May-06	Nan	N55W	NUPHLUT	4	3.5
27-May-06	Nan	N55W	UNK2	1	0.1
27-May-06	Nan	N55W	VERNNOV	1	0.1
27-May-06	Nan	N55W	ROSAPAL	2	0.5
27-May-06	Nan	N45E	ACORCAL	9	85
27-May-06	Nan	N45E	IMPACPN	7	37.5
27-May-06	Nan	N45E	POLYARI	6	17.5
27-May-06	Nan	N45E	BIDELAE	2	0.5

27-May-06	Nan	N45E	CINNARU	3	1.5
27-May-06	Nan	N45E	CAREKOB	2	0.5
27-May-06	Nan	N45E	PELTVIR	6	17.5
27-May-06	Nan	N45E	POLYSAG	6	17.5
27-May-06	Nan	N45E	GALITIN	4	3.5
27-May-06	Nan	N45E	CICUMACM	3	1.5
27-May-06	Nan	N45E	CARESCOS	2	0.5
27-May-06	Nan	N45E	SYMPPUNP	2	0.5
27-May-06	Nan	N45E	CUSCGROG	1	0.1
27-May-06	Nan	N45E	BIDE1S1	4	3.5
27-May-06	Nan	N45E	BIDECOR	3	1.5
27-May-06	Nan	N45E	DULIARU	1	0.1
27-May-06	Nan	N45E	DECOVER	1	0.1
27-May-06	Nan	N45E	ROSAPAL	1	0.1
27-May-06	Nan	N45E	MIKASCA	1	0.1
27-May-06	Nan	N45E	BOEHCYL	2	0.5
27-May-06	Nan	N45E	CEPHOCC	2	0.5
27-May-06	Nan	N45E	IRIS1S1	1	0.1
27-May-06	Nan	N45E	VERNNOV	1	0.1
27-May-06	Nan	N45E	HIBIMOSM	2	0.5
27-May-06	Nan	N45E	CARELUR	1	0.1
27-May-06	Nan	N45E	APIOAME	1	0.1
27-May-06	Nan	N55W	ACORCAL	9	85
27-May-06	Nan	N55W	IMPACPN	4	3.5
27-May-06	Nan	N55W	PELTVIR	5	7.5
27-May-06	Nan	N55W	COMMCOM	3	1.5
27-May-06	Nan	N55W	UNK1	1	0.1
27-May-06	Nan	N55W	POLYARI	3	1.5
27-May-06	Nan	N55W	BIDELAE	2	0.5
27-May-06	Nan	N55W	GALITIN	1	0.1
9-Jun-06	Nan	N42E	ACORCAL	9	85
9-Jun-06	Nan	N42E	IMPACPN	7	37.5
9-Jun-06	Nan	N42E	POLYARI	7	37.5
9-Jun-06	Nan	N42E	BIDECOR	5	7.5
9-Jun-06	Nan	N42E	LEERORY	1	0.1
9-Jun-06	Nan	N42E	CUSCGROG	2	0.5
9-Jun-06	Nan	N42E	PELTVIR	6	17.5
9-Jun-06	Nan	N42E	BIDEFRO	3	1.5
9-Jun-06	Nan	N42E	TYPHLAT	4	3.5
9-Jun-06	Nan	N42E	SAGILAT	2	0.5
9-Jun-06	Nan	N42E	SPARAME	2	0.5
9-Jun-06	Nan	N42E	CINN1S1	3	1.5
9-Jun-06	Nan	N42E	SYMPPUNP	3	1.5
9-Jun-06	Nan	N42E	BIDELAE	4	3.5
9-Jun-06	Nan	N42E	NUPHLUT	5	7.5
9-Jun-06	Nan	N42E	HIBIMOSM	2	0.5
9-Jun-06	Nan	N42E	MIKASCA	1	0.1
9-Jun-06	Nan	N42E	IRIS1S1	1	0.1
9-Jun-06	Nan	N42E	MENTARV	3	1.5
9-Jun-06	Nan	N42E	CEPHOCC	3	1.5

10-Jun-06	Nan	N49W	PELTVIR	6	17.5
10-Jun-06	Nan	N49W	IMPACPN	4	3.5
10-Jun-06	Nan	N49W	CUSCGROG	3	1.5
10-Jun-06	Nan	N49W	LEERORY	4	3.5
10-Jun-06	Nan	N49W	CINNARU	3	1.5
10-Jun-06	Nan	N49W	POLYSAG	3	1.5
10-Jun-06	Nan	N49W	BIDECOR	2	0.5
10-Jun-06	Nan	N49W	GALITIN	4	3.5
10-Jun-06	Nan	N49W	BIDEFRO	2	0.5
10-Jun-06	Nan	N49W	LUDWPAL	1	0.1
10-Jun-06	Nan	N49W	BIDELAE	2	0.5
10-Jun-06	Nan	N49W	CEPHOCC	1	0.1
10-Jun-06	Nan	N49W	CAREKOB	3	1.5
10-Jun-06	Nan	N49W	NUPHLUT	2	0.5
10-Jun-06	Nan	N56W	ACORCAL	9	85
10-Jun-06	Nan	N56W	PELTVIR	6	17.5
10-Jun-06	Nan	N56W	LEERORY	4	3.5
10-Jun-06	Nan	N56W	POLYLAP	4	3.5
10-Jun-06	Nan	N56W	COMMCOM	4	3.5
10-Jun-06	Nan	N56W	UNK2	3	1.5
10-Jun-06	Nan	N56W	POLYARI	4	3.5
10-Jun-06	Nan	N56W	POLYSAG	1	0.1
10-Jun-06	Nan	N56W	NUPHLUT	7	37.5
10-Jun-06	Nan	N56W	MIKASCA	1	0.1
10-Jun-06	Nan	N56W	IMPACPN	2	0.5
10-Jun-06	Nan	N56W	CORNAMO	3	1.5
10-Jun-06	Nan	N56W	RUBU1S1	3	1.5
10-Jun-06	Nan	N56W	SAMBNIGC	3	1.5
10-Jun-06	Nan	N56W	CEPHOCC	4	3.5
10-Jun-06	Nan	N56W	TOXIRAD	2	0.5
10-Jun-06	Nan	N56W	CARE1S1	3	1.5
10-Jun-06	Nan	N56W	LUDWPAL	1	0.1
10-Jun-06	Nan	N56W	FRAXPEN	5	7.5
10-Jun-06	Nan	N56W	VIBUREC	2	0.5
10-Jun-06	Nan	N56W	APIOAME	1	0.1
10-Jun-06	Nan	N56W	THAL1S1	2	0.5
10-Jun-06	Nan	N56W	VIOL1S1	1	0.1
10-Jun-06	Nan	N56W	PARTQUI	1	0.1
10-Jun-06	Nan	N56W	SYMPPUNP	1	0.1
10-Jun-06	Nan	N56W	BOEHCYL	1	0.1
10-Jun-06	Nan	N49W	ACORCAL	9	85
10-Jun-06	Nan	N49W	POLYARI	7	37.5
10-Jun-06	Nan	N49W	COMMCOM	5	7.5
11-Jun-06	Nan	N27W	POLYARI	4	3.5
11-Jun-06	Nan	N27W	PELTVIR	5	7.5
11-Jun-06	Nan	N27W	SPARALT	1	0.1
11-Jun-06	Nan	N27W	POLYLAP	2	0.5
11-Jun-06	Nan	N27W	SCHOAME	3	1.5
11-Jun-06	Nan	N27W	SCHOTAB	2	0.5
11-Jun-06	Nan	N27W	SPARCYN	8	62.5

11-Jun-06	Nan	N27W	ELEO1S1	5	7.5
11-Jun-06	Nan	N27W	HIBIMOSM	1	0.1
11-Jun-06	Nan	N27W	IMPACPN	6	17.5
11-Jun-06	Nan	N27W	CARESTC	5	7.5
11-Jun-06	Nan	N27W	GALITIN	3	1.5
11-Jun-06	Nan	N27W	STAC1T1	4	3.5
11-Jun-06	Nan	N27W	LEERORY	2	0.5
11-Jun-06	Nan	N27W	ASCLINC	1	0.1
11-Jun-06	Nan	N27W	BOEHCYL	1	0.1
11-Jun-06	Nan	N27W	MIKASCA	3	1.5
11-Jun-06	Nan	N27W	BIDELAE	1	0.1
11-Jun-06	Nan	N27W	RUMEVER	2	0.5
11-Jun-06	Nan	N27W	SYMPPUNP	1	0.1
11-Jun-06	Nan	N27W	PHRAAUS	7	37.5
11-Jun-06	Nan	N27W	JUNCEFF	2	0.5
11-Jun-06	Nan	N27W	THAL1S1	2	0.5
11-Jun-06	Nan	N27W	TOXIRAD	4	3.5
11-Jun-06	Nan	N27W	IRIS1S1	3	1.5
11-Jun-06	Nan	N27W	CARESCOS	2	0.5
11-Jun-06	Nan	N27W	TRIAVIR	2	0.5
11-Jun-06	Nan	N27W	UNK1	1	0.1
11-Jun-06	Nan	N27W	EUPAPERP	1	0.1
11-Jun-06	Nan	N27W	BOEHCYL	3	1.5
11-Jun-06	Nan	N27W	POLYCONC	1	0.1
11-Jun-06	Nan	N27W	ROSAPAL	3	1.5
11-Jun-06	Nan	N27W	HELEAUT	1	0.1
11-Jun-06	Nan	N27W	OSMUCINC	2	0.5
11-Jun-06	Nan	N27W	TYPHLAT	1	0.1
11-Jun-06	Nan	N27W	TYPHANS	1	0.1
11-Jun-06	Nan	N27W	PTILCAP	1	0.1
11-Jun-06	Nan	N27W	CUSCGROG	1	0.1
11-Jun-06	Nan	N33W	PELTVIR	8	62.5
11-Jun-06	Nan	N33W	ACORCAL	6	17.5
11-Jun-06	Nan	N33W	POLYARI	7	37.5
11-Jun-06	Nan	N33W	HIBIMOSM	5	7.5
11-Jun-06	Nan	N33W	CUSCGROG	2	0.5
11-Jun-06	Nan	N33W	IMPACPN	4	3.5
11-Jun-06	Nan	N33W	TYPHANS	5	7.5
11-Jun-06	Nan	N33W	SCHOTAB	3	1.5
11-Jun-06	Nan	N33W	LEERORY	1	0.1
11-Jun-06	Nan	N33W	BIDELAE	4	3.5
11-Jun-06	Nan	N33W	SIUMSUA	1	0.1
11-Jun-06	Nan	N33W	PTILCAP	2	0.5
11-Jun-06	Nan	N33W	CINNARU	2	0.5
11-Jun-06	Nan	N33W	RUMEVER	3	1.5
11-Jun-06	Nan	N33W	LYSI1S1	1	0.1
11-Jun-06	Nan	N33W	POLY1S1	3	1.5
11-Jun-06	Nan	N33W	NUPHLUT	2	0.5
11-Jun-06	Nan	N33W	CICUMACM	1	0.1
11-Jun-06	Nan	N33W	BIDECOR	1	0.1

Nanticoke August 2006 Plant Species and Cover Data

Date	tributary	plot	Species	cover	MidPoint%
30-Jul-06	Nan	N40W	ACORCAL	7	37.5
30-Jul-06	Nan	N40W	POLYARI	7	37.5
30-Jul-06	Nan	N40W	IMPACPN	8	62.5
30-Jul-06	Nan	N40W	POLYSAG	3	1.5
30-Jul-06	Nan	N40W	PELTVIR	3	1.5
30-Jul-06	Nan	N40W	GALITIN	4	3.5
30-Jul-06	Nan	N40W	CUSCGROG	2	0.5
30-Jul-06	Nan	N40W	LEERORY	4	3.5
30-Jul-06	Nan	N40W	CINNARU	4	3.5
30-Jul-06	Nan	N40W	TYPHXGL	3	1.5
30-Jul-06	Nan	N40W	BIDECOR	3	1.5
30-Jul-06	Nan	N40W	MIKASCA	3	1.5
30-Jul-06	Nan	N40W	SCIR1S1	2	0.5
30-Jul-06	Nan	N40W	TYPHLAT	4	3.5
30-Jul-06	Nan	N40W	CICUMACM	3	1.5
30-Jul-06	Nan	N40W	CEPHOCC	3	1.5
30-Jul-06	Nan	N40W	SYMPPUNP	2	0.5
30-Jul-06	Nan	N40W	NUPHLUT	3	1.5
30-Jul-06	Nan	N40W	SPARAME	1	0.1
30-Jul-06	Nan	N40W	SCHOTAB	1	0.1
30-Jul-06	Nan	N40W	CARESCOS	1	0.1
30-Jul-06	Nan	N40W	BOEHCYL	4	3.5
30-Jul-06	Nan	N40W	CARESTC	1	0.1
30-Jul-06	Nan	N40W	ACERRUB	1	0.1
30-Jul-06	Nan	N40W	CARELUR	1	0.1
30-Jul-06	Nan	N40W	VIOL1S1	1	0.1
30-Jul-06	Nan	N40W	CARECMS	2	0.5
30-Jul-06	Nan	N40W	HIBIMOSM	4	3.5
30-Jul-06	Nan	N40W	AMARCAN	1	0.1
30-Jul-06	Nan	N40W	ASCLINC	1	0.1
31-Jul-06	Nan	N30E	SCHOTAB	2	0.5
31-Jul-06	Nan	N30E	PELTVIR	4	3.5
31-Jul-06	Nan	N30E	POLYARI	9	85
31-Jul-06	Nan	N30E	ZIZAAQU1	6	17.5
31-Jul-06	Nan	N30E	BIDELAE	3	1.5
31-Jul-06	Nan	N30E	TYPHANS	4	3.5
31-Jul-06	Nan	N30E	AMARCAN	3	1.5
31-Jul-06	Nan	N30E	CUSCGROG	2	0.5
31-Jul-06	Nan	N30E	SCIR1S1	2	0.5
31-Jul-06	Nan	N30E	BIDECOR	1	0.1
31-Jul-06	Nan	N30E	CICUMACM	1	0.1
31-Jul-06	Nan	N30E	IMPACPN	3	1.5
31-Jul-06	Nan	N30E	CINN1S1	1	0.1
31-Jul-06	Nan	N30E	HIBIMOSM	4	3.5
31-Jul-06	Nan	N30E	SCUTGAL	1	0.1
31-Jul-06	Nan	N30E	SIUMSUA	3	1.5
31-Jul-06	Nan	N30E	LEERORY	2	0.5

31-Jul-06	Nan	N30E	POLYHDR	2	0.5
31-Jul-06	Nan	N30E	PONTCOR	3	1.5
31-Jul-06	Nan	N33W	HIBIMOSM	4	3.5
31-Jul-06	Nan	N33W	PELTVIR	7	37.5
31-Jul-06	Nan	N33W	POLYARI	8	62.5
31-Jul-06	Nan	N33W	ACORCAL	6	17.5
31-Jul-06	Nan	N33W	CUSCGROG	3	1.5
31-Jul-06	Nan	N33W	IMPACPN	4	3.5
31-Jul-06	Nan	N33W	SCHOTAB	2	0.5
31-Jul-06	Nan	N33W	LEERORY	2	0.5
31-Jul-06	Nan	N33W	TYPHANS	5	7.5
31-Jul-06	Nan	N33W	PTILCAP	1	0.1
31-Jul-06	Nan	N33W	AMARCAN	2	0.5
31-Jul-06	Nan	N33W	CINNARU	2	0.5
31-Jul-06	Nan	N33W	TYPHXGL	2	0.5
31-Jul-06	Nan	N33W	ZIZAAQU1	3	1.5
31-Jul-06	Nan	N33W	BIDELAE	1	0.1
31-Jul-06	Nan	N33W	BIDECOR	1	0.1
31-Jul-06	Nan	N33W	SAGILAT	2	0.5
31-Jul-06	Nan	N33W	SCIR1S1	2	0.5
31-Jul-06	Nan	N33W	POLYHDR	2	0.5
31-Jul-06	Nan	N33W	POLYSAG	1	0.1
2-Aug-06	Nan	N19E	SONCOLE	2	0.5
2-Aug-06	Nan	N19E	LEERORY	4	3.5
2-Aug-06	Nan	N19E	PANIVIRV	7	37.5
2-Aug-06	Nan	N19E	HIBIMOSM	6	17.5
2-Aug-06	Nan	N19E	MIKASCA	3	1.5
2-Aug-06	Nan	N19E	DISTSPI	4	3.5
2-Aug-06	Nan	N19E	KOSTVIR	3	1.5
2-Aug-06	Nan	N19E	PELTVIR	1	0.1
2-Aug-06	Nan	N19E	CINNARU	1	0.1
2-Aug-06	Nan	N19E	PLUCODOO	3	1.5
2-Aug-06	Nan	N19E	ASCLINC	3	1.5
2-Aug-06	Nan	N19E	JUNCCAN	4	3.5
2-Aug-06	Nan	N19E	CYPE1S1	2	0.5
2-Aug-06	Nan	N19E	SYMPPUNP	1	0.1
2-Aug-06	Nan	N19E	IVA_FRUF	3	1.5
2-Aug-06	Nan	N19E	EUPAPERP	3	1.5
2-Aug-06	Nan	N19E	CYPESTR	1	0.1
2-Aug-06	Nan	N19E	SPARALT	4	3.5
2-Aug-06	Nan	N19E	SPARPAT	5	7.5
2-Aug-06	Nan	N19E	ELEOPAR	2	0.5
2-Aug-06	Nan	N19E	SPARCYN	2	0.5
2-Aug-06	Nan	N19E	SCIR1S1	2	0.5
2-Aug-06	Nan	N27W	SPARCYN	8	62.5
2-Aug-06	Nan	N27W	POLYARI	5	7.5
2-Aug-06	Nan	N27W	PELTVIR	4	3.5
2-Aug-06	Nan	N27W	KOSTVIR	3	1.5
2-Aug-06	Nan	N27W	SCHOTAB	2	0.5
2-Aug-06	Nan	N27W	POLYPUN1	1	0.1

2-Aug-06	Nan	N27W	SCHOAME	3	1.5
2-Aug-06	Nan	N27W	IMPACPN	3	1.5
2-Aug-06	Nan	N27W	LEERORY	3	1.5
2-Aug-06	Nan	N27W	PLUCODOO	2	0.5
2-Aug-06	Nan	N27W	MIKASCA	4	3.5
2-Aug-06	Nan	N27W	POLYHDR	3	1.5
2-Aug-06	Nan	N27W	HIBIMOSM	5	7.5
2-Aug-06	Nan	N27W	HYPEMUT	1	0.1
2-Aug-06	Nan	N27W	TEUCCAN	4	3.5
2-Aug-06	Nan	N27W	CARESTC	5	7.5
2-Aug-06	Nan	N27W	GALITIN	2	0.5
2-Aug-06	Nan	N27W	SYMPPUNP	2	0.5
2-Aug-06	Nan	N27W	CYPESTR	1	0.1
2-Aug-06	Nan	N27W	CINNARU	1	0.1
2-Aug-06	Nan	N27W	LOBECAR	2	0.5
2-Aug-06	Nan	N27W	PANIVIRV	5	7.5
2-Aug-06	Nan	N27W	AMARCAN	2	0.5
2-Aug-06	Nan	N27W	TOXIRAD	3	1.5
2-Aug-06	Nan	N27W	EUPAPERP	2	0.5
2-Aug-06	Nan	N27W	PHRAAUS	6	17.5
2-Aug-06	Nan	N27W	THAL1S1	1	0.1
2-Aug-06	Nan	N27W	JUNCEFF	2	0.5
2-Aug-06	Nan	N27W	CAREFRN	2	0.5
2-Aug-06	Nan	N27W	IRIS1S1	3	1.5
2-Aug-06	Nan	N27W	ROSAPAL	3	1.5
2-Aug-06	Nan	N27W	LYCOAME	1	0.1
2-Aug-06	Nan	N27W	CUSCGROG	2	0.5
2-Aug-06	Nan	N27W	BOEHCYL	4	3.5
2-Aug-06	Nan	N27W	CARE1S1	1	0.1
2-Aug-06	Nan	N27W	ELEO1S1	2	0.5
2-Aug-06	Nan	N27W	ASCLINC	2	0.5
2-Aug-06	Nan	N27W	TYPHLAT	2	0.5
2-Aug-06	Nan	N27W	SAGILAT	2	0.5
2-Aug-06	Nan	N27W	CICUMACM	1	0.1
2-Aug-06	Nan	N27W	UNK5	1	0.1
2-Aug-06	Nan	N27W	OSMUCINC	2	0.5
2-Aug-06	Nan	N27W	PONTCOR	3	1.5
2-Aug-06	Nan	N27W	TYPHXGL	1	0.1
2-Aug-06	Nan	N27W	SCUTLATL	1	0.1
3-Aug-06	Nan	N15E	SPARCYN	6	17.5
3-Aug-06	Nan	N15E	SCHOROB	3	1.5
3-Aug-06	Nan	N15E	HIBIMOSM	4	3.5
3-Aug-06	Nan	N15E	MIKASCA	3	1.5
3-Aug-06	Nan	N15E	ELEO1S1	4	3.5
3-Aug-06	Nan	N15E	SYMPPUNP	1	0.1
3-Aug-06	Nan	N15E	PLUCODOO	3	1.5
3-Aug-06	Nan	N15E	IVA_FRUF	8	62.5
3-Aug-06	Nan	N15E	SPARALT	7	37.5
3-Aug-06	Nan	N15E	PTILCAP	1	0.1
3-Aug-06	Nan	N15E	KOSTVIR	3	1.5

3-Aug-06	Nan	N15E	DISTSPI	4	3.5
3-Aug-06	Nan	N15E	PHRAAUS	2	0.5
3-Aug-06	Nan	N15E	SPARPAT	3	1.5
3-Aug-06	Nan	N15E	ELEOPAR	2	0.5
3-Aug-06	Nan	N15E	ASCLINC	1	0.1
3-Aug-06	Nan	N15E	AMARCAN	1	0.1
3-Aug-06	Nan	N25E	ACORCAL	4	3.5
3-Aug-06	Nan	N25E	LEERORY	5	7.5
3-Aug-06	Nan	N25E	PELTVIR	7	37.5
3-Aug-06	Nan	N25E	HIBIMOSM	5	7.5
3-Aug-06	Nan	N25E	IMPACPN	3	1.5
3-Aug-06	Nan	N25E	POLYARI	3	1.5
3-Aug-06	Nan	N25E	POLYPRS	2	0.5
3-Aug-06	Nan	N25E	SPARCYN	8	62.5
3-Aug-06	Nan	N25E	MIKASCA	6	17.5
3-Aug-06	Nan	N25E	ASCLINC	3	1.5
3-Aug-06	Nan	N25E	POLYHDR	2	0.5
3-Aug-06	Nan	N25E	CINNARU	1	0.1
3-Aug-06	Nan	N25E	RUMEVER	3	1.5
3-Aug-06	Nan	N25E	CUSCGROG	3	1.5
3-Aug-06	Nan	N25E	PLUCODOO	2	0.5
3-Aug-06	Nan	N25E	PTILCAP	3	1.5
3-Aug-06	Nan	N25E	ELEO1S1	3	1.5
3-Aug-06	Nan	N25E	KOSTVIR	3	1.5
3-Aug-06	Nan	N25E	TYPHANS	4	3.5
3-Aug-06	Nan	N25E	TYPHLAT	4	3.5
3-Aug-06	Nan	N25E	GALITIN	2	0.5
3-Aug-06	Nan	N25E	AMARCAN	1	0.1
3-Aug-06	Nan	N25E	PHRAAUS	3	1.5
3-Aug-06	Nan	N25E	BIDECOR	1	0.1
3-Aug-06	Nan	N25E	SCHOROB	3	1.5
3-Aug-06	Nan	N25E	PONTCOR	2	0.5
3-Aug-06	Nan	N25E	TEUCCAN	2	0.5
3-Aug-06	Nan	N25E	JUNCEFF	4	3.5
3-Aug-06	Nan	N25E	SCHOTAB	2	0.5
4-Aug-06	Nan	N00W	SPARPAT	9	85
4-Aug-06	Nan	N00W	IVA_FRUF	5	7.5
4-Aug-06	Nan	N00W	DISTSPI	5	7.5
4-Aug-06	Nan	N00W	SCHOROB	2	0.5
4-Aug-06	Nan	N00W	PLUC1S1	3	1.5
4-Aug-06	Nan	N00W	ELEOPAR	1	0.1
4-Aug-06	Nan	N00W	SYMPSUB	2	0.5
4-Aug-06	Nan	N00W	KOSTVIR	2	0.5
4-Aug-06	Nan	N00W	SPARALT	6	17.5
4-Aug-06	Nan	N00W	SYMPSUB	1	0.1
4-Aug-06	Nan	N00W	SPARCYN	5	7.5
4-Aug-06	Nan	N05W	SPARPAT	8	62.5
4-Aug-06	Nan	N05W	SCHOAME	6	17.5
4-Aug-06	Nan	N05W	LYTHLIN	4	3.5
4-Aug-06	Nan	N05W	KOSTVIR	2	0.5

4-Aug-06	Nan	N05W	IVA_FRUF	1	0.1
4-Aug-06	Nan	N05W	DISTSPI	6	17.5
4-Aug-06	Nan	N05W	PLUCODOO	3	1.5
4-Aug-06	Nan	N05W	AMARCAN	1	0.1
4-Aug-06	Nan	N05W	SPARALT	6	17.5
4-Aug-06	Nan	N05W	CYPEBIP	1	0.1
4-Aug-06	Nan	N05W	FIMBCAR	4	3.5
4-Aug-06	Nan	N05W	SABASTE	2	0.5
4-Aug-06	Nan	N05W	SCHOROB	3	1.5
4-Aug-06	Nan	N05W	SPARCYN	3	1.5
4-Aug-06	Nan	N05W	ELEOPAR	2	0.5
4-Aug-06	Nan	N10E	SPARALT	6	17.5
4-Aug-06	Nan	N10E	SPARPAT	8	62.5
4-Aug-06	Nan	N10E	SPARCYN	5	7.5
4-Aug-06	Nan	N10E	IVA_FRUF	7	37.5
4-Aug-06	Nan	N10E	HIBIMOSM	6	17.5
4-Aug-06	Nan	N10E	SCHOROB	2	0.5
4-Aug-06	Nan	N10E	ELEOPAR	2	0.5
4-Aug-06	Nan	N10E	KOSTVIR	5	7.5
4-Aug-06	Nan	N10E	MIKASCA	3	1.5
4-Aug-06	Nan	N10E	PLUCODOO	2	0.5
4-Aug-06	Nan	N10E	DISTSPI	1	0.1
4-Aug-06	Nan	N10E	SCHOAME	4	3.5
4-Aug-06	Nan	N10E	SYMPPUNP	1	0.1
4-Aug-06	Nan	N10E	PHRAAUS	7	37.5
4-Aug-06	Nan	N10E	ASCLINC	1	0.1
4-Aug-06	Nan	N10E	UNK4	1	0.1
7-Aug-06	Nan	N35W	PELTVIR	4	3.5
7-Aug-06	Nan	N35W	ACORCAL	8	62.5
7-Aug-06	Nan	N35W	BIDECOR	2	0.5
7-Aug-06	Nan	N35W	CINNARU	3	1.5
7-Aug-06	Nan	N35W	LEERORY	3	1.5
7-Aug-06	Nan	N35W	POLYARI	6	17.5
7-Aug-06	Nan	N35W	POLYSAG	4	3.5
7-Aug-06	Nan	N35W	GALITIN	3	1.5
7-Aug-06	Nan	N35W	SCHOTAB	2	0.5
7-Aug-06	Nan	N35W	IMPACPN	4	3.5
7-Aug-06	Nan	N35W	MIKASCA	4	3.5
7-Aug-06	Nan	N35W	CUSCGROG	3	1.5
7-Aug-06	Nan	N35W	CICUMACM	2	0.5
7-Aug-06	Nan	N35W	SCIR1S1	4	3.5
7-Aug-06	Nan	N35W	STACTEN	4	3.5
7-Aug-06	Nan	N35W	BOEHCYL	5	7.5
7-Aug-06	Nan	N35W	SYMPPUNP	3	1.5
7-Aug-06	Nan	N35W	TYPHLAT	2	0.5
7-Aug-06	Nan	N35W	NYSSBIF	2	0.5
7-Aug-06	Nan	N35W	SPARAME	3	1.5
7-Aug-06	Nan	N35W	ALNUSER	2	0.5
7-Aug-06	Nan	N35W	SIUMSUA	2	0.5
7-Aug-06	Nan	N35W	PILEPUMP	2	0.5

7-Aug-06	Nan	N35W	HIBIMOSM	3	1.5
7-Aug-06	Nan	N35W	TYPHANS	2	0.5
7-Aug-06	Nan	N35W	AMARCAN	1	0.1
7-Aug-06	Nan	N35W	RUMEVER	1	0.1
7-Aug-06	Nan	N35W	MORECER	1	0.1
7-Aug-06	Nan	N35W	THELPALP	2	0.5
7-Aug-06	Nan	N35W	TEUCCAN	2	0.5
7-Aug-06	Nan	N42E	IMPACPN	5	7.5
7-Aug-06	Nan	N42E	SAGILAT	2	0.5
7-Aug-06	Nan	N42E	ACORCAL	7	37.5
7-Aug-06	Nan	N42E	CUSCGROG	2	0.5
7-Aug-06	Nan	N42E	POLYARI	7	37.5
7-Aug-06	Nan	N42E	PELTVIR	6	17.5
7-Aug-06	Nan	N42E	BIDECOR	3	1.5
7-Aug-06	Nan	N42E	SCIR1S1	2	0.5
7-Aug-06	Nan	N42E	CINN1S1	2	0.5
7-Aug-06	Nan	N42E	TYPHLAT	4	3.5
7-Aug-06	Nan	N42E	BIDELAE	1	0.1
7-Aug-06	Nan	N42E	SYMPPUNP	2	0.5
7-Aug-06	Nan	N42E	LEERORY	2	0.5
7-Aug-06	Nan	N42E	SPARAME	1	0.1
7-Aug-06	Nan	N42E	CALYSEP	1	0.1
7-Aug-06	Nan	N42E	NUPHLUT	4	3.5
7-Aug-06	Nan	N42E	CEPHOCC	2	0.5
7-Aug-06	Nan	N42E	HIBIMOSM	2	0.5
7-Aug-06	Nan	N42E	CICUMACM	2	0.5
7-Aug-06	Nan	N42E	MENTARV	3	1.5
7-Aug-06	Nan	N42E	MIKASCA	1	0.1
7-Aug-06	Nan	N42E	AMARCAN	1	0.1
7-Aug-06	Nan	N45E	ACORCAL	8	62.5
7-Aug-06	Nan	N45E	BIDECOR	3	1.5
7-Aug-06	Nan	N45E	IMPACPN	5	7.5
7-Aug-06	Nan	N45E	GALITIN	3	1.5
7-Aug-06	Nan	N45E	POLYARI	6	17.5
7-Aug-06	Nan	N45E	CARECMS	3	1.5
7-Aug-06	Nan	N45E	CINNARU	4	3.5
7-Aug-06	Nan	N45E	POLYSAG	5	7.5
7-Aug-06	Nan	N45E	CARELUR	3	1.5
7-Aug-06	Nan	N45E	CICUMACM	4	3.5
7-Aug-06	Nan	N45E	SYMPPUNP	2	0.5
7-Aug-06	Nan	N45E	CUSCGROG	3	1.5
7-Aug-06	Nan	N45E	IRIS1S1	2	0.5
7-Aug-06	Nan	N45E	DULIARU	3	1.5
7-Aug-06	Nan	N45E	PELTVIR	5	7.5
7-Aug-06	Nan	N45E	LEERORY	2	0.5
7-Aug-06	Nan	N45E	DECOVER	2	0.5
7-Aug-06	Nan	N45E	BOEHCYL	3	1.5
7-Aug-06	Nan	N45E	ROSAPAL	1	0.1
7-Aug-06	Nan	N45E	MIKASCA	2	0.5
7-Aug-06	Nan	N45E	BIDELAE	1	0.1

7-Aug-06	Nan	N45E	CEPHOCC	2	0.5
7-Aug-06	Nan	N45E	HIBIMOSM	3	1.5
7-Aug-06	Nan	N45E	EUPAPERP	1	0.1
7-Aug-06	Nan	N49W	POLYARI	8	62.5
7-Aug-06	Nan	N49W	LEERORY	3	1.5
7-Aug-06	Nan	N49W	ACORCAL	6	17.5
7-Aug-06	Nan	N49W	PELTVIR	6	17.5
7-Aug-06	Nan	N49W	COMMCOM	4	3.5
7-Aug-06	Nan	N49W	CUSCGROG	2	0.5
7-Aug-06	Nan	N49W	IMPACPN	4	3.5
7-Aug-06	Nan	N49W	CINNARU	3	1.5
7-Aug-06	Nan	N49W	POLYSAG	3	1.5
7-Aug-06	Nan	N49W	ZIZAAQU1	5	7.5
7-Aug-06	Nan	N49W	BIDELAE	3	1.5
7-Aug-06	Nan	N49W	BIDECOR	3	1.5
7-Aug-06	Nan	N49W	GALITIN	2	0.5
7-Aug-06	Nan	N49W	CEPHOCC	1	0.1
7-Aug-06	Nan	N49W	CARE1S1	1	0.1
7-Aug-06	Nan	N49W	NUPHLUT	1	0.1
7-Aug-06	Nan	N49W	BOEHCYL	1	0.1
7-Aug-06	Nan	N49W	CICUMACM	1	0.1
9-Aug-06	Nan	N55W	COMMCOM	4	3.5
9-Aug-06	Nan	N55W	ACORCAL	9	85
9-Aug-06	Nan	N55W	PELTVIR	6	17.5
9-Aug-06	Nan	N55W	LEERORY	3	1.5
9-Aug-06	Nan	N55W	POLYSAG	2	0.5
9-Aug-06	Nan	N55W	BIDELAE	3	1.5
9-Aug-06	Nan	N55W	IMPACPN	5	7.5
9-Aug-06	Nan	N55W	POLYARI	2	0.5
9-Aug-06	Nan	N55W	GALITIN	2	0.5
9-Aug-06	Nan	N55W	POLYPUN1	3	1.5
9-Aug-06	Nan	N55W	CEPHOCC	3	1.5
9-Aug-06	Nan	N55W	MIKASCA	3	1.5
9-Aug-06	Nan	N55W	BIDEFRO	2	0.5
9-Aug-06	Nan	N55W	BIDECOR	2	0.5
9-Aug-06	Nan	N55W	STACTEN	2	0.5
9-Aug-06	Nan	N55W	HUMULUP	2	0.5
9-Aug-06	Nan	N55W	CUSCGROG	2	0.5
9-Aug-06	Nan	N55W	APIOAME	2	0.5
9-Aug-06	Nan	N55W	BOEHCYL	2	0.5
9-Aug-06	Nan	N55W	CARESTC	2	0.5
9-Aug-06	Nan	N55W	ROSAPAL	2	0.5
9-Aug-06	Nan	N55W	THALPUB	1	0.1
9-Aug-06	Nan	N55W	VITIRIP	1	0.1
9-Aug-06	Nan	N55W	LILISUP	1	0.1
9-Aug-06	Nan	N55W	VERNNOV	2	0.5
9-Aug-06	Nan	N55W	SYMPPUNP	1	0.1
9-Aug-06	Nan	N55W	NUPHLUT	4	3.5
9-Aug-06	Nan	N55W	LUDWPAL	1	0.1
9-Aug-06	Nan	N55W	SAGILAT	1	0.1

9-Aug-06	Nan	N55W	ALNUSER	2	0.5
9-Aug-06	Nan	N55W	IPOM1S1	1	0.1
9-Aug-06	Nan	N56W	ACORCAL	9	85
9-Aug-06	Nan	N56W	SAGILAT	2	0.5
9-Aug-06	Nan	N56W	PELTVIR	5	7.5
9-Aug-06	Nan	N56W	POLYARI	2	0.5
9-Aug-06	Nan	N56W	COMMCOM	3	1.5
9-Aug-06	Nan	N56W	LEERORY	2	0.5
9-Aug-06	Nan	N56W	BIDELAE	2	0.5
9-Aug-06	Nan	N56W	POLYPUN1	2	0.5
9-Aug-06	Nan	N56W	IMPACPN	3	1.5
9-Aug-06	Nan	N56W	MIKASCA	2	0.5
9-Aug-06	Nan	N56W	CORNAMO	2	0.5
9-Aug-06	Nan	N56W	ROSAPAL	2	0.5
9-Aug-06	Nan	N56W	TOXIRAD	2	0.5
9-Aug-06	Nan	N56W	CARESTC	2	0.5
9-Aug-06	Nan	N56W	CEPHOCC	2	0.5
9-Aug-06	Nan	N56W	NUPHLUT	6	17.5
9-Aug-06	Nan	N56W	POLYSAG	2	0.5
9-Aug-06	Nan	N56W	AMARCAN	3	1.5
9-Aug-06	Nan	N56W	LUDWPAL	1	0.1
9-Aug-06	Nan	N56W	FRAXPEN	5	7.5
9-Aug-06	Nan	N56W	APIOAME	1	0.1
9-Aug-06	Nan	N56W	BOEHCYL	1	0.1
9-Aug-06	Nan	N56W	THALPUB	1	0.1
9-Aug-06	Nan	N56W	VIBUREC	2	0.5
9-Aug-06	Nan	N56W	PILEPUMP	1	0.1
9-Aug-06	Nan	N56W	SYMPPUNP	1	0.1
9-Aug-06	Nan	N56W	PARTQUI	1	0.1
9-Aug-06	Nan	N56W	VIOL1S1	1	0.1
9-Aug-06	Nan	N56W	NYSSBIF	2	0.5

Patuxent June 2006 Plant Species and Cover Data

Date	tributary	plot	Species	cover	Mid-Point %
12-Jun-06	Pax	X00W	SPARALT	5	7.5
12-Jun-06	Pax	X00W	SPARPAT	8	62.5
12-Jun-06	Pax	X00W	IVA_FRUF	6	17.5
12-Jun-06	Pax	X00W	PLUCODOO	3	1.5
12-Jun-06	Pax	X00W	DISTSPI	6	17.5
12-Jun-06	Pax	X00W	ATRIPRO	2	0.5
12-Jun-06	Pax	X00W	ELEOPAR	2	0.5
12-Jun-06	Pax	X00W	SCHOAME	1	0.1
12-Jun-06	Pax	X00W	SPARCYN	4	3.5
12-Jun-06	Pax	X00W	PHRAAUS	2	0.5
12-Jun-06	Pax	X00W	AMARCAN	1	0.1
17-Jun-06	Pax	X05W	SPARCYN	6	17.5
17-Jun-06	Pax	X05W	IVA_FRUF	9	97.5
17-Jun-06	Pax	X05W	PLUC1S1	3	1.5
17-Jun-06	Pax	X05W	SPARALT	4	3.5
17-Jun-06	Pax	X05W	SPARPAT	5	7.5
17-Jun-06	Pax	X05W	PHRAAUS	6	17.5
17-Jun-06	Pax	X05W	HIBIMOSM	1	0.1
17-Jun-06	Pax	X05W	DISTSPI	2	0.5
17-Jun-06	Pax	X05W	ELEOPAR	2	0.5
17-Jun-06	Pax	X05W	ATRIPRO	2	0.5
17-Jun-06	Pax	X05W	AMARCAN	1	0.1
16-Jun-06	Pax	X10E	SPARALT	7	37.5
16-Jun-06	Pax	X10E	IVA_FRUF	7	37.5
16-Jun-06	Pax	X10E	AMARCAN	3	1.5
16-Jun-06	Pax	X10E	SPARPAT	6	17.5
16-Jun-06	Pax	X10E	ATRIPRO	2	0.5
16-Jun-06	Pax	X10E	HIBIMOSM	1	0.1
16-Jun-06	Pax	X10E	RUMEVER	2	0.5
16-Jun-06	Pax	X10E	ELEOPAR	2	0.5
16-Jun-06	Pax	X10E	PLUCODOO	2	0.5
16-Jun-06	Pax	X10E	SCHOROB	1	0.1
16-Jun-06	Pax	X10E	SYMPTEN	1	0.1
16-Jun-06	Pax	X10E	DISTSPI	3	1.5
16-Jun-06	Pax	X10E	UNK1	2	0.5
16-Jun-06	Pax	X10E	CUSCGROG	1	0.1
16-Jun-06	Pax	X10E	SPARCYN	5	7.5
16-Jun-06	Pax	X15W	SPARALT	5	7.5
16-Jun-06	Pax	X15W	SCHOAME	6	17.5
16-Jun-06	Pax	X15W	PLUCODOO	2	0.5
16-Jun-06	Pax	X15W	SPARCYN	7	37.5
16-Jun-06	Pax	X15W	POLYPUN1	1	0.1
16-Jun-06	Pax	X15W	ELEOPAR	2	0.5
16-Jun-06	Pax	X15W	ELEOOBT	2	0.5
16-Jun-06	Pax	X15W	PELTVIR	2	0.5

16-Jun-06 Pax	X15W	SCHOTAB	1	0.1
16-Jun-06 Pax	X15W	PHRAAUS	2	0.5
16-Jun-06 Pax	X15W	AMARCAN	2	0.5
16-Jun-06 Pax	X15W	TYPHANS	3	1.5
16-Jun-06 Pax	X15W	HIBIMOSM	2	0.5
16-Jun-06 Pax	X15W	ASCLINC	1	0.1
16-Jun-06 Pax	X15W	SCHOROB	1	0.1
16-Jun-06 Pax	X15W	DISTSPI	2	0.5
16-Jun-06 Pax	X15W	SPARPAT	5	7.5
15-Jun-06 Pax	X20E	PELTVIR	7	37.5
15-Jun-06 Pax	X20E	SPARCYN	7	37.5
15-Jun-06 Pax	X20E	SCHOROB	3	1.5
15-Jun-06 Pax	X20E	LEERORY	6	17.5
15-Jun-06 Pax	X20E	IMPACPN	3	1.5
15-Jun-06 Pax	X20E	AMARCAN	2	0.5
15-Jun-06 Pax	X20E	POLYARI	3	1.5
15-Jun-06 Pax	X20E	HIBIMOSM	4	3.5
15-Jun-06 Pax	X20E	SCHOAME	3	1.5
15-Jun-06 Pax	X20E	ASCLINC	2	0.5
15-Jun-06 Pax	X20E	SCHOTAB	1	0.1
15-Jun-06 Pax	X20E	RUMEVER	1	0.1
17-Jun-06 Pax	X22W	POLYPUN1	3	1.5
17-Jun-06 Pax	X22W	SPARCYN	8	62.5
17-Jun-06 Pax	X22W	PELTVIR	7	37.5
17-Jun-06 Pax	X22W	STAC1S1	4	3.5
17-Jun-06 Pax	X22W	CUSCGROG	2	0.5
17-Jun-06 Pax	X22W	ATRIPRO	1	0.1
17-Jun-06 Pax	X22W	AMARCAN	2	0.5
17-Jun-06 Pax	X22W	HIBIMOSM	2	0.5
17-Jun-06 Pax	X22W	ASCLINC	1	0.1
17-Jun-06 Pax	X22W	POLYARI	2	0.5
17-Jun-06 Pax	X22W	MIKASCA	2	0.5
17-Jun-06 Pax	X22W	SCHOAME	3	1.5
17-Jun-06 Pax	X22W	RUMEVER	2	0.5
17-Jun-06 Pax	X22W	SCIR1S1	1	0.1
17-Jun-06 Pax	X22W	IMPACPN	1	0.1
17-Jun-06 Pax	X22W	ELEO1S1	1	0.1
17-Jun-06 Pax	X22W	LEERORY	2	0.5
17-Jun-06 Pax	X22W	PONTCOR	1	0.1
17-Jun-06 Pax	X22W	SCHOTAB	2	0.5
17-Jun-06 Pax	X22W	TYPHANS	2	0.5
15-Jun-06 Pax	X26W	PELTVIR	7	37.5
15-Jun-06 Pax	X26W	TYPHANS	6	17.5
15-Jun-06 Pax	X26W	IMPACPN	6	17.5
15-Jun-06 Pax	X26W	POLYARI	6	17.5
15-Jun-06 Pax	X26W	HIBIMOSM	4	3.5
15-Jun-06 Pax	X26W	LEERORY	3	1.5

15-Jun-06 Pax	X26W	AMARCAN	3	1.5
15-Jun-06 Pax	X26W	SPARCYN	8	62.5
15-Jun-06 Pax	X26W	POLYPUN1	2	0.5
15-Jun-06 Pax	X26W	CUSCGROG	2	0.5
15-Jun-06 Pax	X26W	MIKASCA	2	0.5
15-Jun-06 Pax	X26W	ASCLINC	2	0.5
15-Jun-06 Pax	X26W	UNK2	2	0.5
15-Jun-06 Pax	X26W	PONTCOR	3	1.5
15-Jun-06 Pax	X26W	LYSITER	2	0.5
15-Jun-06 Pax	X26W	RUMEVER	1	0.1
15-Jun-06 Pax	X26W	ONOCSEN	1	0.1
15-Jun-06 Pax	X26W	TYPHXGL	4	3.5
15-Jun-06 Pax	X26W	OSMUCINC	1	0.1
15-Jun-06 Pax	X26W	BIDELAE	1	0.1
15-Jun-06 Pax	X26W	GALITIN	1	0.1
15-Jun-06 Pax	X26W	SIUMSUA	1	0.1
15-Jun-06 Pax	X26W	CARESTC	2	0.5
15-Jun-06 Pax	X26W	SCHOAME	2	0.5
15-Jun-06 Pax	X26W	SCHOTAB	2	0.5
14-Jun-06 Pax	X30E	PHRAAUS	10	10
14-Jun-06 Pax	X30E	IMPACPN	3	1.5
14-Jun-06 Pax	X30E	PELTVIR	4	3.5
14-Jun-06 Pax	X30E	POLYARI	1	0.1
14-Jun-06 Pax	X30E	POLYPUN1	1	0.1
14-Jun-06 Pax	X30E	RUMEVER	1	0.1
14-Jun-06 Pax	X30E	MIKASCA	1	0.1
14-Jun-06 Pax	X30E	LEERORY	1	0.1
18-Jun-06 Pax	X30W	PELTVIR	8	62.5
18-Jun-06 Pax	X30W	LEERORY	3	1.5
18-Jun-06 Pax	X30W	TYPHANS	7	37.5
18-Jun-06 Pax	X30W	HIBIMOSM	4	3.5
18-Jun-06 Pax	X30W	AMARCAN	1	0.1
18-Jun-06 Pax	X30W	IMPACPN	4	3.5
18-Jun-06 Pax	X30W	POLYARI	2	0.5
18-Jun-06 Pax	X30W	CUSCGROG	1	0.1
18-Jun-06 Pax	X30W	SAGILAT	2	0.5
18-Jun-06 Pax	X30W	OSMUCINC	2	0.5
18-Jun-06 Pax	X30W	LYSI1S1	1	0.1
18-Jun-06 Pax	X30W	TYPHXGL	3	1.5
18-Jun-06 Pax	X30W	POLYPUN1	2	0.5
18-Jun-06 Pax	X30W	MIKASCA	2	0.5
18-Jun-06 Pax	X30W	EUPA1S1	2	0.5
18-Jun-06 Pax	X30W	PONTCOR	3	1.5
18-Jun-06 Pax	X30W	ROSAPAL	4	3.5
18-Jun-06 Pax	X30W	RUMEVER	1	0.1
18-Jun-06 Pax	X30W	ASCLINC	1	0.1
18-Jun-06 Pax	X30W	SCHOAME	1	0.1

18-Jun-06	Pax	X30W	SPARAME	2	0.5
14-Jun-06	Pax	X35W	TYPHLAT	7	37.5
14-Jun-06	Pax	X35W	ZIZAAQU1	4	3.5
14-Jun-06	Pax	X35W	SAGILAT	5	7.5
14-Jun-06	Pax	X35W	PELTVIR	3	1.5
14-Jun-06	Pax	X35W	MIKASCA	4	3.5
14-Jun-06	Pax	X35W	LEERORY	7	37.5
14-Jun-06	Pax	X35W	ELEOOBT	3	1.5
14-Jun-06	Pax	X35W	LUDWPAL	2	0.5
14-Jun-06	Pax	X35W	PLUC1S1	2	0.5
14-Jun-06	Pax	X35W	POLYPUN1	2	0.5
14-Jun-06	Pax	X35W	BIDELAE	1	0.1
14-Jun-06	Pax	X35W	LIMNSPO	1	0.1
14-Jun-06	Pax	X35W	UNK2	2	0.5
14-Jun-06	Pax	X35W	PILEPUMP	1	0.1
14-Jun-06	Pax	X35W	RANUSCLS	1	0.1
14-Jun-06	Pax	X35W	CARE1S1	1	0.1
14-Jun-06	Pax	X35W	COMMCAR	4	3.5
14-Jun-06	Pax	X35W	PHRAAUS	6	17.5
14-Jun-06	Pax	X35W	TYPHANS	4	3.5
14-Jun-06	Pax	X35W	TYPHXGL	2	0.5
14-Jun-06	Pax	X35W	AMARCAN	2	0.5
14-Jun-06	Pax	X35W	DECOVER	1	0.1
14-Jun-06	Pax	X35W	SCHOTAB	3	1.5
14-Jun-06	Pax	X35W	PONTCOR	2	0.5
14-Jun-06	Pax	X35W	HIBIMOSM	1	0.1
14-Jun-06	Pax	X35W	CAREKOB	1	0.1
14-Jun-06	Pax	X35W	PTILCAP	1	0.1
14-Jun-06	Pax	X35W	SIUMSUA	1	0.1
14-Jun-06	Pax	X35W	CARE1S2	1	0.1
14-Jun-06	Pax	X35W	SPARAME	1	0.1
14-Jun-06	Pax	X35W	RUMEVER	1	0.1
14-Jun-06	Pax	X35W	POLYSAG	1	0.1
14-Jun-06	Pax	X35W	POLYARI	1	0.1
18-Jun-06	Pax	X39W	PELTVIR	6	17.5
18-Jun-06	Pax	X39W	TYPHANS	8	62.5
18-Jun-06	Pax	X39W	IMPACPN	3	1.5
18-Jun-06	Pax	X39W	TYPHXGL	6	17.5
18-Jun-06	Pax	X39W	LEERORY	3	1.5
18-Jun-06	Pax	X39W	SAGILAT	2	0.5
18-Jun-06	Pax	X39W	POLYPUN1	2	0.5
18-Jun-06	Pax	X39W	POLYARI	2	0.5
18-Jun-06	Pax	X39W	NUPHLUT	6	17.5
18-Jun-06	Pax	X39W	BIDELAE	1	0.1
18-Jun-06	Pax	X39W	UNK1	2	0.5
18-Jun-06	Pax	X39W	SIUMSUA	1	0.1
18-Jun-06	Pax	X39W	MIKASCA	1	0.1

18-Jun-06 Pax	X39W	RUMEVER	1	0.1
18-Jun-06 Pax	X39W	SPARAME	1	0.1
18-Jun-06 Pax	X39W	SCHOTAB	2	0.5
18-Jun-06 Pax	X39W	HIBIMOSM	2	0.5
18-Jun-06 Pax	X39W	PONTCOR	1	0.1
18-Jun-06 Pax	X39W	AMARCAN	1	0.1
13-Jun-06 Pax	X43W	POLYARI	5	7.5
13-Jun-06 Pax	X43W	GALITIN	3	1.5
13-Jun-06 Pax	X43W	ACORCAL	7	37.5
13-Jun-06 Pax	X43W	PILEPUMP	5	7.5
13-Jun-06 Pax	X43W	SYMPPUN	4	3.5
13-Jun-06 Pax	X43W	POLYSAG	3	1.5
13-Jun-06 Pax	X43W	CUSCGROG	3	1.5
13-Jun-06 Pax	X43W	PELTVIR	5	7.5
13-Jun-06 Pax	X43W	IMPACPN	6	17.5
13-Jun-06 Pax	X43W	UNK2	1	0.1
13-Jun-06 Pax	X43W	COMMCAR	2	0.5
13-Jun-06 Pax	X43W	TYPHLAT	3	1.5
13-Jun-06 Pax	X43W	BOEHCYL	1	0.1
13-Jun-06 Pax	X43W	LEERORY	1	0.1
13-Jun-06 Pax	X43W	HIBIMOSM	3	1.5
13-Jun-06 Pax	X43W	CICUMACM	1	0.1
13-Jun-06 Pax	X43W	MIKASCA	2	0.5
13-Jun-06 Pax	X43W	MENTARV	5	7.5
13-Jun-06 Pax	X43W	SCIR1S1	2	0.5
13-Jun-06 Pax	X43W	POLYPUN1	1	0.1
13-Jun-06 Pax	X43W	BIDELAE	1	0.1
13-Jun-06 Pax	X43W	NUPHLUT	1	0.1
13-Jun-06 Pax	X43W	SCHOTAB	2	0.5
13-Jun-06 Pax	X43W	DECOVER	1	0.1
13-Jun-06 Pax	X43W	SPARAME	1	0.1
13-Jun-06 Pax	X43W	CARESTC	1	0.1
13-Jun-06 Pax	X47E	IMPACPN	6	17.5
13-Jun-06 Pax	X47E	PELTVIR	7	37.5
13-Jun-06 Pax	X47E	POLYARI	5	7.5
13-Jun-06 Pax	X47E	SCIR1S1	5	7.5
13-Jun-06 Pax	X47E	SPARAME	3	1.5
13-Jun-06 Pax	X47E	TYPHLAT	2	0.5
13-Jun-06 Pax	X47E	CUSCGROG	2	0.5
13-Jun-06 Pax	X47E	PILEPUMP	2	0.5
13-Jun-06 Pax	X47E	POLYSAG	3	1.5
13-Jun-06 Pax	X47E	SYMPPUN	5	7.5
13-Jun-06 Pax	X47E	GALITIN	3	1.5
13-Jun-06 Pax	X47E	CINN1S1	3	1.5
13-Jun-06 Pax	X47E	CAREVUL	2	0.5
13-Jun-06 Pax	X47E	CAREKOB	2	0.5
13-Jun-06 Pax	X47E	COMMCAR	2	0.5

13-Jun-06	Pax	X47E	LEERORY	1	0.1
13-Jun-06	Pax	X47E	RANU1S1	1	0.1
13-Jun-06	Pax	X47E	SIUMSUA	1	0.1
13-Jun-06	Pax	X47E	RORIPALF	1	0.1
13-Jun-06	Pax	X47E	CARESCOS	2	0.5
13-Jun-06	Pax	X47E	MENTARV	2	0.5
13-Jun-06	Pax	X47E	MIKASCA	2	0.5
13-Jun-06	Pax	X47E	APIOAME	1	0.1
13-Jun-06	Pax	X47E	UNK1	1	0.1
13-Jun-06	Pax	X47E	CARE1S1	2	0.5
13-Jun-06	Pax	X47E	SAGILAT	1	0.1
13-Jun-06	Pax	X47E	ZIZAAQU1	1	0.1
13-Jun-06	Pax	X47E	PTILCAP	1	0.1
13-Jun-06	Pax	X47E	CICUMACM	1	0.1
13-Jun-06	Pax	X47E	BIDELAE	1	0.1

Patuxent August 2006 Plant Species and Cover Data

Date	tributary	plot	Species	cover	Mid-Point %
25-Aug-06	Pax	X00W	SPARALT	7	37.5
25-Aug-06	Pax	X00W	SPARPAT	8	62.5
25-Aug-06	Pax	X00W	IVA_FRUF	6	17.5
25-Aug-06	Pax	X00W	PLUCODOO	5	7.5
25-Aug-06	Pax	X00W	DISTSPI	6	17.5
25-Aug-06	Pax	X00W	SPARCYN	5	7.5
25-Aug-06	Pax	X00W	SCHOAME	2	0.5
25-Aug-06	Pax	X00W	ELEOPAR	2	0.5
25-Aug-06	Pax	X00W	SALIVRG	1	0.1
25-Aug-06	Pax	X00W	PHRAAUS	1	0.1
24-Aug-06	Pax	X05W	SPARCYN	5	7.5
24-Aug-06	Pax	X05W	IVA_FRUF	9	85
24-Aug-06	Pax	X05W	SPARALT	5	7.5
24-Aug-06	Pax	X05W	PLUCODOO	2	0.5
24-Aug-06	Pax	X05W	SPARPAT	3	1.5
24-Aug-06	Pax	X05W	PHRAAUS	6	17.5
24-Aug-06	Pax	X05W	ATRIPRO	2	0.5
24-Aug-06	Pax	X05W	KOSTVIR	2	0.5
24-Aug-06	Pax	X05W	HIBIMOSM	1	0.1
24-Aug-06	Pax	X05W	DISTSPI	2	0.5
24-Aug-06	Pax	X05W	AMARCAN	1	0.1
24-Aug-06	Pax	X10E	SPARALT	7	37.5
24-Aug-06	Pax	X10E	IVA_FRUF	8	62.5
24-Aug-06	Pax	X10E	AMARCAN	6	17.5
24-Aug-06	Pax	X10E	SPARCYN	5	7.5
24-Aug-06	Pax	X10E	PLUCODOO	2	0.5
24-Aug-06	Pax	X10E	SCHOROB	1	0.1
24-Aug-06	Pax	X10E	ELEOPAR	2	0.5
24-Aug-06	Pax	X10E	SYMPTEN	5	7.5
24-Aug-06	Pax	X10E	SPARPAT	6	17.5
24-Aug-06	Pax	X10E	ATRIPRO	2	0.5
24-Aug-06	Pax	X10E	CUSCGROG	2	0.5
24-Aug-06	Pax	X10E	DISTSPI	4	3.5
24-Aug-06	Pax	X10E	LYTHLIN	2	0.5
24-Aug-06	Pax	X10E	RUMEVER	2	0.5
24-Aug-06	Pax	X10E	HIBIMOSM	1	0.1
24-Aug-06	Pax	X10E	CYPEODO	1	0.1
24-Aug-06	Pax	X10E	ECHIMUR	1	0.1
24-Aug-06	Pax	X15W	SPARALT	7	37.5
24-Aug-06	Pax	X15W	ECHIMUR	3	1.5
24-Aug-06	Pax	X15W	PLUCODOO	2	0.5
24-Aug-06	Pax	X15W	ELEOPAR	2	0.5
24-Aug-06	Pax	X15W	SCHOAME	6	17.5
24-Aug-06	Pax	X15W	SPARCYN	7	37.5
24-Aug-06	Pax	X15W	ELEO1S1	3	1.5
24-Aug-06	Pax	X15W	SCHOROB	3	1.5
24-Aug-06	Pax	X15W	SCHOTAB	1	0.1
24-Aug-06	Pax	X15W	PHRAAUS	2	0.5

24-Aug-06	Pax	X15W	AMARCAN	2	0.5
24-Aug-06	Pax	X15W	TYPHANS	4	3.5
24-Aug-06	Pax	X15W	HIBIMOSM	2	0.5
24-Aug-06	Pax	X15W	KOSTVIR	4	3.5
24-Aug-06	Pax	X15W	PELTVIR	2	0.5
24-Aug-06	Pax	X15W	DISTSPI	4	3.5
24-Aug-06	Pax	X15W	ASCLINC	2	0.5
24-Aug-06	Pax	X15W	SPARPAT	5	7.5
24-Aug-06	Pax	X15W	PONTCOR	1	0.1
24-Aug-06	Pax	X15W	MIKASCA	1	0.1
24-Aug-06	Pax	X15W	CYPEODO	1	0.1
18-Aug-06	Pax	X20E	SPARCYN	8	62.5
18-Aug-06	Pax	X20E	PELTVIR	7	37.5
18-Aug-06	Pax	X20E	SCHOROB	2	0.5
18-Aug-06	Pax	X20E	LEERORY	7	37.5
18-Aug-06	Pax	X20E	POLYARI	3	1.5
18-Aug-06	Pax	X20E	IMPACPN	2	0.5
18-Aug-06	Pax	X20E	POLYHDR	2	0.5
18-Aug-06	Pax	X20E	AMARCAN	3	1.5
18-Aug-06	Pax	X20E	HIBIMOSM	3	1.5
18-Aug-06	Pax	X20E	SCHOAME	3	1.5
18-Aug-06	Pax	X20E	ASCLINC	2	0.5
18-Aug-06	Pax	X20E	KOSTVIR	2	0.5
18-Aug-06	Pax	X20E	CINNARU	1	0.1
18-Aug-06	Pax	X20E	ELEOPAR	5	7.5
18-Aug-06	Pax	X20E	IRIS1S1	2	0.5
18-Aug-06	Pax	X20E	SCHOTAB	1	0.1
18-Aug-06	Pax	X22W	PELTVIR	5	7.5
18-Aug-06	Pax	X22W	CUSCGROG	2	0.5
18-Aug-06	Pax	X22W	AMARCAN	4	3.5
18-Aug-06	Pax	X22W	POLYPUN1	5	7.5
18-Aug-06	Pax	X22W	TEUCCAN	6	17.5
18-Aug-06	Pax	X22W	SPARCYN	7	37.5
18-Aug-06	Pax	X22W	ATRIPRO	2	0.5
18-Aug-06	Pax	X22W	ECHIMUR	3	1.5
18-Aug-06	Pax	X22W	KOSTVIR	5	7.5
18-Aug-06	Pax	X22W	ASCLINC	3	1.5
18-Aug-06	Pax	X22W	MIKASCA	4	3.5
18-Aug-06	Pax	X22W	POLYARI	2	0.5
18-Aug-06	Pax	X22W	LEERORY	2	0.5
18-Aug-06	Pax	X22W	SCHOAME	3	1.5
18-Aug-06	Pax	X22W	IMPACPN	2	0.5
18-Aug-06	Pax	X22W	HIBIMOSM	4	3.5
18-Aug-06	Pax	X22W	PLUCODOO	2	0.5
18-Aug-06	Pax	X22W	CYPESTR	2	0.5
18-Aug-06	Pax	X22W	SONCOLE	2	0.5
18-Aug-06	Pax	X22W	RUMEVER	2	0.5
18-Aug-06	Pax	X22W	CINNARU	1	0.1
18-Aug-06	Pax	X22W	SAGILAT	2	0.5
18-Aug-06	Pax	X22W	ELEO1S1	4	3.5

18-Aug-06	Pax	X22W	TYPHANS	4	3.5
18-Aug-06	Pax	X22W	PONTCOR	2	0.5
18-Aug-06	Pax	X22W	SCHOTAB	2	0.5
18-Aug-06	Pax	X22W	SCHOROB	1	0.1
17-Aug-06	Pax	X26W	PELTVIR	6	17.5
17-Aug-06	Pax	X26W	TYPHANS	5	7.5
17-Aug-06	Pax	X26W	POLYARI	6	17.5
17-Aug-06	Pax	X26W	IMPACPN	5	7.5
17-Aug-06	Pax	X26W	HIBIMOSM	4	3.5
17-Aug-06	Pax	X26W	CUSCGROG	2	0.5
17-Aug-06	Pax	X26W	SPARCYN	8	62.5
17-Aug-06	Pax	X26W	AMARCAN	2	0.5
17-Aug-06	Pax	X26W	LEERORY	2	0.5
17-Aug-06	Pax	X26W	MIKASCA	3	1.5
17-Aug-06	Pax	X26W	ASCLINC	2	0.5
17-Aug-06	Pax	X26W	VERNNOV	3	1.5
17-Aug-06	Pax	X26W	POLYHDR	2	0.5
17-Aug-06	Pax	X26W	LYTHSAL	3	1.5
17-Aug-06	Pax	X26W	PONTCOR	2	0.5
17-Aug-06	Pax	X26W	SAGILAT	1	0.1
17-Aug-06	Pax	X26W	THELPALP	2	0.5
17-Aug-06	Pax	X26W	ONOCSEN	2	0.5
17-Aug-06	Pax	X26W	GALITIN	1	0.1
17-Aug-06	Pax	X26W	CALYSEP	1	0.1
17-Aug-06	Pax	X26W	CINNARU	1	0.1
17-Aug-06	Pax	X26W	CARE1S1	2	0.5
17-Aug-06	Pax	X26W	SCHOTAB	1	0.1
17-Aug-06	Pax	X26W	KOSTVIR	1	0.1
16-Aug-06	Pax	X30E	PHRAAUS	10	97.5
16-Aug-06	Pax	X30E	PELTVIR	2	0.5
16-Aug-06	Pax	X30E	IMPACPN	2	0.5
16-Aug-06	Pax	X30E	POLYARI	1	0.1
16-Aug-06	Pax	X30E	CALYSEP	1	0.1
16-Aug-06	Pax	X30W	PELTVIR	4	3.5
16-Aug-06	Pax	X30W	LEERORY	4	3.5
16-Aug-06	Pax	X30W	HIBIMOSM	5	7.5
16-Aug-06	Pax	X30W	TYPHANS	7	37.5
16-Aug-06	Pax	X30W	SAGILAT	5	7.5
16-Aug-06	Pax	X30W	IMPACPN	4	3.5
16-Aug-06	Pax	X30W	POLYARI	5	7.5
16-Aug-06	Pax	X30W	CUSCGROG	2	0.5
16-Aug-06	Pax	X30W	PONTCOR	2	0.5
16-Aug-06	Pax	X30W	THELPALP	2	0.5
16-Aug-06	Pax	X30W	LYTHSAL	3	1.5
16-Aug-06	Pax	X30W	TYPHXGL	3	1.5
16-Aug-06	Pax	X30W	MIKASCA	3	1.5
16-Aug-06	Pax	X30W	POLYHDR	1	0.1
16-Aug-06	Pax	X30W	AMARCAN	2	0.5
16-Aug-06	Pax	X30W	ASCLINC	1	0.1
16-Aug-06	Pax	X30W	VERNNOV	2	0.5

16-Aug-06	Pax	X30W	SPARAME	2	0.5
16-Aug-06	Pax	X30W	RUMEVER	2	0.5
16-Aug-06	Pax	X30W	ROSAPAL	2	0.5
16-Aug-06	Pax	X30W	SCHOAME	1	0.1
16-Aug-06	Pax	X35W	TYPHLAT	6	17.5
16-Aug-06	Pax	X35W	ZIZAAQU1	6	17.5
16-Aug-06	Pax	X35W	SAGILAT	5	7.5
16-Aug-06	Pax	X35W	PELTVIR	1	0.1
16-Aug-06	Pax	X35W	MIKASCA	5	7.5
16-Aug-06	Pax	X35W	LEERORY	7	37.5
16-Aug-06	Pax	X35W	PLUCODOO	3	1.5
16-Aug-06	Pax	X35W	COMMCOM	4	3.5
16-Aug-06	Pax	X35W	POLYPUN1	2	0.5
16-Aug-06	Pax	X35W	ECHIWAL	3	1.5
16-Aug-06	Pax	X35W	LIMNSPO	2	0.5
16-Aug-06	Pax	X35W	CYPESTR	2	0.5
16-Aug-06	Pax	X35W	ELEOOBT	2	0.5
16-Aug-06	Pax	X35W	BIDELAE	1	0.1
16-Aug-06	Pax	X35W	SONCOLE	3	1.5
16-Aug-06	Pax	X35W	ELEOPAR	1	0.1
16-Aug-06	Pax	X35W	AMARCAN	2	0.5
16-Aug-06	Pax	X35W	PHRAAUS	6	17.5
16-Aug-06	Pax	X35W	RANUSCLS	1	0.1
16-Aug-06	Pax	X35W	UNK2	2	0.5
16-Aug-06	Pax	X35W	SCHOTAB	2	0.5
16-Aug-06	Pax	X35W	PONTCOR	1	0.1
16-Aug-06	Pax	X35W	SIUMSUA	1	0.1
16-Aug-06	Pax	X35W	HIBIMOSM	1	0.1
16-Aug-06	Pax	X35W	PTILCAP	1	0.1
16-Aug-06	Pax	X35W	CARECMS	2	0.5
16-Aug-06	Pax	X35W	LAMI-S1	1	0.1
16-Aug-06	Pax	X35W	MIMURINR	1	0.1
16-Aug-06	Pax	X35W	POLYARI	1	0.1
17-Aug-06	Pax	X39W	TYPHANS	8	62.5
17-Aug-06	Pax	X39W	PELTVIR	5	7.5
17-Aug-06	Pax	X39W	IMPACPN	5	7.5
17-Aug-06	Pax	X39W	POLYARI	5	7.5
17-Aug-06	Pax	X39W	SAGILAT	5	7.5
17-Aug-06	Pax	X39W	BIDELAE	2	0.5
17-Aug-06	Pax	X39W	LEERORY	2	0.5
17-Aug-06	Pax	X39W	ZIZAAQU1	6	17.5
17-Aug-06	Pax	X39W	POLYPUN1	3	1.5
17-Aug-06	Pax	X39W	PONTCOR	2	0.5
17-Aug-06	Pax	X39W	AMARCAN	3	1.5
17-Aug-06	Pax	X39W	SIUMSUA	1	0.1
17-Aug-06	Pax	X39W	NUPHLUT	2	0.5
17-Aug-06	Pax	X39W	MIKASCA	2	0.5
17-Aug-06	Pax	X39W	PILEPUMP	1	0.1
17-Aug-06	Pax	X39W	SPARAME	2	0.5
17-Aug-06	Pax	X39W	SCIR1S1	1	0.1

17-Aug-06	Pax	X39W	HIBIMOSM	2	0.5
17-Aug-06	Pax	X39W	SCHOTAB	1	0.1
17-Aug-06	Pax	X39W	LYTHSAL	1	0.1
17-Aug-06	Pax	X39W	ECHIWAL	1	0.1
17-Aug-06	Pax	X39W	PTILCAP	1	0.1
15-Aug-06	Pax	X43W	SYMPPUNP	5	7.5
15-Aug-06	Pax	X43W	PILEPUMP	7	37.5
15-Aug-06	Pax	X43W	PELTVIR	6	17.5
15-Aug-06	Pax	X43W	ACORCAL	8	62.5
15-Aug-06	Pax	X43W	POLYSAG	2	0.5
15-Aug-06	Pax	X43W	POLYARI	7	37.5
15-Aug-06	Pax	X43W	GALITIN	3	1.5
15-Aug-06	Pax	X43W	IMPACPN	5	7.5
15-Aug-06	Pax	X43W	CUSCGROG	4	3.5
15-Aug-06	Pax	X43W	BOEHCYL	3	1.5
15-Aug-06	Pax	X43W	TYPHLAT	5	7.5
15-Aug-06	Pax	X43W	MIKASCA	4	3.5
15-Aug-06	Pax	X43W	HIBIMOSM	5	7.5
15-Aug-06	Pax	X43W	CICUMACM	1	0.1
15-Aug-06	Pax	X43W	COMMCOM	3	1.5
15-Aug-06	Pax	X43W	LYSI1S1	1	0.1
15-Aug-06	Pax	X43W	MENTARV	6	17.5
15-Aug-06	Pax	X43W	SCIR1S1	3	1.5
15-Aug-06	Pax	X43W	SPARAME	2	0.5
15-Aug-06	Pax	X43W	POLYHDR	2	0.5
15-Aug-06	Pax	X43W	SCHOTAB	3	1.5
15-Aug-06	Pax	X43W	LEERORY	2	0.5
15-Aug-06	Pax	X43W	NUPHLUT	2	0.5
15-Aug-06	Pax	X43W	LOBECAR	1	0.1
15-Aug-06	Pax	X43W	JUNCEFF	1	0.1
15-Aug-06	Pax	X47E	SPARAME	5	7.5
15-Aug-06	Pax	X47E	POLYARI	7	37.5
15-Aug-06	Pax	X47E	POLYSAG	3	1.5
15-Aug-06	Pax	X47E	SCIR1S1	8	62.5
15-Aug-06	Pax	X47E	CUSCGROG	8	62.5
15-Aug-06	Pax	X47E	PILEPUMP	8	62.5
15-Aug-06	Pax	X47E	COMMCOM	5	7.5
15-Aug-06	Pax	X47E	PELTVIR	7	37.5
15-Aug-06	Pax	X47E	SYMPPUNP	6	17.5
15-Aug-06	Pax	X47E	GALITIN	3	1.5
15-Aug-06	Pax	X47E	LEERORY	3	1.5
15-Aug-06	Pax	X47E	CINNARU	4	3.5
15-Aug-06	Pax	X47E	IMPACPN	1	0.1
15-Aug-06	Pax	X47E	ZIZAAQU1	4	3.5
15-Aug-06	Pax	X47E	CICUMACM	2	0.5
15-Aug-06	Pax	X47E	TYPHLAT	3	1.5
15-Aug-06	Pax	X47E	POLYSAG	3	1.5
15-Aug-06	Pax	X47E	CARECMS	3	1.5
15-Aug-06	Pax	X47E	MENTARV	5	7.5
15-Aug-06	Pax	X47E	CARESCOS	1	0.1

15-Aug-06	Pax	X47E	LYSI1S1	1	0.1
15-Aug-06	Pax	X47E	MIKASCA	4	3.5
15-Aug-06	Pax	X47E	LOBECAR	1	0.1
15-Aug-06	Pax	X47E	CLEM1S1	1	0.1
15-Aug-06	Pax	X47E	APIOAME	2	0.5
15-Aug-06	Pax	X47E	LYSINUM	2	0.5
15-Aug-06	Pax	X47E	CARECRN	2	0.5
15-Aug-06	Pax	X47E	BIDEFRO	1	0.1
15-Aug-06	Pax	X47E	SIUMSUA	3	1.5
15-Aug-06	Pax	X47E	CARELUR	1	0.1

Appendix C. Raw Species and Plant Cover Data Mesocosm Study June 2007

Date	Mesocosm	Species	Frequency	Cover Class	Mid-Point Percent
6/19/2007	1	Pilea pumila	12	7	37.5
6/19/2007	1	Amaranthus cannabinu	5	7	37.5
6/19/2007	1	Leersia oryzoides	20	6	17.5
6/19/2007	1	Pluchea purpurascens	14	7	37.5
6/19/2007	1	Polygonum arifolium	1	6	17.5
6/19/2007	1	Polygonum punctatum	1	6	17.5
6/19/2007	1	Mast. offi.	4	2	0.5
6/19/2007	1	Typha angustifolia	5	2	0.5
6/19/2007	1	Spartina patens	24	5	7.5
6/19/2007	1	Spartina cynosuroides	1	3	1.5
6/19/2007	1	Spartina alterniflora	7	5	7.5
6/19/2007	1	Phragmites australis	4	3	1.5
6/19/2007	1	Mikania scandens	5	3	1.5
6/19/2007	1	Distichlis spicata	11	5	7.5
6/19/2007	1	Cyprus escul.	1	2	0.5
6/19/2007	1	Acorus calamus	2	3	1.5
6/19/2007	1	Murdannia keisak	2	2	0.5
6/19/2007	1	Peltandra virginica	1	2	0.5
6/19/2007	2	Cuscuta gronovii	6	3	1.5
6/19/2007	2	Pilea pumila	14	7	37.5
6/19/2007	2	Amaranthus cannabinu	4	6	17.5
6/19/2007	2	Polygonum arifolium	2	6	17.5
6/19/2007	2	Leersia oryzoides	13	6	17.5
6/19/2007	2	Polygonum punctatum	2	6	17.5
6/19/2007	2	Spartina alterniflora	8	5	7.5
6/19/2007	2	Spartina cynosuroides	1	3	1.5
6/19/2007	2	Spartina patens	10	5	7.5
6/19/2007	2	Distichlis spicata	16	5	7.5
6/19/2007	2	Acorus calamus	4	3	1.5
6/19/2007	2	Typha angustifolia	3	2	0.5
6/19/2007	2	Mikania scandens	3	3	1.5
6/19/2007	2	Pluchea purpurascens	12	8	62.5
6/19/2007	2	Murdannia keisak	2	2	0.5
6/19/2007	2	Phragmites australis	2	2	0.5
6/19/2007	2	Schoenplectus sp.	1	2	0.5
6/19/2007	2	Peltandra virginica	1	3	1.5
6/19/2007	2	Mast. offi.	4	2	0.5
6/19/2007	3	Amaranthus cannabinu	3	9	85
6/19/2007	3	Pilea pumila	9	6	17.5
6/19/2007	3	Leersia oryzoides	15	6	17.5
6/19/2007	3	Mikania scandens	3	6	17.5
6/19/2007	3	Pluchea purpurascens	16	7	37.5
6/19/2007	3	Polygonum arifolium	3	7	37.5
6/19/2007	3	Polygonum punctatum	1	7	37.5
6/19/2007	3	Spartina patens	14	5	7.5
6/19/2007	3	Spartina alterniflora	8	5	7.5
6/19/2007	3	Spartina cynosuroides	1	2	0.5

6/19/2007	3	Typha angustifolia	3	2	0.5
6/19/2007	3	Acorus calamus	4	3	1.5
6/19/2007	3	Phragmites australis	2	3	1.5
6/19/2007	3	Murdannia keisak	5	2	0.5
6/19/2007	3	Cuscuta gronovii	3	3	1.5
6/19/2007	3	Echina walt	3	4	3.5
6/19/2007	3	Gal tinc	2	2	0.5
6/19/2007	4	Amaranthus cannabinu	4	8	62.5
6/19/2007	4	Polygonum arifolium	2	7	37.5
6/19/2007	4	Polygonum sagittatum	1	6	17.5
6/19/2007	4	Pilea pumila	8	6	17.5
6/19/2007	4	Mikania scandens	4	5	7.5
6/19/2007	4	Leersia oryzoides	13	6	17.5
6/19/2007	4	Cuscuta gronovii	3	4	3.5
6/19/2007	4	Spartina patens	14	5	7.5
6/19/2007	4	Spartina alterniflora	5	5	7.5
6/19/2007	4	Spartina cynosuroides	1	2	0.5
6/19/2007	4	Phragmites australis	5	3	1.5
6/19/2007	4	Peltandra virginica	1	2	0.5
6/19/2007	4	Typha angustifolia	3	2	0.5
6/19/2007	4	Polygonum punctatum	1	7	37.5
6/19/2007	4	Acorus calamus	4	3	1.5
6/19/2007	4	Murdannia keisak	4	3	1.5
6/19/2007	4	Pluchea purpurascens	12	6	17.5
6/19/2007	5	Pilea pumila	17	7	37.5
6/19/2007	5	Amaranthus cannabinu	1	8	62.5
6/19/2007	5	Polygonum sagittatum	1	4	3.5
6/19/2007	5	Leersia oryzoides	21	6	17.5
6/19/2007	5	Spartina cynosuroides	1	2	0.5
6/19/2007	5	Phragmites australis	3	2	0.5
6/19/2007	5	Mikania scandens	4	4	3.5
6/19/2007	5	Spartina patens	10	5	7.5
6/19/2007	5	Spartina alterniflora	4	5	7.5
6/19/2007	5	Distichlis spicata	14	5	7.5
6/19/2007	5	Acorus calamus	4	3	1.5
6/19/2007	5	Pluchea purpurascens	20	7	37.5
6/19/2007	5	Polygonum punctatum	1	6	17.5
6/19/2007	5	Typha angustifolia	4	2	0.5
6/19/2007	5	Polygonum arifolium	1	7	37.5
6/19/2007	5	Murdannia keisak	2	2	0.5
6/19/2007	5	Rorippa islandica	1	2	0.5
6/19/2007	5	Aster puniceus	1	2	0.5
6/19/2007	5	Mast. offi.	5	2	0.5
6/19/2007	6	Echina walt	1	2	0.5
6/19/2007	6	Amaranthus cannabinu	5	9	85
6/19/2007	6	Pilea pumila	14	7	37.5
6/19/2007	6	Leersia oryzoides	22	6	17.5
6/19/2007	6	Pluchea purpurascens	22	7	37.5
6/19/2007	6	Mikania scandens	3	4	3.5
6/19/2007	6	Phragmites australis	3	4	3.5

6/19/2007	6	Acorus calamus	2	3	1.5
6/19/2007	6	Spartina cynosuroides	1	2	0.5
6/19/2007	6	Spartina patens	16	5	7.5
6/19/2007	6	Spartina alterniflora	4	5	7.5
6/19/2007	6	Distichlis spicata	14	5	7.5
6/19/2007	6	Cuscuta gronovii	3	3	1.5
6/19/2007	6	Polygonum sagittatum	2	3	1.5
6/19/2007	6	Polygonum arifolium	1	6	17.5
6/19/2007	6	Typha angustifolia	2	2	0.5
6/19/2007	6	Schoenplectus sp.	1	2	0.5
6/19/2007	6	Murdannia keisak	4	2	0.5
6/19/2007	6	Aster puniceus	1	2	0.5
6/19/2007	7	Amaranthus cannabinu	2	7	37.5
6/19/2007	7	Pilea pumila	16	8	62.5
6/19/2007	7	Mikania scandens	4	4	3.5
6/19/2007	7	Leersia oryzoides	12	6	17.5
6/19/2007	7	Pluchea purpurascens	17	8	62.5
6/19/2007	7	Phragmites australis	2	4	3.5
6/19/2007	7	Polygonum punctatum	1	5	7.5
6/19/2007	7	Polygonum arifolium	3	7	37.5
6/19/2007	7	Distichlis spicata	10	5	7.5
6/19/2007	7	Spartina alterniflora	7	5	7.5
6/19/2007	7	Spartina patens	15	5	7.5
6/19/2007	7	Typha angustifolia	2	2	0.5
6/19/2007	7	Acorus calamus	2	3	1.5
6/19/2007	7	Cuscuta gronovii	1	2	0.5
6/19/2007	7	Galium palustre	1	2	0.5
6/19/2007	7	Spartina cynosuroides	1	3	1.5
6/19/2007	8	Mast. offi.	2	2	0.5
6/19/2007	8	Mikania scandens	2	4	3.5
6/19/2007	8	Echina walt	2	6	17.5
6/19/2007	8	Pluchea purpurascens	32	7	37.5
6/19/2007	8	Pilea pumila	21	8	62.5
6/19/2007	8	Polygonum sagittatum	1	5	7.5
6/19/2007	8	Leersia oryzoides	17	6	17.5
6/19/2007	8	Amaranthus cannabinu	1	6	17.5
6/19/2007	8	Spartina cynosuroides	1	2	0.5
6/19/2007	8	Polygonum punctatum	1	6	17.5
6/19/2007	8	Phragmites australis	3	5	7.5
6/19/2007	8	Gal tinc	1	2	0.5
6/19/2007	8	Spartina patens	9	5	7.5
6/19/2007	8	Spartina alterniflora	4	5	7.5
6/19/2007	8	Distichlis spicata	10	5	7.5
6/19/2007	8	Typha angustifolia	3	2	0.5
6/19/2007	8	Cyprus escul.	2	2	0.5
6/19/2007	8	Peltandra virginica	1	2	0.5
6/19/2007	8	Acorus calamus	3	3	1.5
6/19/2007	8	Polygonum arifolium	1	6	17.5
6/19/2007	8	Murdannia keisak	1	2	0.5
6/19/2007	8	Cuscuta gronovii	1	2	0.5

6/19/2007	9	Amaranthus cannabinu	3	9	85
6/19/2007	9	Polygonum arifolium	3	8	62.5
6/19/2007	9	Mikania scandens	4	4	3.5
6/19/2007	9	Phragmites australis	2	2	0.5
6/19/2007	9	Pluchea purpurascens	28	7	37.5
6/19/2007	9	Leersia oryzoides	22	6	17.5
6/19/2007	9	Murdannia keisak	6	2	0.5
6/19/2007	9	Pilea pumila	12	6	17.5
6/19/2007	9	Cuscuta gronovii	3	2	0.5
6/19/2007	9	Typha angustifolia	2	2	0.5
6/19/2007	9	Acorus calamus	3	3	1.5
6/19/2007	9	Spartina patens	12	5	7.5
6/19/2007	9	Bidens laevis	1	7	37.5
6/19/2007	9	Spartina alterniflora	4	5	7.5
6/19/2007	9	Spartina cynosuroides	1	2	0.5
6/19/2007	9	Galium palustre	2	2	0.5
6/19/2007	9	Polygonum sagittatum	1	5	7.5
6/19/2007	9	Peltandra virginica	3	2	0.5
6/19/2007	10	Amaranthus cannabinu	1	7	37.5
6/19/2007	10	Bidens spp 2 (coronatus)	1	6	17.5
6/19/2007	10	Pilea pumila	14	7	37.5
6/19/2007	10	Leersia oryzoides	10	6	17.5
6/19/2007	10	Mikania scandens	2	3	1.5
6/19/2007	10	Phragmites australis	3	3	1.5
6/19/2007	10	Spartina cynosuroides	1	2	0.5
6/19/2007	10	Spartina patens	14	5	7.5
6/19/2007	10	Spartina alterniflora	4	5	7.5
6/19/2007	10	Distichlis spicata	11	5	7.5
6/19/2007	10	Typha angustifolia	2	2	0.5
6/19/2007	10	Murdannia keisak	1	2	0.5
6/19/2007	10	Pluchea purpurascens	19	7	37.5
6/19/2007	10	Aster puniceus	1	2	0.5
6/19/2007	10	Acorus calamus	3	3	1.5
6/19/2007	10	Polygonum arifolium	1	7	37.5
6/19/2007	10	Galium palustre	1	2	0.5
6/19/2007	10	Mast. offi.	1	2	0.5
6/20/2007	11	Amaranthus cannabinu	n/a	7	37.5
6/20/2007	11	Polygonum punctatum	n/a	6	17.5
6/20/2007	11	Pluchea purpurascens	n/a	6	17.5
6/20/2007	11	Pilea pumila	n/a	7	37.5
6/20/2007	11	Leersia oryzoides	n/a	6	17.5
6/20/2007	11	Murdannia keisak	n/a	4	3.5
6/20/2007	11	Phragmites australis	n/a	2	0.5
6/20/2007	11	Spartina patens	n/a	5	7.5
6/20/2007	11	Spartina cynosuroides	n/a	5	7.5
6/20/2007	11	Typha angustifolia	n/a	2	0.5
6/20/2007	11	Distichlis spicata	n/a	5	7.5
6/20/2007	11	Galium palustre	n/a	2	0.5
6/20/2007	11	Cuscuta gronovii	n/a	3	1.5
6/20/2007	11	Spartina alterniflora	n/a	5	7.5

6/20/2007	11	Acorus calamus	n/a	3	1.5
6/20/2007	11	Mikania scandens	n/a	5	7.5
6/20/2007	11	Peltandra virginica	n/a	3	1.5
6/20/2007	12	Pilea pumila	n/a	6	17.5
6/20/2007	12	Polygonum arifolium	n/a	8	62.5
6/20/2007	12	Cuscuta gronovii	n/a	5	7.5
6/20/2007	12	Leersia oryzoides	n/a	6	17.5
6/20/2007	12	Murdannia keisak	n/a	2	0.5
6/20/2007	12	Typha angustifolia	n/a	2	0.5
6/20/2007	12	Polygonum punctatum	n/a	4	3.5
6/20/2007	12	Spartina alterniflora	n/a	5	7.5
6/20/2007	12	Spartina patens	n/a	5	7.5
6/20/2007	12	Spartina cynosuroides	n/a	3	1.5
6/20/2007	12	Distichlis spicata	n/a	5	7.5
6/20/2007	12	Acorus calamus	n/a	4	3.5
6/20/2007	12	Mikania scandens	n/a	6	17.5
6/20/2007	12	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	12	Pluchea purpurascens	n/a	7	37.5
6/20/2007	12	Phragmites australis	n/a	2	0.5
6/20/2007	12	Peltandra virginica	n/a	2	0.5
6/20/2007	13	Bidens laevis	n/a	6	17.5
6/20/2007	13	Polygonum punctatum	n/a	5	7.5
6/20/2007	13	Amaranthus cannabinu	n/a	7	37.5
6/20/2007	13	Pilea pumila	n/a	7	37.5
6/20/2007	13	Spartina alterniflora	n/a	5	7.5
6/20/2007	13	Spartina patens	n/a	5	7.5
6/20/2007	13	Spartina cynosuroides	n/a	3	1.5
6/20/2007	13	Distichlis spicata	n/a	5	7.5
6/20/2007	13	Leersia oryzoides	n/a	5	7.5
6/20/2007	13	Polygonum arifolium	n/a	7	37.5
6/20/2007	13	Mikania scandens	n/a	4	3.5
6/20/2007	13	Typha angustifolia	n/a	2	0.5
6/20/2007	13	Phragmites australis	n/a	5	7.5
6/20/2007	13	Acorus calamus	n/a	3	1.5
6/20/2007	13	Pluchea purpurascens	n/a	6	17.5
6/20/2007	14	Mikania scandens	n/a	6	17.5
6/20/2007	14	Amaranthus cannabinu	n/a	9	85
6/20/2007	14	Polygonum punctatum	n/a	6	17.5
6/20/2007	14	Phragmites australis	n/a	6	17.5
6/20/2007	14	Pluchea purpurascens	n/a	6	17.5
6/20/2007	14	Pilea pumila	n/a	7	37.5
6/20/2007	14	Leersia oryzoides	n/a	6	17.5
6/20/2007	14	Spartina patens	n/a	5	7.5
6/20/2007	14	Spartina cynosuroides	n/a	2	0.5
6/20/2007	14	Spartina alterniflora	n/a	5	7.5
6/20/2007	14	Typha angustifolia	n/a	2	0.5
6/20/2007	14	Acorus calamus	n/a	3	1.5
6/20/2007	14	Senecio sp.	n/a	2	0.5
6/20/2007	14	Distichlis spicata	n/a	5	7.5
6/20/2007	15	Amaranthus cannabinu	n/a	8	62.5

6/20/2007	15	Zizania aquatica	n/a	6	17.5
6/20/2007	15	Pluchea purpurascens	n/a	7	37.5
6/20/2007	15	Pilea pumila	n/a	7	37.5
6/20/2007	15	Polygonum sagittatum	n/a	4	3.5
6/20/2007	15	Leersia oryzoides	n/a	6	17.5
6/20/2007	15	Spartina patens	n/a	5	7.5
6/20/2007	15	Spartina alterniflora	n/a	5	7.5
6/20/2007	15	Spartina cynosuroides	n/a	3	1.5
6/20/2007	15	Aster puniceus	n/a	2	0.5
6/20/2007	15	Typha angustifolia	n/a	2	0.5
6/20/2007	15	Acorus calamus	n/a	3	1.5
6/20/2007	15	Phragmites australis	n/a	3	1.5
6/20/2007	15	Senecio sp.	n/a	2	0.5
6/20/2007	15	Mikania scandens	n/a	5	7.5
6/20/2007	15	Apios americana	n/a	3	1.5
6/20/2007	15	Distichlis spicata	n/a	5	7.5
6/20/2007	15	Polygonum arifolium	n/a	6	17.5
6/20/2007	16	Acorus calamus	n/a	5	7.5
6/20/2007	16	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	16	Polygonum arifolium	n/a	8	62.5
6/20/2007	16	Pilea pumila	n/a	6	17.5
6/20/2007	16	Phragmites australis	n/a	5	7.5
6/20/2007	16	Mikania scandens	n/a	5	7.5
6/20/2007	16	Pluchea purpurascens	n/a	7	37.5
6/20/2007	16	Leersia oryzoides	n/a	6	17.5
6/20/2007	16	Spartina patens	n/a	5	7.5
6/20/2007	16	Spartina cynosuroides	n/a	2	0.5
6/20/2007	16	Spartina alterniflora	n/a	5	7.5
6/20/2007	16	Distichlis spicata	n/a	5	7.5
6/20/2007	16	Typha angustifolia	n/a	2	0.5
6/20/2007	16	Aster puniceus	n/a	2	0.5
6/20/2007	16	Polygonum punctatum	n/a	5	7.5
6/20/2007	17	Amaranthus cannabinu	n/a	8	62.5
6/20/2007	17	Polygonum arifolium	n/a	7	37.5
6/20/2007	17	Phragmites australis	n/a	4	3.5
6/20/2007	17	Pluchea purpurascens	n/a	8	62.5
6/20/2007	17	Mikania scandens	n/a	5	7.5
6/20/2007	17	Leersia oryzoides	n/a	6	17.5
6/20/2007	17	Polygonum sagittatum	n/a	3	1.5
6/20/2007	17	Cuscuta gronovii	n/a	2	0.5
6/20/2007	17	Spartina alterniflora	n/a	5	7.5
6/20/2007	17	Spartina patens	n/a	5	7.5
6/20/2007	17	Spartina cynosuroides	n/a	4	3.5
6/20/2007	17	Distichlis spicata	n/a	5	7.5
6/20/2007	17	Acorus calamus	n/a	3	1.5
6/20/2007	17	Typha angustifolia	n/a	2	0.5
6/20/2007	17	Polygonum punctatum	n/a	4	3.5
6/20/2007	17	Echina walt	n/a	6	17.5
6/20/2007	17	Rorippa islandica	n/a	2	0.5
6/20/2007	18	Amaranthus cannabinu	n/a	7	37.5

6/20/2007	18	Echina walt	n/a	6	17.5
6/20/2007	18	Phragmites australis	n/a	5	7.5
6/20/2007	18	Gal tinc	n/a	2	0.5
6/20/2007	18	Leersia oryzoides	n/a	6	17.5
6/20/2007	18	Polygonum sagittatum	n/a	5	7.5
6/20/2007	18	Impatiens capensis	n/a	5	7.5
6/20/2007	18	Pilea pumila	n/a	6	17.5
6/20/2007	18	Polygonum punctatum	n/a	5	7.5
6/20/2007	18	Pluchea purpurascens	n/a	6	17.5
6/20/2007	18	Mikania scandens	n/a	3	1.5
6/20/2007	18	Cuscuta gronovii	n/a	2	0.5
6/20/2007	18	Spartina patens	n/a	5	7.5
6/20/2007	18	Spartina cynosuroides	n/a	3	1.5
6/20/2007	18	Spartina alterniflora	n/a	5	7.5
6/20/2007	18	Distichlis spicata	n/a	5	7.5
6/20/2007	18	Peltandra virginica	n/a	2	0.5
6/20/2007	18	Acorus calamus	n/a	3	1.5
6/20/2007	18	Typha angustifolia	n/a	2	0.5
6/20/2007	18	Lythrum salicaria	n/a	2	0.5
6/20/2007	18	Hibiscus sp.	n/a	4	3.5
6/20/2007	19	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	19	Polygonum punctatum	n/a	6	17.5
6/20/2007	19	Polygonum arifolium	n/a	6	17.5
6/20/2007	19	Mikania scandens	n/a	5	7.5
6/20/2007	19	Polygonum sagittatum	n/a	4	3.5
6/20/2007	19	Cuscuta gronovii	n/a	2	0.5
6/20/2007	19	Leersia oryzoides	n/a	6	17.5
6/20/2007	19	Phragmites australis	n/a	5	7.5
6/20/2007	19	Spartina cynosuroides	n/a	2	0.5
6/20/2007	19	Pluchea purpurascens	n/a	7	37.5
6/20/2007	19	Spartina patens	n/a	5	7.5
6/20/2007	19	Spartina alterniflora	n/a	5	7.5
6/20/2007	19	Distichlis spicata	n/a	5	7.5
6/20/2007	19	Pilea pumila	n/a	6	17.5
6/20/2007	19	Echina walt	n/a	5	7.5
6/20/2007	19	Typha angustifolia	n/a	2	0.5
6/20/2007	19	Acorus calamus	n/a	3	1.5
6/20/2007	19	Murdannia keisak	n/a	2	0.5
6/20/2007	19	Peltandra virginica	n/a	6	17.5
6/20/2007	19	Aster puniceus	n/a	2	0.5
6/20/2007	20	Sonchus sp.	n/a	6	17.5
6/20/2007	20	Polygonum arifolium	n/a	8	62.5
6/20/2007	20	Echina walt	n/a	7	37.5
6/20/2007	20	Mikania scandens	n/a	4	3.5
6/20/2007	20	Leersia oryzoides	n/a	4	3.5
6/20/2007	20	Phragmites australis	n/a	3	1.5
6/20/2007	20	Spartina cynosuroides	n/a	3	1.5
6/20/2007	20	Spartina patens	n/a	5	7.5
6/20/2007	20	Spartina alterniflora	n/a	5	7.5
6/20/2007	20	Acorus calamus	n/a	3	1.5

6/20/2007	20	Pilea pumila	n/a	7	37.5
6/20/2007	20	Pluchea purpurascens	n/a	6	17.5
6/20/2007	20	Peltandra virginica	n/a	2	0.5
6/20/2007	20	Typha angustifolia	n/a	2	0.5
6/20/2007	20	Distichlis spicata	n/a	5	7.5
6/20/2007	20	Nasturtium officinale	n/a	2	0.5
6/20/2007	20	Murdannia keisak	n/a	2	0.5
6/20/2007	21	Amaranthus cannabinu	n/a	7	37.5
6/20/2007	21	Polygonum arifolium	n/a	9	85
6/20/2007	21	Leersia oryzoides	n/a	6	17.5
6/20/2007	21	Pilea pumila	n/a	7	37.5
6/20/2007	21	Typha angustifolia	n/a	2	0.5
6/20/2007	21	Mikania scandens	n/a	5	7.5
6/20/2007	21	Phragmites australis	n/a	4	3.5
6/20/2007	21	Spartina patens	n/a	5	7.5
6/20/2007	21	Spartina alterniflora	n/a	5	7.5
6/20/2007	21	Spartina cynosuroides	n/a	4	3.5
6/20/2007	21	Pluchea purpurascens	n/a	6	17.5
6/20/2007	21	Acorus calamus	n/a	3	1.5
6/20/2007	21	Distichlis spicata	n/a	5	7.5
6/20/2007	21	Aster puniceus	n/a	2	0.5
6/20/2007	21	Murdannia keisak	n/a	2	0.5
6/20/2007	21	Rorippa islandica	n/a	2	0.5
6/20/2007	21	Lythrum salicaria	n/a	2	0.5
6/20/2007	22	Amaranthus cannabinu	n/a	8	62.5
6/20/2007	22	Polygonum punctatum	n/a	7	37.5
6/20/2007	22	Mikania scandens	n/a	6	17.5
6/20/2007	22	Leersia oryzoides	n/a	5	7.5
6/20/2007	22	Pilea pumila	n/a	6	17.5
6/20/2007	22	Pluchea purpurascens	n/a	7	37.5
6/20/2007	22	Cuscuta gronovii	n/a	2	0.5
6/20/2007	22	Boehmeria cylindrica	n/a	2	0.5
6/20/2007	22	Gal tinc	n/a	2	0.5
6/20/2007	22	Phragmites australis	n/a	2	0.5
6/20/2007	22	Spartina patens	n/a	5	7.5
6/20/2007	22	Spartina cynosuroides	n/a	3	1.5
6/20/2007	22	Spartina alterniflora	n/a	5	7.5
6/20/2007	22	Typha angustifolia	n/a	2	0.5
6/20/2007	22	Acorus calamus	n/a	3	1.5
6/20/2007	22	Polygonum sagittatum	n/a	4	3.5
6/20/2007	22	Polygonum arifolium	n/a	7	37.5
6/20/2007	22	Murdannia keisak	n/a	2	0.5
6/20/2007	23	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	23	Polygonum arifolium	n/a	7	37.5
6/20/2007	23	Echina walt	n/a	7	37.5
6/20/2007	23	Pluchea purpurascens	n/a	8	62.5
6/20/2007	23	Leersia oryzoides	n/a	6	17.5
6/20/2007	23	Cuscuta gronovii	n/a	2	0.5
6/20/2007	23	Phragmites australis	n/a	2	0.5
6/20/2007	23	Spartina cynosuroides	n/a	2	0.5

6/20/2007	23	Spartina patens	n/a	5	7.5
6/20/2007	23	Spartina alterniflora	n/a	5	7.5
6/20/2007	23	Distichlis spicata	n/a	5	7.5
6/20/2007	23	Pilea pumila	n/a	4	3.5
6/20/2007	23	Typha angustifolia	n/a	2	0.5
6/20/2007	23	Acorus calamus	n/a	3	1.5
6/20/2007	23	Peltandra virginica	n/a	2	0.5
6/20/2007	23	Mikania scandens	n/a	4	3.5
6/20/2007	23	Hibiscus sp.	n/a	2	0.5
6/20/2007	24	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	24	Leersia oryzoides	n/a	6	17.5
6/20/2007	24	Polygonum arifolium	n/a	8	62.5
6/20/2007	24	Typha angustifolia	n/a	2	0.5
6/20/2007	24	Phragmites australis	n/a	3	1.5
6/20/2007	24	Cuscuta gronovii	n/a	2	0.5
6/20/2007	24	Mikania scandens	n/a	5	7.5
6/20/2007	24	Spartina cynosuroides	n/a	2	0.5
6/20/2007	24	Spartina patens	n/a	5	7.5
6/20/2007	24	Spartina alterniflora	n/a	5	7.5
6/20/2007	24	Distichlis spicata	n/a	5	7.5
6/20/2007	24	Pluchea purpurascens	n/a	6	17.5
6/20/2007	24	Acorus calamus	n/a	3	1.5
6/20/2007	24	Murdannia keisak	n/a	2	0.5
6/20/2007	24	Pilea pumila	n/a	6	17.5
6/20/2007	25	Amaranthus cannabinu	n/a	7	37.5
6/20/2007	25	Leersia oryzoides	n/a	6	17.5
6/20/2007	25	Polygonum punctatum	n/a	6	17.5
6/20/2007	25	Pilea pumila	n/a	6	17.5
6/20/2007	25	Cuscuta gronovii	n/a	2	0.5
6/20/2007	25	Mikania scandens	n/a	4	3.5
6/20/2007	25	Phragmites australis	n/a	3	1.5
6/20/2007	25	Spartina cynosuroides	n/a	2	0.5
6/20/2007	25	Bidens laevis	n/a	6	17.5
6/20/2007	25	Spartina alterniflora	n/a	5	7.5
6/20/2007	25	Spartina patens	n/a	5	7.5
6/20/2007	25	Distichlis spicata	n/a	5	7.5
6/20/2007	25	Acorus calamus	n/a	3	1.5
6/20/2007	25	Typha angustifolia	n/a	2	0.5
6/20/2007	25	Pluchea purpurascens	n/a	6	17.5
6/20/2007	25	Polygonum arifolium	n/a	7	37.5
6/20/2007	25	Echina walt	n/a	6	17.5
6/20/2007	25	Polygonum sagittatum	n/a	4	3.5
6/20/2007	26	Amaranthus cannabinu	n/a	6	17.5
6/20/2007	26	Pluchea purpurascens	n/a	6	17.5
6/20/2007	26	Polygonum arifolium	n/a	9	85
6/20/2007	26	Pilea pumila	n/a	5	7.5
6/20/2007	26	Phragmites australis	n/a	3	1.5
6/20/2007	26	Mikania scandens	n/a	3	1.5
6/20/2007	26	Polygonum sagittatum	n/a	4	3.5
6/20/2007	26	Gal tinc	n/a	2	0.5

6/20/2007	26	Cuscuta gronovii	n/a	2	0.5
6/20/2007	26	Spartina cynosuroides	n/a	3	1.5
6/20/2007	26	Spartina alterniflora	n/a	5	7.5
6/20/2007	26	Spartina patens	n/a	5	7.5
6/20/2007	26	Distichlis spicata	n/a	5	7.5
6/20/2007	26	Typha angustifolia	n/a	2	0.5
6/20/2007	26	Acorus calamus	n/a	3	1.5
6/20/2007	26	Aster puniceus	n/a	2	0.5
6/20/2007	26	Leersia oryzoides	n/a	6	17.5
6/20/2007	27	Amaranthus cannabinu	n/a	8	62.5
6/20/2007	27	Leersia oryzoides	n/a	6	17.5
6/20/2007	27	Polygonum arifolium	n/a	7	37.5
6/20/2007	27	Pluchea purpurascens	n/a	6	17.5
6/20/2007	27	Pilea pumila	n/a	6	17.5
6/20/2007	27	Polygonum sagittatum	n/a	4	3.5
6/20/2007	27	Phragmites australis	n/a	3	1.5
6/20/2007	27	Spartina cynosuroides	n/a	3	1.5
6/20/2007	27	Cuscuta gronovii	n/a	2	0.5
6/20/2007	27	Typha angustifolia	n/a	2	0.5
6/20/2007	27	Acorus calamus	n/a	3	1.5
6/20/2007	27	Spartina patens	n/a	5	7.5
6/20/2007	27	Spartina alterniflora	n/a	5	7.5
6/20/2007	27	Distichlis spicata	n/a	5	7.5
6/20/2007	27	Mikania scandens	n/a	5	7.5
6/20/2007	28	Murdannia keisak	n/a	2	0.5
6/20/2007	28	Amaranthus cannabinu	n/a	8	62.5
6/20/2007	28	Polygonum arifolium	n/a	7	37.5
6/20/2007	28	Leersia oryzoides	n/a	6	17.5
6/20/2007	28	Polygonum punctatum	n/a	4	3.5
6/20/2007	28	Pluchea purpurascens	n/a	7	37.5
6/20/2007	28	Polygonum sagittatum	n/a	4	3.5
6/20/2007	28	Mikania scandens	n/a	5	7.5
6/20/2007	28	Pilea pumila	n/a	6	17.5
6/20/2007	28	Phragmites australis	n/a	3	1.5
6/20/2007	28	Spartina cynosuroides	n/a	2	0.5
6/20/2007	28	Spartina patens	n/a	5	7.5
6/20/2007	28	Spartina alterniflora	n/a	5	7.5
6/20/2007	28	Distichlis spicata	n/a	5	7.5
6/20/2007	28	Typha angustifolia	n/a	2	0.5
6/20/2007	28	Acorus calamus	n/a	3	1.5
6/20/2007	28	Cuscuta gronovii	n/a	2	0.5
6/20/2007	28	Peltandra virginica	n/a	2	0.5
6/20/2007	29	Amaranthus cannabinu	n/a	7	37.5
6/20/2007	29	Mikania scandens	n/a	6	17.5
6/20/2007	29	Leersia oryzoides	n/a	6	17.5
6/20/2007	29	Polygonum punctatum	n/a	6	17.5
6/20/2007	29	Polygonum sagittatum	n/a	5	7.5
6/20/2007	29	Pluchea purpurascens	n/a	7	37.5
6/20/2007	29	Aster puniceus	n/a	2	0.5
6/20/2007	29	Cuscuta gronovii	n/a	2	0.5

6/20/2007	29	Pilea pumila	n/a	7	37.5
6/20/2007	29	Gal tinc	n/a	2	0.5
6/20/2007	29	Phragmites australis	n/a	2	0.5
6/20/2007	29	Spartina cynosuroides	n/a	2	0.5
6/20/2007	29	Spartina patens	n/a	5	7.5
6/20/2007	29	Spartina alterniflora	n/a	5	7.5
6/20/2007	29	Distichlis spicata	n/a	5	7.5
6/20/2007	29	Typha angustifolia	n/a	2	0.5
6/20/2007	29	Acorus calamus	n/a	3	1.5
6/20/2007	29	Peltandra virginica	n/a	2	0.5
6/20/2007	29	Polygonum arifolium	n/a	6	17.5
6/20/2007	30	Phragmites australis	n/a	4	3.5
6/20/2007	30	Polygonum sp. 1	n/a	5	7.5
6/20/2007	30	Cuscuta gronovii	n/a	7	37.5
6/20/2007	30	Polygonum arifolium	n/a	8	62.5
6/20/2007	30	Mikania scandens	n/a	6	17.5
6/20/2007	30	Leersia oryzoides	n/a	5	7.5
6/20/2007	30	Pluchea purpurascens	n/a	7	37.5
6/20/2007	30	Pilea pumila	n/a	6	17.5
6/20/2007	30	Zizania aquatica	n/a	5	7.5
6/20/2007	30	Peltandra virginica	n/a	2	0.5
6/20/2007	30	Spartina cynosuroides	n/a	2	0.5
6/20/2007	30	Spartina patens	n/a	5	7.5
6/20/2007	30	Spartina alterniflora	n/a	5	7.5
6/20/2007	30	Distichlis spicata	n/a	5	7.5
6/20/2007	30	Typha angustifolia	n/a	2	0.5
6/20/2007	30	Acorus calamus	n/a	3	1.5

Appendix D. Raw Species and Plant Cover Data Mesocosm Study September 2007

Date	Mesocosm	Species	Frequency	Cover Class	Mid-Point Percent
9/13/2007	1	Pilea pumila	n/a	6	17.5
9/13/2007	1	Amaranthus cannabinu	n/a	7	37.5
9/13/2007	1	Leersia oryzoides	n/a	7	37.5
9/13/2007	1	Pluchea purpurascens	n/a	5	7.5
9/13/2007	1	Polygonum arifolium	n/a	6	17.5
9/13/2007	1	Polygonum punctatum	n/a	6	17.5
9/13/2007	1	Mast. offi.	n/a	0	0
9/13/2007	1	Typha angustifolia	n/a	3	1.5
9/13/2007	1	Spartina patens	n/a	2	0.5
9/13/2007	1	Spartina cynosuroides	n/a	2	0.5
9/13/2007	1	Spartina alterniflora	n/a	0	0
9/13/2007	1	Phragmites australis	n/a	5	7.5
9/13/2007	1	Mikania scandens	n/a	6	17.5
9/13/2007	1	Distichlis spicata	n/a	3	1.5
9/13/2007	1	Cyprus escul.	n/a	2	0.5
9/13/2007	1	Acorus calamus	n/a	4	3.5
9/13/2007	1	Murdannia keisak	n/a	4	3.5
9/13/2007	1	Peltandra virginica	n/a	0	0
9/13/2007	2	Cuscuta gronovii	n/a	4	3.5
9/13/2007	2	Pilea pumila	n/a	0	0
9/13/2007	2	Amaranthus cannabinu	n/a	6	17.5
9/13/2007	2	Polygonum arifolium	n/a	6	17.5
9/13/2007	2	Leersia oryzoides	n/a	7	37.5
9/13/2007	2	Polygonum punctatum	n/a	6	17.5
9/13/2007	2	Spartina alterniflora	n/a	0	0
9/13/2007	2	Spartina cynosuroides	n/a	3	1.5
9/13/2007	2	Spartina patens	n/a	5	7.5
9/13/2007	2	Distichlis spicata	n/a	3	1.5
9/13/2007	2	Acorus calamus	n/a	4	3.5
9/13/2007	2	Typha angustifolia	n/a	0	0
9/13/2007	2	Mikania scandens	n/a	6	17.5
9/13/2007	2	Pluchea purpurascens	n/a	5	7.5
9/13/2007	2	Murdannia keisak	n/a	0	0
9/13/2007	2	Phragmites australis	n/a	0	0
9/13/2007	2	Schoenplectus sp.	n/a	0	0
9/13/2007	2	Peltandra virginica	n/a	0	0
9/13/2007	2	Mast. offi.	n/a	0	0
9/11/2007	3	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	3	Pilea pumila	n/a	5	7.5
9/11/2007	3	Leersia oryzoides	n/a	7	37.5
9/11/2007	3	Mikania scandens	n/a	5	7.5
9/11/2007	3	Pluchea purpurascens	n/a	5	7.5
9/11/2007	3	Polygonum arifolium	n/a	5	7.5
9/11/2007	3	Polygonum punctatum	n/a	0	0
9/11/2007	3	Spartina patens	n/a	5	7.5
9/11/2007	3	Spartina alterniflora	n/a	0	0

9/11/2007	3	Spartina cynosuroides	n/a	4	3.5
9/11/2007	3	Typha angustifolia	n/a	2	0.5
9/11/2007	3	Acorus calamus	n/a	3	1.5
9/11/2007	3	Phragmites australis	n/a	3	1.5
9/11/2007	3	Murdannia keisak	n/a	2	0.5
9/11/2007	3	Cuscuta gronovii	n/a	2	0.5
9/11/2007	3	Echina Walt	n/a	6	17.5
9/11/2007	3	Gal tinc	n/a	2	0.5
9/11/2007	3	Kost vir	n/a	3	1.5
9/6/2007	4	Amaranthus cannabinu	n/a	6	17.5
9/6/2007	4	Polygonum arifolium	n/a	0	0
9/6/2007	4	Polygonum sagittatum	n/a	0	0
9/6/2007	4	Pilea pumila	n/a	0	0
9/6/2007	4	Mikania scandens	n/a	0	0
9/6/2007	4	Leersia oryzoides	n/a	6	17.5
9/6/2007	4	Cuscuta gronovii	n/a	0	0
9/6/2007	4	Spartina patens	n/a	4	3.5
9/6/2007	4	Spartina alterniflora	n/a	6	17.5
9/6/2007	4	Spartina cynosuroides	n/a	5	7.5
9/6/2007	4	Phragmites australis	n/a	6	17.5
9/6/2007	4	Peltandra virginica	n/a	0	0
9/6/2007	4	Typha angustifolia	n/a	0	0
9/6/2007	4	Polygonum punctatum	n/a	7	37.5
9/6/2007	4	Acorus calamus	n/a	0	0
9/6/2007	4	Murdannia keisak	n/a	0	0
9/6/2007	4	Pluchea purpurascens	n/a	0	0
9/13/2007	5	Pilea pumila	n/a	7	37.5
9/13/2007	5	Amaranthus cannabinu	n/a	8	62.5
9/13/2007	5	Polygonum sagittatum	n/a	0	0
9/13/2007	5	Leersia oryzoides	n/a	5	7.5
9/13/2007	5	Spartina cynosuroides	n/a	3	1.5
9/13/2007	5	Phragmites australis	n/a	5	7.5
9/13/2007	5	Mikania scandens	n/a	6	17.5
9/13/2007	5	Spartina patens	n/a	2	0.5
9/13/2007	5	Spartina alterniflora	n/a	2	0.5
9/13/2007	5	Distichlis spicata	n/a	0	0
9/13/2007	5	Acorus calamus	n/a	2	0.5
9/13/2007	5	Pluchea purpurascens	n/a	3	1.5
9/13/2007	5	Polygonum punctatum	n/a	6	17.5
9/13/2007	5	Typha angustifolia	n/a	2	0.5
9/13/2007	5	Polygonum arifolium	n/a	6	17.5
9/13/2007	5	Murdannia keisak	n/a	3	1.5
9/13/2007	5	Rorippa islandica	n/a	0	0
9/13/2007	5	Aster puniceus	n/a	0	0
9/13/2007	5	Mast. offi.	n/a	0	0
9/13/2007	5	Cyprus strig	n/a	3	1.5
9/11/2007	6	Echina Walt	n/a	5	7.5
9/11/2007	6	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	6	Pilea pumila	n/a	7	37.5
9/11/2007	6	Leersia oryzoides	n/a	6	17.5

9/11/2007	6	Pluchea purpurascens	n/a	6	17.5
9/11/2007	6	Mikania scandens	n/a	6	17.5
9/11/2007	6	Phragmites australis	n/a	6	17.5
9/11/2007	6	Acorus calamus	n/a	4	3.5
9/11/2007	6	Spartina cynosuroides	n/a	4	3.5
9/11/2007	6	Spartina patens	n/a	3	1.5
9/11/2007	6	Spartina alterniflora	n/a	3	1.5
9/11/2007	6	Distichlis spicata	n/a	2	0.5
9/11/2007	6	Cuscuta gronovii	n/a	5	7.5
9/11/2007	6	Polygonum sagittatum	n/a	0	0
9/11/2007	6	Polygonum arifolium	n/a	4	3.5
9/11/2007	6	Typha angustifolia	n/a	2	0.5
9/11/2007	6	Schoenplectus sp.	n/a	0	0
9/11/2007	6	Murdannia keisak	n/a	0	0
9/11/2007	6	Aster puniceus	n/a	0	0
9/13/2007	7	Amaranthus cannabinu	n/a	8	62.5
9/13/2007	7	Pilea pumila	n/a	0	0
9/13/2007	7	Mikania scandens	n/a	0	0
9/13/2007	7	Leersia oryzoides	n/a	4	3.5
9/13/2007	7	Pluchea purpurascens	n/a	0	0
9/13/2007	7	Phragmites australis	n/a	5	7.5
9/13/2007	7	Polygonum punctatum	n/a	0	0
9/13/2007	7	Polygonum arifolium	n/a	0	0
9/13/2007	7	Distichlis spicata	n/a	2	0.5
9/13/2007	7	Spartina alterniflora	n/a	3	1.5
9/13/2007	7	Spartina patens	n/a	5	7.5
9/13/2007	7	Typha angustifolia	n/a	2	0.5
9/13/2007	7	Acorus calamus	n/a	2	0.5
9/13/2007	7	Cuscuta gronovii	n/a	0	0
9/13/2007	7	Galium palustre	n/a	0	0
9/13/2007	7	Spartina cynosuroides	n/a	4	3.5
9/13/2007	8	Mast. offi.	n/a	0	0
9/13/2007	8	Mikania scandens	n/a	7	37.5
9/13/2007	8	Echina Walt	n/a	8	62.5
9/13/2007	8	Pluchea purpurascens	n/a	6	17.5
9/13/2007	8	Pilea pumila	n/a	2	0.5
9/13/2007	8	Polygonum sagittatum	n/a	0	0
9/13/2007	8	Leersia oryzoides	n/a	5	7.5
9/13/2007	8	Amaranthus cannabinu	n/a	6	17.5
9/13/2007	8	Spartina cynosuroides	n/a	2	0.5
9/13/2007	8	Polygonum punctatum	n/a	6	17.5
9/13/2007	8	Phragmites australis	n/a	5	7.5
9/13/2007	8	Gal tinc	n/a	0	0
9/13/2007	8	Spartina patens	n/a	2	0.5
9/13/2007	8	Spartina alterniflora	n/a	3	1.5
9/13/2007	8	Distichlis spicata	n/a	2	0.5
9/13/2007	8	Typha angustifolia	n/a	0	0
9/13/2007	8	Cyprus escul.	n/a	4	3.5
9/13/2007	8	Peltandra virginica	n/a	0	0
9/13/2007	8	Acorus calamus	n/a	2	0.5

9/13/2007	8	Polygonum arifolium	n/a	7	37.5
9/13/2007	8	Murdannia keisak	n/a	0	0
9/13/2007	8	Cuscuta gronovii	n/a	0	0
9/13/2007	8	Uni dic	n/a	2	0.5
9/13/2007	8	Boehmeria cylindrica	n/a	3	1.5
9/13/2007	9	Amaranthus cannabinu	n/a	6	17.5
9/13/2007	9	Polygonum arifolium	n/a	5	7.5
9/13/2007	9	Mikania scandens	n/a	7	37.5
9/13/2007	9	Phragmites australis	n/a	5	7.5
9/13/2007	9	Pluchea purpurascens	n/a	4	3.5
9/13/2007	9	Leersia oryzoides	n/a	7	37.5
9/13/2007	9	Murdannia keisak	n/a	5	7.5
9/13/2007	9	Pilea pumila	n/a	5	7.5
9/13/2007	9	Cuscuta gronovii	n/a	4	3.5
9/13/2007	9	Typha angustifolia	n/a	0	0
9/13/2007	9	Acorus calamus	n/a	4	3.5
9/13/2007	9	Spartina patens	n/a	5	7.5
9/13/2007	9	Bidens laevis	n/a	8	62.5
9/13/2007	9	Spartina alterniflora	n/a	4	3.5
9/13/2007	9	Spartina cynosuroides	n/a	3	1.5
9/13/2007	9	Galium palustre	n/a	2	0.5
9/13/2007	9	Polygonum sagittatum	n/a	0	0
9/13/2007	9	Peltandra virginica	n/a	3	1.5
9/13/2007	9	Distichlis spicata	n/a	0	0
9/11/2007	10	Amaranthus cannabinu	n/a	7	37.5
9/11/2007	10	Bidens spp 2 (coronatus)	n/a	0	0
9/11/2007	10	Pilea pumila	n/a	0	0
9/11/2007	10	Leersia oryzoides	n/a	6	17.5
9/11/2007	10	Mikania scandens	n/a	6	17.5
9/11/2007	10	Phragmites australis	n/a	5	7.5
9/11/2007	10	Spartina cynosuroides	n/a	0	0
9/11/2007	10	Spartina patens	n/a	6	17.5
9/11/2007	10	Spartina alterniflora	n/a	0	0
9/11/2007	10	Distichlis spicata	n/a	3	1.5
9/11/2007	10	Typha angustifolia	n/a	0	0
9/11/2007	10	Murdannia keisak	n/a	2	0.5
9/11/2007	10	Pluchea purpurascens	n/a	4	3.5
9/11/2007	10	Aster puniceus	n/a	3	1.5
9/11/2007	10	Acorus calamus	n/a	4	3.5
9/11/2007	10	Polygonum arifolium	n/a	6	17.5
9/11/2007	10	Galium palustre	n/a	0	0
9/11/2007	10	Mast. offi.	n/a	0	0
9/11/2007	10	Juncus sp.	n/a	2	0.5
9/11/2007	11	Amaranthus cannabinu	n/a	6	17.5
9/11/2007	11	Polygonum punctatum	n/a	0	0
9/11/2007	11	Pluchea purpurascens	n/a	0	0
9/11/2007	11	Pilea pumila	n/a	6	17.5
9/11/2007	11	Leersia oryzoides	n/a	7	37.5
9/11/2007	11	Murdannia keisak	n/a	5	7.5
9/11/2007	11	Phragmites australis	n/a	0	0

9/11/2007	11	Spartina patens	n/a	5	7.5
9/11/2007	11	Spartina cynosuroides	n/a	5	7.5
9/11/2007	11	Typha angustifolia	n/a	0	0
9/11/2007	11	Distichlis spicata	n/a	3	1.5
9/11/2007	11	Galium palustre	n/a	0	0
9/11/2007	11	Cuscuta gronovii	n/a	2	0.5
9/11/2007	11	Spartina alterniflora	n/a	4	3.5
9/11/2007	11	Acorus calamus	n/a	4	3.5
9/11/2007	11	Mikania scandens	n/a	0	0
9/11/2007	11	Peltandra virginica	n/a	3	1.5
9/6/2007	12	Pilea pumila	n/a	2	0.5
9/6/2007	12	Polygonum arifolium	n/a	6	17.5
9/6/2007	12	Cuscuta gronovii	n/a	2	0.5
9/6/2007	12	Leersia oryzoides	n/a	8	62.5
9/6/2007	12	Murdannia keisak	n/a	0	0
9/6/2007	12	Typha angustifolia	n/a	0	0
9/6/2007	12	Polygonum punctatum	n/a	5	7.5
9/6/2007	12	Spartina alterniflora	n/a	0	0
9/6/2007	12	Spartina patens	n/a	3	1.5
9/6/2007	12	Spartina cynosuroides	n/a	3	1.5
9/6/2007	12	Distichlis spicata	n/a	2	0.5
9/6/2007	12	Acorus calamus	n/a	6	17.5
9/6/2007	12	Mikania scandens	n/a	7	37.5
9/6/2007	12	Amaranthus cannabinu	n/a	5	7.5
9/6/2007	12	Pluchea purpurascens	n/a	0	0
9/6/2007	12	Phragmites australis	n/a	4	3.5
9/6/2007	12	Peltandra virginica	n/a	2	0.5
9/13/2007	13	Bidens laevis	n/a	6	17.5
9/13/2007	13	Polygonum punctatum	n/a	7	37.5
9/13/2007	13	Amaranthus cannabinu	n/a	7	37.5
9/13/2007	13	Pilea pumila	n/a	5	7.5
9/13/2007	13	Spartina alterniflora	n/a	2	0.5
9/13/2007	13	Spartina patens	n/a	4	3.5
9/13/2007	13	Spartina cynosuroides	n/a	3	1.5
9/13/2007	13	Distichlis spicata	n/a	0	0
9/13/2007	13	Leersia oryzoides	n/a	6	17.5
9/13/2007	13	Polygonum arifolium	n/a	5	7.5
9/13/2007	13	Mikania scandens	n/a	6	17.5
9/13/2007	13	Typha angustifolia	n/a	0	0
9/13/2007	13	Phragmites australis	n/a	5	7.5
9/13/2007	13	Acorus calamus	n/a	4	3.5
9/13/2007	13	Pluchea purpurascens	n/a	5	7.5
9/11/2007	14	Mikania scandens	n/a	7	37.5
9/11/2007	14	Amaranthus cannabinu	n/a	7	37.5
9/11/2007	14	Polygonum punctatum	n/a	5	7.5
9/11/2007	14	Phragmites australis	n/a	4	3.5
9/11/2007	14	Pluchea purpurascens	n/a	3	1.5
9/11/2007	14	Pilea pumila	n/a	7	37.5
9/11/2007	14	Leersia oryzoides	n/a	8	62.5
9/11/2007	14	Spartina patens	n/a	5	7.5

9/11/2007	14	Spartina cynosuroides	n/a	4	3.5
9/11/2007	14	Spartina alterniflora	n/a	0	0
9/11/2007	14	Typha angustifolia	n/a	3	1.5
9/11/2007	14	Acorus calamus	n/a	4	3.5
9/11/2007	14	Senecio sp.	n/a	0	0
9/11/2007	14	Distichlis spicata	n/a	2	0.5
9/11/2007	14	Peltandra virginica	n/a	2	0.5
9/11/2007	14	Cyperus sp.	n/a	4	3.5
9/11/2007	15	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	15	Zizania aquatica	n/a	5	7.5
9/11/2007	15	Pluchea purpurascens	n/a	6	17.5
9/11/2007	15	Pilea pumila	n/a	6	17.5
9/11/2007	15	Polygonum sagittatum	n/a	0	0
9/11/2007	15	Leersia oryzoides	n/a	7	37.5
9/11/2007	15	Spartina patens	n/a	6	17.5
9/11/2007	15	Spartina alterniflora	n/a	0	0
9/11/2007	15	Spartina cynosuroides	n/a	3	1.5
9/11/2007	15	Aster puniceus	n/a	5	7.5
9/11/2007	15	Typha angustifolia	n/a	2	0.5
9/11/2007	15	Acorus calamus	n/a	2	0.5
9/11/2007	15	Phragmites australis	n/a	4	3.5
9/11/2007	15	Senecio sp.	n/a	0	0
9/11/2007	15	Mikania scandens	n/a	6	17.5
9/11/2007	15	Apios americana	n/a	0	0
9/11/2007	15	Distichlis spicata	n/a	6	17.5
9/11/2007	15	Polygonum arifolium	n/a	5	7.5
9/11/2007	15	Decadon pert? (vegetative)	n/a	2	0.5
9/13/2007	16	Acorus calamus	n/a	6	17.5
9/13/2007	16	Amaranthus cannabinu	n/a	6	17.5
9/13/2007	16	Polygonum arifolium	n/a	5	7.5
9/13/2007	16	Pilea pumila	n/a	2	0.5
9/13/2007	16	Phragmites australis	n/a	6	17.5
9/13/2007	16	Mikania scandens	n/a	5	7.5
9/13/2007	16	Pluchea purpurascens	n/a	3	1.5
9/13/2007	16	Leersia oryzoides	n/a	7	37.5
9/13/2007	16	Spartina patens	n/a	5	7.5
9/13/2007	16	Spartina cynosuroides	n/a	2	0.5
9/13/2007	16	Spartina alterniflora	n/a	3	1.5
9/13/2007	16	Distichlis spicata	n/a	0	0
9/13/2007	16	Typha angustifolia	n/a	2	0.5
9/13/2007	16	Aster puniceus	n/a	3	1.5
9/13/2007	16	Polygonum punctatum	n/a	4	3.5
9/13/2007	16	Cypreus escul.	n/a	3	1.5
9/13/2007	17	Amaranthus cannabinu	n/a	7	37.5
9/13/2007	17	Polygonum arifolium	n/a	7	37.5
9/13/2007	17	Phragmites australis	n/a	4	3.5
9/13/2007	17	Pluchea purpurascens	n/a	3	1.5
9/13/2007	17	Mikania scandens	n/a	0	0
9/13/2007	17	Leersia oryzoides	n/a	7	37.5
9/13/2007	17	Polygonum sagittatum	n/a	0	0

9/13/2007	17	Cuscuta gronovii	n/a	4	3.5
9/13/2007	17	Spartina alterniflora	n/a	4	3.5
9/13/2007	17	Spartina patens	n/a	3	1.5
9/13/2007	17	Spartina cynosuroides	n/a	5	7.5
9/13/2007	17	Distichlis spicata	n/a	2	0.5
9/13/2007	17	Acorus calamus	n/a	2	0.5
9/13/2007	17	Typha angustifolia	n/a	2	0.5
9/13/2007	17	Polygonum punctatum	n/a	0	0
9/13/2007	17	Echina Walt	n/a	7	37.5
9/13/2007	17	Rorippa islandica	n/a	0	0
9/13/2007	18	Amaranthus cannabinu	n/a	7	37.5
9/13/2007	18	Echina Walt	n/a	7	37.5
9/13/2007	18	Phragmites australis	n/a	7	37.5
9/13/2007	18	Gal tinc	n/a	0	0
9/13/2007	18	Leersia oryzoides	n/a	7	37.5
9/13/2007	18	Polygonum sagittatum	n/a	4	3.5
9/13/2007	18	Impatiens capensis	n/a	0	0
9/13/2007	18	Pilea pumila	n/a	6	17.5
9/13/2007	18	Polygonum punctatum	n/a	0	0
9/13/2007	18	Pluchea purpurascens	n/a	4	3.5
9/13/2007	18	Mikania scandens	n/a	6	17.5
9/13/2007	18	Cuscuta gronovii	n/a	0	0
9/13/2007	18	Spartina patens	n/a	5	7.5
9/13/2007	18	Spartina cynosuroides	n/a	3	1.5
9/13/2007	18	Spartina alterniflora	n/a	3	1.5
9/13/2007	18	Distichlis spicata	n/a	2	0.5
9/13/2007	18	Peltandra virginica	n/a	0	0
9/13/2007	18	Acorus calamus	n/a	4	3.5
9/13/2007	18	Typha angustifolia	n/a	2	0.5
9/13/2007	18	Lythrum salicaria	n/a	4	3.5
9/13/2007	18	Hibiscus sp.	n/a	4	3.5
9/13/2007	19	Amaranthus cannabinu	n/a	5	7.5
9/13/2007	19	Polygonum punctatum	n/a	7	37.5
9/13/2007	19	Polygonum arifolium	n/a	0	0
9/13/2007	19	Mikania scandens	n/a	6	17.5
9/13/2007	19	Polygonum sagittatum	n/a	0	0
9/13/2007	19	Cuscuta gronovii	n/a	0	0
9/13/2007	19	Leersia oryzoides	n/a	5	7.5
9/13/2007	19	Phragmites australis	n/a	6	17.5
9/13/2007	19	Spartina cynosuroides	n/a	2	0.5
9/13/2007	19	Pluchea purpurascens	n/a	5	7.5
9/13/2007	19	Spartina patens	n/a	4	3.5
9/13/2007	19	Spartina alterniflora	n/a	2	0.5
9/13/2007	19	Distichlis spicata	n/a	3	1.5
9/13/2007	19	Pilea pumila	n/a	0	0
9/13/2007	19	Echina Walt	n/a	6	17.5
9/13/2007	19	Typha angustifolia	n/a	3	1.5
9/13/2007	19	Acorus calamus	n/a	2	0.5
9/13/2007	19	Murdannia keisak	n/a	0	0
9/13/2007	19	Peltandra virginica	n/a	0	0

9/13/2007	19	Aster puniceus	n/a	4	3.5
9/13/2007	20	Sonchus sp.	n/a	0	0
9/13/2007	20	Polygonum arifolium	n/a	7	37.5
9/13/2007	20	Echina Walt	n/a	7	37.5
9/13/2007	20	Mikania scandens	n/a	4	3.5
9/13/2007	20	Leersia oryzoides	n/a	5	7.5
9/13/2007	20	Phragmites australis	n/a	5	7.5
9/13/2007	20	Spartina cynosuroides	n/a	4	3.5
9/13/2007	20	Spartina patens	n/a	4	3.5
9/13/2007	20	Spartina alterniflora	n/a	3	1.5
9/13/2007	20	Acorus calamus	n/a	3	1.5
9/13/2007	20	Pilea pumila	n/a	0	0
9/13/2007	20	Pluchea purpurascens	n/a	6	17.5
9/13/2007	20	Peltandra virginica	n/a	0	0
9/13/2007	20	Typha angustifolia	n/a	0	0
9/13/2007	20	Distichlis spicata	n/a	0	0
9/13/2007	20	Nasturtium officinale	n/a	0	0
9/13/2007	20	Murdannia keisak	n/a	0	0
9/13/2007	20	Cuscuta gronovii	n/a	2	0.5
9/6/2007	21	Amaranthus cannabinu	n/a	7	37.5
9/6/2007	21	Polygonum arifolium	n/a	6	17.5
9/6/2007	21	Leersia oryzoides	n/a	7	37.5
9/6/2007	21	Pilea pumila	n/a	7	37.5
9/6/2007	21	Typha angustifolia	n/a	2	0.5
9/6/2007	21	Mikania scandens	n/a	6	17.5
9/6/2007	21	Phragmites australis	n/a	4	3.5
9/6/2007	21	Spartina patens	n/a	2	0.5
9/6/2007	21	Spartina alterniflora	n/a	0	0
9/6/2007	21	Spartina cynosuroides	n/a	3	1.5
9/6/2007	21	Pluchea purpurascens	n/a	5	7.5
9/6/2007	21	Acorus calamus	n/a	2	0.5
9/6/2007	21	Distichlis spicata	n/a	3	1.5
9/6/2007	21	Aster puniceus	n/a	2	0.5
9/6/2007	21	Murdannia keisak	n/a	2	0.5
9/6/2007	21	Rorippa islandica	n/a	2	0.5
9/6/2007	21	Lythrum salicaria	n/a	0	0
9/6/2007	21	Cuscuta gronovii	n/a	3	1.5
9/13/2007	22	Amaranthus cannabinu	n/a	7	37.5
9/13/2007	22	Polygonum punctatum	n/a	0	0
9/13/2007	22	Mikania scandens	n/a	6	17.5
9/13/2007	22	Leersia oryzoides	n/a	7	37.5
9/13/2007	22	Pilea pumila	n/a	6	17.5
9/13/2007	22	Pluchea purpurascens	n/a	4	3.5
9/13/2007	22	Cuscuta gronovii	n/a	4	3.5
9/13/2007	22	Boehmeria cylindrica	n/a	3	1.5
9/13/2007	22	Gal tinc	n/a	3	1.5
9/13/2007	22	Phragmites australis	n/a	5	7.5
9/13/2007	22	Spartina patens	n/a	4	3.5
9/13/2007	22	Spartina cynosuroides	n/a	3	1.5
9/13/2007	22	Spartina alterniflora	n/a	2	0.5

9/13/2007	22	Typha angustifolia	n/a	2	0.5
9/13/2007	22	Acorus calamus	n/a	4	3.5
9/13/2007	22	Polygonum sagittatum	n/a	5	7.5
9/13/2007	22	Polygonum arifolium	n/a	3	1.5
9/13/2007	22	Murdannia keisak	n/a	3	1.5
9/13/2007	22	Peltandra virginica	n/a	2	0.5
9/13/2007	22	Distichlis spicata	n/a	3	1.5
9/13/2007	23	Amaranthus cannabinu	n/a	6	17.5
9/13/2007	23	Polygonum arifolium	n/a	0	0
9/13/2007	23	Echina Walt	n/a	8	62.5
9/13/2007	23	Pluchea purpurascens	n/a	6	17.5
9/13/2007	23	Leersia oryzoides	n/a	5	7.5
9/13/2007	23	Cuscuta gronovii	n/a	0	0
9/13/2007	23	Phragmites australis	n/a	5	7.5
9/13/2007	23	Spartina cynosuroides	n/a	3	1.5
9/13/2007	23	Spartina patens	n/a	6	17.5
9/13/2007	23	Spartina alterniflora	n/a	3	1.5
9/13/2007	23	Distichlis spicata	n/a	3	1.5
9/13/2007	23	Pilea pumila	n/a	0	0
9/13/2007	23	Typha angustifolia	n/a	2	0.5
9/13/2007	23	Acorus calamus	n/a	2	0.5
9/13/2007	23	Peltandra virginica	n/a	0	0
9/13/2007	23	Mikania scandens	n/a	0	0
9/13/2007	23	Hibiscus sp.	n/a	5	7.5
9/6/2007	24	Amaranthus cannabinu	n/a	6	17.5
9/6/2007	24	Leersia oryzoides	n/a	8	62.5
9/6/2007	24	Polygonum arifolium	n/a	6	17.5
9/6/2007	24	Typha angustifolia	n/a	2	0.5
9/6/2007	24	Phragmites australis	n/a	3	1.5
9/6/2007	24	Cuscuta gronovii	n/a	5	7.5
9/6/2007	24	Mikania scandens	n/a	4	3.5
9/6/2007	24	Spartina cynosuroides	n/a	2	0.5
9/6/2007	24	Spartina patens	n/a	3	1.5
9/6/2007	24	Spartina alterniflora	n/a	2	0.5
9/6/2007	24	Distichlis spicata	n/a	2	0.5
9/6/2007	24	Pluchea purpurascens	n/a	4	3.5
9/6/2007	24	Acorus calamus	n/a	4	3.5
9/6/2007	24	Murdannia keisak	n/a	2	0.5
9/6/2007	24	Pilea pumila	n/a	5	7.5
9/6/2007	24	Hibiscus mo.	n/a	5	7.5
9/6/2007	24	Bidens laevis	n/a	5	7.5
9/6/2007	25	Amaranthus cannabinu	n/a	6	17.5
9/6/2007	25	Leersia oryzoides	n/a	5	7.5
9/6/2007	25	Polygonum punctatum	n/a	6	17.5
9/6/2007	25	Pilea pumila	n/a	0	0
9/6/2007	25	Cuscuta gronovii	n/a	0	0
9/6/2007	25	Mikania scandens	n/a	0	0
9/6/2007	25	Phragmites australis	n/a	6	17.5
9/6/2007	25	Spartina cynosuroides	n/a	0	0
9/6/2007	25	Bidens laevis	n/a	0	0

9/6/2007	25	Spartina alterniflora	n/a	3	1.5
9/6/2007	25	Spartina patens	n/a	5	7.5
9/6/2007	25	Distichlis spicata	n/a	4	3.5
9/6/2007	25	Acorus calamus	n/a	0	0
9/6/2007	25	Typha angustifolia	n/a	2	0.5
9/6/2007	25	Pluchea purpurascens	n/a	4	3.5
9/6/2007	25	Polygonum arifolium	n/a	0	0
9/6/2007	25	Echina Walt	n/a	6	17.5
9/6/2007	25	Polygonum sagittatum	n/a	0	0
9/11/2007	26	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	26	Pluchea purpurascens	n/a	6	17.5
9/11/2007	26	Polygonum arifolium	n/a	6	17.5
9/11/2007	26	Pilea pumila	n/a	6	17.5
9/11/2007	26	Phragmites australis	n/a	5	7.5
9/11/2007	26	Mikania scandens	n/a	3	1.5
9/11/2007	26	Polygonum sagittatum	n/a	4	3.5
9/11/2007	26	Gal tinc	n/a	2	0.5
9/11/2007	26	Cuscuta gronovii	n/a	4	3.5
9/11/2007	26	Cyperus sp.	n/a	3	1.5
9/11/2007	26	Spartina cynosuroides	n/a	2	0.5
9/11/2007	26	Spartina alterniflora	n/a	2	0.5
9/11/2007	26	Spartina patens	n/a	6	17.5
9/11/2007	26	Distichlis spicata	n/a	2	0.5
9/11/2007	26	Typha angustifolia	n/a	2	0.5
9/11/2007	26	Acorus calamus	n/a	4	3.5
9/11/2007	26	Aster puniceus	n/a	0	0
9/11/2007	26	Leersia oryzoides	n/a	6	17.5
9/11/2007	26	Boehmeria cylindrica	n/a	5	7.5
9/11/2007	27	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	27	Leersia oryzoides	n/a	7	37.5
9/11/2007	27	Polygonum arifolium	n/a	7	37.5
9/11/2007	27	Pluchea purpurascens	n/a	6	17.5
9/11/2007	27	Pilea pumila	n/a	6	17.5
9/11/2007	27	Polygonum sagittatum	n/a	4	3.5
9/11/2007	27	Phragmites australis	n/a	4	3.5
9/11/2007	27	Spartina cynosuroides	n/a	4	3.5
9/11/2007	27	Cuscuta gronovii	n/a	3	1.5
9/11/2007	27	Typha angustifolia	n/a	0	0
9/11/2007	27	Acorus calamus	n/a	4	3.5
9/11/2007	27	Spartina patens	n/a	3	1.5
9/11/2007	27	Spartina alterniflora	n/a	2	0.5
9/11/2007	27	Distichlis spicata	n/a	4	3.5
9/11/2007	27	Mikania scandens	n/a	6	17.5
9/11/2007	27	Cinna sp.	n/a	2	0.5
9/11/2007	27	Cypreus fili	n/a	3	1.5
9/11/2007	27	Peltandra virginica	n/a	4	3.5
9/11/2007	27	Echina Walt	n/a	3	1.5
9/11/2007	28	Murdannia keisak	n/a	3	1.5
9/11/2007	28	Amaranthus cannabinu	n/a	8	62.5
9/11/2007	28	Polygonum arifolium	n/a	8	62.5

9/11/2007	28	Leersia oryzoides	n/a	7	37.5
9/11/2007	28	Polygonum punctatum	n/a	5	7.5
9/11/2007	28	Pluchea purpurascens	n/a	6	17.5
9/11/2007	28	Polygonum sagittatum	n/a	0	0
9/11/2007	28	Mikania scandens	n/a	7	37.5
9/11/2007	28	Pilea pumila	n/a	6	17.5
9/11/2007	28	Phragmites australis	n/a	0	0
9/11/2007	28	Spartina cynosuroides	n/a	4	3.5
9/11/2007	28	Spartina patens	n/a	4	3.5
9/11/2007	28	Spartina alterniflora	n/a	2	0.5
9/11/2007	28	Distichlis spicata	n/a	3	1.5
9/11/2007	28	Typha angustifolia	n/a	0	0
9/11/2007	28	Acorus calamus	n/a	5	7.5
9/11/2007	28	Cuscuta gronovii	n/a	5	7.5
9/11/2007	28	Peltandra virginica	n/a	0	0
9/11/2007	28	Bidens sp.	n/a	2	0.5
9/6/2007	29	Amaranthus cannabinu	n/a	6	17.5
9/6/2007	29	Mikania scandens	n/a	0	0
9/6/2007	29	Leersia oryzoides	n/a	6	17.5
9/6/2007	29	Polygonum punctatum	n/a	0	0
9/6/2007	29	Polygonum sagittatum	n/a	0	0
9/6/2007	29	Pluchea purpurascens	n/a	5	7.5
9/6/2007	29	Aster puniceus	n/a	4	3.5
9/6/2007	29	Cuscuta gronovii	n/a	0	0
9/6/2007	29	Pilea pumila	n/a	0	0
9/6/2007	29	Gal tinc	n/a	2	0.5
9/6/2007	29	Phragmites australis	n/a	4	3.5
9/6/2007	29	Spartina cynosuroides	n/a	3	1.5
9/6/2007	29	Spartina patens	n/a	6	17.5
9/6/2007	29	Spartina alterniflora	n/a	4	3.5
9/6/2007	29	Distichlis spicata	n/a	5	7.5
9/6/2007	29	Typha angustifolia	n/a	0	0
9/6/2007	29	Acorus calamus	n/a	0	0
9/6/2007	29	Peltandra virginica	n/a	0	0
9/6/2007	29	Polygonum arifolium	n/a	0	0
9/6/2007	29	Cyperus sp.	n/a	2	0.5
9/13/2007	30	Phragmites australis	n/a	6	17.5
9/13/2007	30	Polygonum punctatum	n/a	0	0
9/13/2007	30	Cuscuta gronovii	n/a	0	0
9/13/2007	30	Polygonum arifolium	n/a	0	0
9/13/2007	30	Mikania scandens	n/a	6	17.5
9/13/2007	30	Leersia oryzoides	n/a	6	17.5
9/13/2007	30	Pluchea purpurascens	n/a	5	7.5
9/13/2007	30	Pilea pumila	n/a	6	17.5
9/13/2007	30	Echina Walt	n/a	6	17.5
9/13/2007	30	Peltandra virginica	n/a	0	0
9/13/2007	30	Spartina cynosuroides	n/a	4	3.5
9/13/2007	30	Spartina patens	n/a	4	3.5
9/13/2007	30	Spartina alterniflora	n/a	3	1.5
9/13/2007	30	Distichlis spicata	n/a	0	0

9/13/2007	30	Typha angustifolia	n/a	0	0
9/13/2007	30	Acorus calamus	n/a	4	3.5
9/13/2007	30	Boehmeria cylindrica	n/a	3	1.5

Appendix E. Raw Species and Plant Cover Data Mesocosm Study July 2008

Date	Mesocosm	Species	Frequency	Mid-Point Percent
7/29/2008	1	Spartina patens	n/a	0.5
7/29/2008	1	Spartina alterniflora	n/a	0
7/29/2008	1	Typha angustifolia	n/a	0.5
7/29/2008	1	Spartina cynosuroides	n/a	0
7/29/2008	1	Phragmites australis	n/a	17.5
7/29/2008	1	Distichlis spicata	n/a	3.5
7/29/2008	1	Acorus calamus	n/a	0.5
7/29/2008	1	Leersia oryzoides	n/a	37.5
7/29/2008	1	Cyperus spp1	n/a	7.5
7/29/2008	1	Mikania scandens	n/a	62.5
7/29/2008	1	Pluchea purpurascens	n/a	1.5
7/29/2008	1	Murdannia keisak	n/a	0.5
7/29/2008	1	Amaranthus cannabinu	n/a	0.1
7/29/2008	1	Pilea pumila	n/a	0.1
7/29/2008	1	Peltandra virginica	n/a	0.1
7/29/2008	2	Spartina patens	n/a	62.5
7/29/2008	2	Phragmites australis	n/a	0
7/29/2008	2	Distichlis spicata	n/a	3.5
7/29/2008	2	Leersia oryzoides	n/a	7.5
7/29/2008	2	Typha angustifolia	n/a	1.5
7/29/2008	2	Spartina alterniflora	n/a	0
7/29/2008	2	Acorus calamus	n/a	0.1
7/29/2008	2	Spartina cynosuroides	n/a	3.5
7/29/2008	2	Pluchea purpurascens	n/a	17.5
7/29/2008	2	Mikania scandens	n/a	3.5
7/29/2008	2	Echina mur	n/a	37.5
7/29/2008	2	Amaranthus cannabinu	n/a	0.5
7/29/2008	2	Rumex sp	n/a	3.5
7/29/2008	2	Cyperus spp1	n/a	0.5
7/30/2008	3	Phragmites australis	n/a	0
7/30/2008	3	Spartina cynosuroides	n/a	3.5
7/30/2008	3	Leersia oryzoides	n/a	17.5
7/30/2008	3	Typha angustifolia	n/a	7.5
7/30/2008	3	Acorus calamus	n/a	0
7/30/2008	3	Distichlis spicata	n/a	1.5
7/30/2008	3	Spartina patens	n/a	37.5
7/30/2008	3	Spartina alterniflora	n/a	0
7/30/2008	3	Kost vir	n/a	17.5
7/30/2008	3	Amaranthus cannabinu	n/a	37.5
7/30/2008	4	Distichlis spicata	n/a	0
7/30/2008	4	Leersia oryzoides	n/a	0
7/30/2008	4	Acorus calamus	n/a	0
7/30/2008	4	Spartina alterniflora	n/a	0
7/30/2008	4	Phragmites australis	n/a	37.5
7/30/2008	4	Spartina patens	n/a	0
7/30/2008	4	Spartina cynosuroides	n/a	17.5

7/30/2008	4	Typha angustifolia	n/a	0
7/30/2008	4	Amaranthus cannabinu	n/a	37.5
7/29/2008	5	Acorus calamus	n/a	7.5
7/29/2008	5	Phragmites australis	n/a	17.5
7/29/2008	5	Typha angustifolia	n/a	3.5
7/29/2008	5	Spartina patens	n/a	7.5
7/29/2008	5	Leersia oryzoides	n/a	17.5
7/29/2008	5	Distichlis spicata	n/a	0.1
7/29/2008	5	Spartina alterniflora	n/a	0
7/29/2008	5	Spartina cynosuroides	n/a	1.5
7/29/2008	5	Mikania scandens	n/a	37.5
7/29/2008	5	Cyperus spp1	n/a	3.5
7/29/2008	5	Murdannia keisak	n/a	0.1
7/29/2008	5	Pluchea purpurascens	n/a	0.5
7/29/2008	5	Lythrum salicaria	n/a	1.5
7/29/2008	5	Samolus parviflorus	n/a	3.5
7/29/2008	5	Aster puniceus	n/a	3.5
7/29/2008	5	Cinna sp.	n/a	0.5
7/29/2008	5	Amaranthus cannabinu	n/a	0.5
7/30/2008	6	Spartina cynosuroides	n/a	3.5
7/30/2008	6	Distichlis spicata	n/a	0.5
7/30/2008	6	Phragmites australis	n/a	37.5
7/30/2008	6	Spartina alterniflora	n/a	1.5
7/30/2008	6	Leersia oryzoides	n/a	37.5
7/30/2008	6	Typha angustifolia	n/a	0.5
7/30/2008	6	Spartina patens	n/a	3.5
7/30/2008	6	Acorus calamus	n/a	0
7/30/2008	6	Mikania scandens	n/a	17.5
7/30/2008	6	Aster puniceus	n/a	3.5
7/30/2008	6	Amaranthus cannabinu	n/a	7.5
7/30/2008	6	Cyperus spp1	n/a	17.5
7/30/2008	6	Schoenplectus sp1	n/a	7.5
7/30/2008	6	Echina mur	n/a	0.5
7/30/2008	7	Spartina patens	n/a	37.5
7/30/2008	7	Spartina alterniflora	n/a	0
7/30/2008	7	Spartina cynosuroides	n/a	7.5
7/30/2008	7	Phragmites australis	n/a	37.5
7/30/2008	7	Distichlis spicata	n/a	0
7/30/2008	7	Typha angustifolia	n/a	3.5
7/30/2008	7	Leersia oryzoides	n/a	0
7/30/2008	7	Acorus calamus	n/a	0
7/30/2008	7	Amaranthus cannabinu	n/a	62.5
7/30/2008	7	Echina mur	n/a	0.1
7/29/2008	8	Spartina cynosuroides	n/a	1.5
7/29/2008	8	Spartina alterniflora	n/a	0.1
7/29/2008	8	Acorus calamus	n/a	0.1
7/29/2008	8	Distichlis spicata	n/a	0.5
7/29/2008	8	Spartina patens	n/a	7.5
7/29/2008	8	Phragmites australis	n/a	37.5
7/29/2008	8	Typha angustifolia	n/a	0

7/29/2008	8	Mikania scandens	n/a	37.5
7/29/2008	8	Amaranthus cannabinu	n/a	7.5
7/29/2008	8	Pluchea purpurascens	n/a	37.5
7/29/2008	8	Leersia oryzoides	n/a	17.5
7/30/2008	9	Phragmites australis	n/a	17.5
7/30/2008	9	Samolus parviflorus	n/a	17.5
7/30/2008	9	Mikania scandens	n/a	85
7/30/2008	9	Leersia oryzoides	n/a	17.5
7/30/2008	9	Aster puniceus	n/a	7.5
7/30/2008	9	Pluchea purpurascens	n/a	7.5
7/30/2008	9	Spartina patens	n/a	17.5
7/30/2008	9	Acorus calamus	n/a	0.5
7/30/2008	9	Distichlis spicata	n/a	0.5
7/30/2008	9	Typha angustifolia	n/a	0
7/30/2008	9	Spartina alterniflora	n/a	0
7/30/2008	9	Spartina cynosuroides	n/a	0
7/30/2008	9	Echina mur	n/a	0.5
7/30/2008	9	Murdannia keisak	n/a	1.5
7/30/2008	9	Gal tinc	n/a	0.5
7/30/2008	9	Cyperus spp1	n/a	0.5
7/30/2008	9	Amaranthus cannabinu	n/a	0.5
7/30/2008	10	Spartina alterniflora	n/a	0
7/30/2008	10	Leersia oryzoides	n/a	3.5
7/30/2008	10	Typha angustifolia	n/a	1.5
7/30/2008	10	Spartina cynosuroides	n/a	0
7/30/2008	10	Acorus calamus	n/a	0
7/30/2008	10	Phragmites australis	n/a	37.5
7/30/2008	10	Distichlis spicata	n/a	7.5
7/30/2008	10	Eleocharis parvula	n/a	3.5
7/30/2008	10	Amaranthus cannabinu	n/a	62.5
7/30/2008	10	Spartina patens	n/a	7.5
7/30/2008	10	Pluchea purpurascens	n/a	0.5
7/30/2008	10	Juncus eff	n/a	0.5
7/30/2008	11	Spartina patens	n/a	0
7/30/2008	11	Leersia oryzoides	n/a	37.5
7/30/2008	11	Spartina alterniflora	n/a	0
7/30/2008	11	Phragmites australis	n/a	7.5
7/30/2008	11	Typha angustifolia	n/a	0.5
7/30/2008	11	Acorus calamus	n/a	1.5
7/30/2008	11	Distichlis spicata	n/a	0
7/30/2008	11	Cyperus spp1	n/a	37.5
7/30/2008	11	Amaranthus cannabinu	n/a	7.5
7/30/2008	11	Murdannia keisak	n/a	3.5
7/30/2008	11	Pluchea purpurascens	n/a	7.5
7/30/2008	11	Pilea pumila	n/a	0.1
7/30/2008	11	Spartina cynosuroides	n/a	3.5
7/30/2008	12	Spartina alterniflora	n/a	0
7/30/2008	12	Spartina cynosuroides	n/a	7.5
7/30/2008	12	Phragmites australis	n/a	37.5
7/30/2008	12	Acorus calamus	n/a	7.5

7/30/2008	12	Typha angustifolia	n/a	0
7/30/2008	12	Distichlis spicata	n/a	0
7/30/2008	12	Spartina patens	n/a	0.5
7/30/2008	12	Amaranthus cannabinu	n/a	3.5
7/30/2008	12	Pilea pumila	n/a	1.5
7/30/2008	12	Murdannia keisak	n/a	3.5
7/30/2008	12	Leersia oryzoides	n/a	62.5
7/29/2008	13	Leersia oryzoides	n/a	37.5
7/29/2008	13	Typha angustifolia	n/a	0
7/29/2008	13	Distichlis spicata	n/a	0
7/29/2008	13	Spartina alterniflora	n/a	0
7/29/2008	13	Phragmites australis	n/a	62.5
7/29/2008	13	Acorus calamus	n/a	1.5
7/29/2008	13	Spartina cynosuroides	n/a	3.5
7/29/2008	13	Spartina patens	n/a	3.5
7/29/2008	13	Pluchea purpurascens	n/a	17.5
7/29/2008	13	Cyperus spp1	n/a	17.5
7/29/2008	13	Pilea pumila	n/a	0.5
7/29/2008	13	Samolus parviflorus	n/a	0.1
7/29/2008	13	Juncus eff	n/a	0.5
7/29/2008	13	Mikania scandens	n/a	37.5
7/29/2008	13	Uni dic2	n/a	0.1
7/30/2008	14	Leersia oryzoides	n/a	62.5
7/30/2008	14	Spartina patens	n/a	7.5
7/30/2008	14	Spartina alterniflora	n/a	0
7/30/2008	14	Typha angustifolia	n/a	3.5
7/30/2008	14	Spartina cynosuroides	n/a	3.5
7/30/2008	14	Acorus calamus	n/a	3.5
7/30/2008	14	Phragmites australis	n/a	37.5
7/30/2008	14	Distichlis spicata	n/a	3.5
7/30/2008	14	Mikania scandens	n/a	62.5
7/30/2008	14	Cyperus spp1	n/a	37.5
7/30/2008	14	Kost vir	n/a	7.5
7/30/2008	14	Boehmeria cylindrica	n/a	7.5
7/30/2008	14	Amaranthus cannabinu	n/a	0.5
7/30/2008	14	Schoenplectus sp1	n/a	3.5
7/30/2008	14	Cinna sp.	n/a	1.5
7/30/2008	15	Phragmites australis	n/a	17.5
7/30/2008	15	Spartina patens	n/a	37.5
7/30/2008	15	Acorus calamus	n/a	0
7/30/2008	15	Spartina alterniflora	n/a	0
7/30/2008	15	Leersia oryzoides	n/a	7.5
7/30/2008	15	Typha angustifolia	n/a	0.5
7/30/2008	15	Spartina cynosuroides	n/a	3.5
7/30/2008	15	Distichlis spicata	n/a	0
7/30/2008	15	Amaranthus cannabinu	n/a	62.5
7/30/2008	15	Lythrum salicaria	n/a	7.5
7/30/2008	15	Cyperus spp1	n/a	0.1
7/30/2008	16	Spartina alterniflora	n/a	0
7/30/2008	16	Phragmites australis	n/a	37.5

7/30/2008	16	Distichlis spicata	n/a	0
7/30/2008	16	Acorus calamus	n/a	7.5
7/30/2008	16	Spartina cynosuroides	n/a	3.5
7/30/2008	16	Spartina patens	n/a	17.5
7/30/2008	16	Leersia oryzoides	n/a	3.5
7/30/2008	16	Typha angustifolia	n/a	0.5
7/30/2008	16	Samolus parviflorus	n/a	17.5
7/30/2008	16	Pluchea purpurascens	n/a	17.5
7/30/2008	16	Amaranthus cannabinu	n/a	0.5
7/30/2008	16	Cyperus spp1	n/a	37.5
7/30/2008	16	Aster puniceus	n/a	17.5
7/30/2008	16	Uni. grass	n/a	7.5
7/30/2008	17	Typha angustifolia	n/a	1.5
7/30/2008	17	Acorus calamus	n/a	1.5
7/30/2008	17	Spartina alterniflora	n/a	0
7/30/2008	17	Leersia oryzoides	n/a	37.5
7/30/2008	17	Spartina cynosuroides	n/a	7.5
7/30/2008	17	Phragmites australis	n/a	7.5
7/30/2008	17	Spartina patens	n/a	0.5
7/30/2008	17	Distichlis spicata	n/a	1.5
7/30/2008	17	Mikania scandens	n/a	17.5
7/30/2008	17	Samolus parviflorus	n/a	3.5
7/30/2008	17	Cyperus spp1	n/a	17.5
7/30/2008	17	Amaranthus cannabinu	n/a	3.5
7/30/2008	17	Echina mur	n/a	0.5
7/30/2008	17	Pluchea purpurascens	n/a	0.1
7/30/2008	18	Spartina patens	n/a	37.5
7/30/2008	18	Leersia oryzoides	n/a	37.5
7/30/2008	18	Typha angustifolia	n/a	3.5
7/30/2008	18	Spartina alterniflora	n/a	0
7/30/2008	18	Acorus calamus	n/a	3.5
7/30/2008	18	Spartina cynosuroides	n/a	7.5
7/30/2008	18	Distichlis spicata	n/a	1.5
7/30/2008	18	Phragmites australis	n/a	62.5
7/30/2008	18	Cyperus spp1	n/a	17.5
7/30/2008	18	Lythrum salicaria	n/a	17.5
7/30/2008	18	Amaranthus cannabinu	n/a	1.5
7/30/2008	18	Kost vir	n/a	17.5
7/30/2008	18	Boehmeria cylindrica	n/a	1.5
7/30/2008	19	Typha angustifolia	n/a	7.5
7/30/2008	19	Distichlis spicata	n/a	7.5
7/30/2008	19	Acorus calamus	n/a	0
7/30/2008	19	Leersia oryzoides	n/a	3.5
7/30/2008	19	Spartina alterniflora	n/a	0
7/30/2008	19	Phragmites australis	n/a	37.5
7/30/2008	19	Spartina patens	n/a	37.5
7/30/2008	19	Spartina cynosuroides	n/a	3.5
7/30/2008	19	Pluchea purpurascens	n/a	62.5
7/30/2008	19	Rumex sp	n/a	17.5
7/30/2008	19	Amaranthus cannabinu	n/a	17.5

7/30/2008	19	Echina mur	n/a	17.5
7/29/2008	20	Distichlis spicata	n/a	0
7/29/2008	20	Spartina cynosuroides	n/a	3.5
7/29/2008	20	Phragmites australis	n/a	17.5
7/29/2008	20	Acorus calamus	n/a	0.1
7/29/2008	20	Leersia oryzoides	n/a	1.5
7/29/2008	20	Spartina alterniflora	n/a	0.1
7/29/2008	20	Spartina patens	n/a	1.5
7/29/2008	20	Cyperus spp1	n/a	0.1
7/29/2008	20	Typha angustifolia	n/a	0
7/29/2008	20	Pluchea purpurascens	n/a	17.5
7/29/2008	20	Amaranthus cannabinu	n/a	3.5
7/29/2008	20	Mikania scandens	n/a	7.5
7/30/2008	21	Leersia oryzoides	n/a	85
7/30/2008	21	Phragmites australis	n/a	37.5
7/30/2008	21	Typha angustifolia	n/a	0
7/30/2008	21	Distichlis spicata	n/a	0.5
7/30/2008	21	Spartina alterniflora	n/a	0
7/30/2008	21	Spartina cynosuroides	n/a	17.5
7/30/2008	21	Cyperus spp1	n/a	1.5
7/30/2008	21	Aster puniceus	n/a	17.5
7/30/2008	21	Lythrum salicaria	n/a	7.5
7/30/2008	21	Acorus calamus	n/a	0
7/30/2008	21	Spartina patens	n/a	7.5
7/30/2008	21	Polygonum arifolium	n/a	0.5
7/30/2008	21	Amaranthus cannabinu	n/a	17.5
7/29/2008	22	Spartina cynosuroides	n/a	1.5
7/29/2008	22	Typha angustifolia	n/a	0.1
7/29/2008	22	Spartina patens	n/a	1.5
7/29/2008	22	Phragmites australis	n/a	7.5
7/29/2008	22	Acorus calamus	n/a	1.5
7/29/2008	22	Leersia oryzoides	n/a	62.5
7/29/2008	22	Spartina alterniflora	n/a	0
7/29/2008	22	Distichlis spicata	n/a	7.5
7/29/2008	22	Boehmeria cylindrica	n/a	17.5
7/29/2008	22	Gal tinc	n/a	3.5
7/29/2008	22	Murdannia keisak	n/a	0.5
7/29/2008	22	Mikania scandens	n/a	62.5
7/29/2008	22	Uni dic	n/a	0.1
7/29/2008	22	Cyperus spp1	n/a	3.5
7/30/2008	23	Spartina alterniflora	n/a	0
7/30/2008	23	Distichlis spicata	n/a	7.5
7/30/2008	23	Typha angustifolia	n/a	1.5
7/30/2008	23	Spartina patens	n/a	37.5
7/30/2008	23	Spartina cynosuroides	n/a	17.5
7/30/2008	23	Leersia oryzoides	n/a	0
7/30/2008	23	Acorus calamus	n/a	0
7/30/2008	23	Phragmites australis	n/a	37.5
7/30/2008	23	Kost vir	n/a	17.5
7/30/2008	23	Eleocharis parvula	n/a	0.1

7/30/2008	23	Amaranthus cannabinu	n/a	37.5
7/30/2008	23	Pluchea purpurascens	n/a	17.5
7/30/2008	23	Rumex sp	n/a	3.5
7/30/2008	24	Typha angustifolia	n/a	0.5
7/30/2008	24	Phragmites australis	n/a	37.5
7/30/2008	24	Acorus calamus	n/a	3.5
7/30/2008	24	Distichlis spicata	n/a	1.5
7/30/2008	24	Spartina alterniflora	n/a	0
7/30/2008	24	Spartina cynosuroides	n/a	7.5
7/30/2008	24	Leersia oryzoides	n/a	62.5
7/30/2008	24	Spartina patens	n/a	17.5
7/30/2008	24	Cyperus spp1	n/a	37.5
7/30/2008	24	Amaranthus cannabinu	n/a	3.5
7/30/2008	24	Murdannia keisak	n/a	0.1
7/30/2008	24	Cinna sp.	n/a	1.5
7/30/2008	25	Spartina cynosuroides	n/a	3.5
7/30/2008	25	Spartina patens	n/a	85
7/30/2008	25	Distichlis spicata	n/a	37.5
7/30/2008	25	Leersia oryzoides	n/a	0.1
7/30/2008	25	Phragmites australis	n/a	7.5
7/30/2008	25	Spartina alterniflora	n/a	0
7/30/2008	25	Acorus calamus	n/a	0
7/30/2008	25	Typha angustifolia	n/a	0
7/30/2008	25	Amaranthus cannabinu	n/a	17.5
7/30/2008	25	Kost vir	n/a	3.5
7/30/2008	25	Pluchea purpurascens	n/a	0.1
7/30/2008	26	Distichlis spicata	n/a	3.5
7/30/2008	26	Acorus calamus	n/a	1.5
7/30/2008	26	Spartina cynosuroides	n/a	0
7/30/2008	26	Leersia oryzoides	n/a	37.5
7/30/2008	26	Phragmites australis	n/a	17.5
7/30/2008	26	Typha angustifolia	n/a	1.5
7/30/2008	26	Spartina alterniflora	n/a	0
7/30/2008	26	Spartina patens	n/a	17.5
7/30/2008	26	Cyperus spp1	n/a	17.5
7/30/2008	26	Pluchea purpurascens	n/a	37.5
7/30/2008	26	Amaranthus cannabinu	n/a	3.5
7/30/2008	26	Iva fruf	n/a	1.5
7/30/2008	26	Mikania scandens	n/a	37.5
7/30/2008	26	Murdannia keisak	n/a	7.5
7/30/2008	26	Schoenplectus sp.	n/a	0
7/30/2008	27	Cyperus strig	n/a	3.5
7/30/2008	27	Amaranthus cannabinu	n/a	17.5
7/30/2008	27	Distichlis spicata	n/a	7.5
7/30/2008	27	Spartina cynosuroides	n/a	0
7/30/2008	27	Typha angustifolia	n/a	0
7/30/2008	27	Acorus calamus	n/a	3.5
7/30/2008	27	Phragmites australis	n/a	37.5
7/30/2008	27	Spartina patens	n/a	3.5
7/30/2008	27	Leersia oryzoides	n/a	37.5

7/30/2008	27	Spartina alterniflora	n/a	0
7/30/2008	27	Pluchea purpurascens	n/a	3.5
7/30/2008	27	Peltandra virginica	n/a	0.5
7/30/2008	28	Phragmites australis	n/a	1.5
7/30/2008	28	Acorus calamus	n/a	3.5
7/30/2008	28	Distichlis spicata	n/a	7.5
7/30/2008	28	Typha angustifolia	n/a	0
7/30/2008	28	Spartina cynosuroides	n/a	7.5
7/30/2008	28	Leersia oryzoides	n/a	62.5
7/30/2008	28	Spartina patens	n/a	17.5
7/30/2008	28	Spartina alterniflora	n/a	0
7/30/2008	28	Amaranthus cannabinu	n/a	17.5
7/30/2008	28	Schoenplectus sp.	n/a	1.5
7/30/2008	28	Cyperus spp1	n/a	0.5
7/30/2008	29	Distichlis spicata	n/a	17.5
7/30/2008	29	Spartina patens	n/a	17.5
7/30/2008	29	Acorus calamus	n/a	0
7/30/2008	29	Leersia oryzoides	n/a	7.5
7/30/2008	29	Spartina alterniflora	n/a	0
7/30/2008	29	Spartina cynosuroides	n/a	7.5
7/30/2008	29	Phragmites australis	n/a	37.5
7/30/2008	29	Typha angustifolia	n/a	0.5
7/30/2008	29	Amaranthus cannabinu	n/a	37.5
7/30/2008	29	Pluchea purpurascens	n/a	3.5
7/30/2008	30	Acorus calamus	n/a	0
7/30/2008	30	Distichlis spicata	n/a	0
7/30/2008	30	Leersia oryzoides	n/a	7.5
7/30/2008	30	Typha angustifolia	n/a	0
7/30/2008	30	Spartina cynosuroides	n/a	3.5
7/30/2008	30	Spartina patens	n/a	62.5
7/30/2008	30	Spartina alterniflora	n/a	0
7/30/2008	30	Phragmites australis	n/a	37.5
7/30/2008	30	Kost vir	n/a	17.5
7/30/2008	30	Mikania scandens	n/a	62.5
7/30/2008	30	Amaranthus cannabinu	n/a	3.5
7/30/2008	30	Cyperus spp1	n/a	3.5
7/30/2008	30	Peltandra virginica	n/a	0.1

Appendix F. Mesocosm Biomass, Richness, and Soil Chemistry Data

Mesocsom	Salinity	Flood Freq	Richness 2008	Soluable P (grams)	Total Biomass Aboveground	Below Ground Biomass	Temp Celcius	M3-Mg (Mg/kg)	M3-Al (Mg/kg)	M3-K (Mg/kg)	M3-Ca (Mg/kg)	M3-Fe (Mg/kg)	M3-P (Mg/kg)	NO3-N (mg/l)
1	0	44.35	13	2.0004	89.75	45.2	23.59	1015	856	213	6773	333	82	0.025
2	6	22.77	12	1.9999	58.11	47.1	23.32	1895	959	951	3102	268	158	0
3	6	44.35	7	2.0002	96.42	63.5	23.19	1970	868	1183	3498	223	216	0.275
4	12	62.15	3	2.0000	99.71	94.0	23.28	1696	1002	475	5263	418	75	0.4
5	1.5	44.35	15	2.0005	86.81	59.1	23.13	1568	908	582	4402	298	161	0.2
6	3	22.77	13	2.0000	140.27	115.5	23.04	1640	1072	535	3489	940	123	0.05
7	12	62.15	6	2.0002	67.58	65.4	22.86	2071	859	1607	3188	216	195	0.1
8	6	44.35	10	1.9999	115.03	93.3	23.32	1928	1044	915	3212	478	159	0
9	1.5	22.77	14	2.0006	122.55	76.1	23.13	1549	715	512	5373	238	119	0.2
10	6	62.15	9	2.0001	80.22	41.1	23.19	1936	904	1073	3516	271	242	0.275
11	1.5	62.15	10	2.0002	134.62	99.6	22.92	1634	978	421	4624	542	99	0.2
12	0	62.15	8	2.0000	116.91	89.6	23.07	1155	874	525	7783	225	182	0.45
13	0	62.15	12	2.0001	193.38	161.6	23.59	968	982	260	6913	691	97	0.025
14	1.5	44.35	13	2.0000	180.61	218.5	22.92	2092	902	1570	3134	309	178	0.2
15	6	22.77	8	2.0000	117.65	61.5	23.19	1800	1180	1025	3201	1217	149	0.275
16	3	62.15	12	2.0003	96.61	93.8	23.39	1780	917	767	4905	243	192	0.15
17	1.5	62.15	13	2.0001	97.47	106.1	23.13	1658	900	500	5203	292	162	0.2
18	3	44.35	12	2.0003	164.61	260.7	23.39	1616	1059	753	4224	461	192	0.15
19	12	22.77	10	1.9999	83.69	71.8	22.86	1983	977	1338	2872	243	126	0.1
20	6	62.15	10	2.0000	85.07	70.4	23.32	2011	899	1063	3808	232	165	0
21	0	22.77	10	1.9998	201.31	183.4	23.07	1009	957	704	6433	365	176	0.45
22	0	22.77	13	2.0001	133.13	88.4	23.59	1097	930	263	6643	256	57	0.025
23	12	44.35	10	1.9997	82.74	87.9	22.86	2011	926	1275	3182	288	134	0.1
24	0	44.35	11	2.0000	198.39	196.6	23.07	975	1073	529	5983	1118	165	0.45
25	12	22.77	6	1.9998	154	97.5	23.28	2060	1019	1366	2755	424	131	0.4
26	1.5	22.77	12	2.0003	121.48	85.8	22.92	1580	1096	458	5053	595	62	0.2
27	3	62.15	9	1.9997	111.88	78.8	23.04	1789	930	541	4372	332	121	0.05

28	3	44.35	9	1.9999	100.66	30.0	23.04	1755	964	632	3935	382	133	0.05
29	12	44.35	8	2.0006	93.9	130.3	23.28	2065	998	1375	2960	286	145	0.4
30	3	22.77	9	2.0004	182.14	117.9	23.39	1586	1042	741	4220	639	121	0.15

Appendix G. Redox Chemistry and pH Raw Data

Mesocosm	Flood Frequency	Time	Redox Potential (Eh) - 5 cm Depth	Redox Potential (Eh) - 20 cm Depth	Redox Potential (Eh) - 30 cm Depth	pH
M1	44.35	1	251	360	493	6.63
M1	44.35	2	252	329	365	6.78
M1	44.35	3	253	475	302	6.78
M10	62.15	1	433	380	355	7.33
M10	62.15	2	373	394	268	6.2
M10	62.15	3	395	387	224	6.78
M11	62.15	1	372	355	364	7.83
M11	62.15	2	358	413	336	6.37
M11	62.15	3	414	390	254	6.71
M12	62.15	1	530	389	481	7.73
M12	62.15	2	390	315	351	6.14
M12	62.15	3	349	540	119	6.62
M13	62.15	1	469	233	400	5.52
M13	62.15	2	425	285	222	6.61
M13	62.15	3	371	408	130	6.96
M14	44.35	1	461	372	458	7.63
M14	44.35	2	378	382	364	6.27
M14	44.35	3	367	485	373	6.65
M15	22.77	1	504	382	480	6.88
M15	22.77	2	382	335	367	6.19
M15	22.77	3	350	501	297	6.65
M16	62.15	1	509	380	476	6.41
M16	62.15	2	368	325	294	5.07
M16	62.15	3	348	503	293	6.76
M17	62.15	1	493	359	460	7.27
M17	62.15	2	367	435	296	6.49
M17	62.15	3	409	486	375	6.58
M18	44.35	1	504	380	470	6.36
M18	44.35	2	374	330	361	5.7
M18	44.35	3	360	505	308	6.35
M19	22.77	1	511	292	490	7.19
M19	22.77	2	288	374	261	6.3
M19	22.77	3	373	522	351	6.62
M2	22.77	1	484	360	500	7.02
M2	22.77	2	345	364	356	5.74
M2	22.77	3	363	509	351	6.78
M20	62.15	1	524	261	480	7.31
M20	62.15	2	279	322	251	5.93
M20	62.15	3	396	523	273	6.8
M21	22.77	1	559	381	551	6.74
M21	22.77	2	373	389	360	5.86
M21	22.77	3	366	585	366	6.79
M22	22.77	1	517	328	482	6.14
M22	22.77	2	355	403	382	6.74
M22	22.77	3	390	509	360	7.03

M23	44.35	1	453	359	464	7.02
M23	44.35	2	354	348	268	6.19
M23	44.35	3	346	479	347	6.32
M24	44.35	1	522	367	484	7.64
M24	44.35	2	309	341	302	6.23
M24	44.35	3	338	540	310	6.59
M25	22.77	1	508	345	393	7.46
M25	22.77	2	347	382	294	6.07
M25	22.77	3	375	519	375	6.27
M26	22.77	1	516	386	460	7.68
M26	22.77	2	377	397	278	6.46
M26	22.77	3	372	517	383	6.52
M27	62.15	1	460	355	386	7.05
M27	62.15	2	363	396	255	6.3
M27	62.15	3	390	484	328	6.45
M28	44.35	1	488	369	494	7.49
M28	44.35	2	376	402	358	6.22
M28	44.35	3	390	494	368	6.28
M29	44.35	1	487	378	460	7.43
M29	44.35	2	379	363	287	6.49
M29	44.35	3	342	485	332	6.34
M3	44.35	1	471	371	422	7.08
M3	44.35	2	366	379	335	5.97
M3	44.35	3	370	478	331	6.45
M30	22.77	1	508	373	491	6.65
M30	22.77	2	362	383	338	5.5
M30	22.77	3	365	516	311	6.45
M4	62.15	1	453	357	410	7.62
M4	62.15	2	355	328	229	6.46
M4	62.15	3	315	458	275	6.35
M5	44.35	1	491	408	456	7.26
M5	44.35	2	371	395	336	6.57
M5	44.35	3	387	478	406	6.51
M6	22.77	1	506	347	489	6
M6	22.77	2	334	370	348	6.04
M6	22.77	3	362	485	358	6.55
M7	62.15	1	461	283	394	7.47
M7	62.15	2	351	317	75	6.4
M7	62.15	3	356	477	265	6.36
M8	44.35	1	501	342	484	6.88
M8	44.35	2	353	388	259	6.01
M8	44.35	3	368	499	290	6.73
M9	22.77	1	460	381	476	7.37
M9	22.77	2	360	345	357	6.22
M9	22.77	3	336	467	347	6.62

Appendix H. Example SAS Codes From Data Analysis

Repeated Measures ANOVA Richness Data (Chapter 2)

```
ods html;
   ods graphics on;
title1 'Repeated Measures ANOVA analysis of Patuxent and Nanticoke
River Data';
Options ls=70 ps=48 pageno=1;
data rich;
input River $ Plot $ Group Time     Inun  BpH   CAMg  DisDwn
      EPAP  EPAS  M3Al  M3B   M3Ca  M3Cu  M3Fe  M3K   M3Mg  M3Mn
      M3P   M3S   M3Zn  MRC   MSC   MSS   MT    NP    NH4N  NO3N  OM
      pH    Richness RRC      RS    RSC   RT    TC    TN
;
datalines;
Pax   X00W  1     1     35.54 7.17  0.760619219 47.2  824.52
      12468 1047.43     11.4  1469.6      1.64  1125.69     918.72
      1932.11     66.33 49.31 2792.66     19.83 10955 11982.5
      6.95  21.675      13.07427352 20.5591     0     27.4  3.9   11
      16400 9.6   16330 21.35 12.83 1.078
Pax   X05W  1     1     33.6  7.14  0.669715641 43.3  1026  12676
      1104.81     11.01 2039.11     2.21  1169.91     1209.44
      3044.74     90.38 67.15 3111.86     14.36 12122.5     12050
      6.975 25.725      13.80116959 30.7183     0     32.2  3.8   11
      14115 7.45  13215 27.95 18.54 1.416
Pax   X10E  1     1     63.39 7.12  0.663529351 38.8  1007.2
      14280 1103.44     9.86  1797.01     1.94  968.58      1156.78
      2708.26     220.39      54    3024.6      14.45 8997.75
      10383.25    5.125 25.575      12.92692613 26.8588     0
      26.2  4     15    13910 7.45  12970 29    14.64 1.302
Pax   X15W  1     1     56.8  7.05  0.816467101 35.2  1157.4
      13456 1099.12     6.84  1762.63     1.51  895.9 1012.93
      2158.85     295.69      59.97 2579.43     25.77 6370  6504.75
      3.6   24.425      9.210298946 26.1201     0     19.5  4.2   17
      7015  3.5   6470  29.1  11.24 1.066
Pax   X20E  2     1     50.11 7.12  1.150326503 30.2  1629.88
      5864  1058.86     4.08  1786.25     1.51  982.43      540.55
      1552.82     265.37      59.76 1483.36     33.7  3429.30175
      4154.25     2.2   23.7  5.638451911 27.6307     0     16.1
      4.4   12    5315  2.7   2567.525    27.1  9.22  0.919
Pax   X22W  2     1     30.11 7.19  1.218448758 29.6  2381.08
      3528.24     860.05      4.11  1481.39     1.54  900.94
      599.41      1215.8      445.34      31.04 566   22.07 3542
      3533.5      1.9   23.075      3.359819914 22.8001     0.71
      16.3  4.8   20    5340  2.7   5103.5      27.25 9.07  0.8
Pax   X26W  2     1     40.43 7.09  1.858699433 25.6  1414.44
      4156  1240.44     4.72  2458.13     1.52  963.66      422.84
      1322.5      385.21      54.5  1006.24     23.26 1184  1294.25
      0.625 20.55 9.381804813 34.6691     0.72  23.3  4.6   25
      2597.5      1.25  2455  27.9  13.67 1.327
Pax   X30W  2     1     47.45 6.97  2.632952176 20.4  969.96
      14956 1611.18     4.51  3914.41     1.9   1274.3      242.95
      1486.7      256.05      68.07 3212.86     22.9  1270  1287.25
      0.65  23.825      17.60897357 24.1364     0     39.8  4     8
      1840.5      0.9   1777  28.1  23.39 1.708
```

```
Pax   X35W  2     1     24.54 7.17  4.557444381 14.8  1075  8216
      1697.84     5.07  3195.68     2.18  1309.02     235.14
      701.2 162.87      124.7 2111.51     47.81 651.25      676.25
      0.35  22.125      22    47.8412     1.42  38.6  4.2   33
      683.5 0.35  692   24.8  24.52 2.365
Pax   X39W  2     1     52.98 6.92  5.792673176 10.5  1773  9344
      1353.9      3.41  2390.81     3.23  1568.89     137.06
      412.73      226.39      122.62      1776.83     45.29 381.65
      399.75      0.175 22.725      6.835871404 37.9974     0.8
      24.1  3.8   19    323.05      0.15  317.55      26    14.78
      1.212
Pax   X43W  3     1     27.36 7.1   8.572517373 5.5   1226.52
      2470.72     1024.12     3.42  1912.1      2.61  1559.96
      97.37 223.05      179.54      168.35      463.31      28.01
      359.2 382.275     0.2   21.775      9.066301406 17.4881
      1.59  18.2  4.3   26    326.15      0.2   331.55      24.25
      12.7  1.112
Pax   X47E  3     1     27.24 6.95  10.13704509 0     1594.88
      2993.68     1377.14     4.34  3448.42     2.71  1880.41
      141.92      340.18      498.58      65.39 481.08      46.43
      322.225     352.4 0.15  19.975      11.81907103 31.1001
      4.81  34.6  4.5   30    191   0.15  207.7 22.45 19.54 1.885
Pax   X00W  1     2     35.54 7.17  0.760619219 47.2  824.52
      12468 1047.43     11.4  1469.6      1.64  1125.69     918.72
      1932.11     66.33 49.31 2792.66     19.83 10955 11982.5
      6.95  21.675      13.07427352 20.5591     0     27.4  3.9   10
      16400 9.6   16330 21.35 12.83 1.078
Pax   X05W  1     2     33.6  7.14  0.669715641 43.3  1026  12676
      1104.81     11.01 2039.11     2.21  1169.91     1209.44
      3044.74     90.38 67.15 3111.86     14.36 12122.5     12050
      6.975 25.725      13.80116959 30.7183     0     32.2  3.8   11
      14115 7.45  13215 27.95 18.54 1.416
Pax   X10E  1     2     63.39 7.12  0.663529351 38.8  1007.2
      14280 1103.44     9.86  1797.01     1.94  968.58      1156.78
      2708.26     220.39      54    3024.6      14.45 8997.75
      10383.25    5.125 25.575      12.92692613 26.8588     0
      26.2  4     17    13910 7.45  12970 29    14.64 1.302
Pax   X15W  1     2     56.8  7.05  0.816467101 35.2  1157.4
      13456 1099.12     6.84  1762.63     1.51  895.9 1012.93
      2158.85     295.69      59.97 2579.43     25.77 6370  6504.75
      3.6   24.425      9.210298946 26.1201     0     19.5  4.2   21
      7015  3.5   6470  29.1  11.24 1.066
Pax   X20E  2     2     50.11 7.12  1.150326503 30.2  1629.88
      5864  1058.86     4.08  1786.25     1.51  982.43      540.55
      1552.82     265.37      59.76 1483.36     33.7  3429.30175
      4154.25     2.2   23.7  5.638451911 27.6307     0     16.1
      4.4   16    5315  2.7   2567.525    27.1  9.22  0.919
Pax   X22W  2     2     30.11 7.19  1.218448758 29.6  2381.08
      3528.24     860.05      4.11  1481.39     1.54  900.94
      599.41      1215.8      445.34      31.04 566   22.07 3542
      3533.5      1.9   23.075      3.359819914 22.8001     0.71
      16.3  4.8   27    5340  2.7   5103.5      27.25 9.07  0.8
Pax   X26W  2     2     40.43 7.09  1.858699433 25.6  1414.44
      4156  1240.44     4.72  2458.13     1.52  963.66      422.84
      1322.5      385.21      54.5  1006.24     23.26 1184  1294.25
      0.625 20.55 9.381804813 34.6691     0.72  23.3  4.6   24
      2597.5      1.25  2455  27.9  13.67 1.327
```

```
Pax   X30W  2     2     47.45 6.97  2.632952176 20.4  969.96
      14956 1611.18     4.51  3914.41     1.9   1274.3      242.95
      1486.7      256.05      68.07 3212.86     22.9  1270  1287.25
      0.65  23.825      17.60897357 24.1364     0     39.8  4     5
      1840.5      0.9   1777  28.1  23.39 1.708
Pax   X35W  2     2     24.54 7.17  4.557444381 14.8  1075  8216
      1697.84     5.07  3195.68     2.18  1309.02     235.14
      701.2 162.87      124.7 2111.51     47.81 651.25      676.25
      0.35  22.125      22    47.8412     1.42  38.6  4.2   29
      683.5 0.35  692   24.8  24.52 2.365
Pax   X39W  2     2     52.98 6.92  5.792673176 10.5  1773  9344
      1353.9      3.41  2390.81     3.23  1568.89     137.06
      412.73      226.39      122.62      1776.83     45.29 381.65
      399.75      0.175 22.725      6.835871404 37.9974     0.8
      24.1  3.8   22    323.05      0.15  317.55      26    14.78
      1.212
Pax   X43W  3     2     27.36 7.1   8.572517373 5.5   1226.52
      2470.72     1024.12     3.42  1912.1      2.61  1559.96
      97.37 223.05      179.54      168.35      463.31      28.01
      359.2 382.275     0.2   21.775      9.066301406 17.4881
      1.59  18.2  4.3   25    326.15      0.2   331.55      24.25
      12.7  1.112
Pax   X47E  3     2     27.24 6.95  10.13704509 0     1594.88
      2993.68     1377.14     4.34  3448.42     2.71  1880.41
      141.92      340.18      498.58      65.39 481.08      46.43
      322.225     352.4 0.15  19.975      11.81907103 31.1001
      4.81  34.6  4.5   30    191   0.15  207.7 22.45 19.54 1.885
Nan   N00W  1     1     4.45  7.33  0.66143642  55.9  638.64
      9976  940.94      11.18 1737.19     3.45  1322.06     908.36
      2626.39     31.63 37.18 3475  11.94 12245 13760 7.925 19.4
      18.61768759 31.9052     0     29.8  4     4     17210 8.7
      15180 31.8  16.73 1.189
Nan   N05W  1     1     11.75 7.49  0.775195231 54.5  518.12
      10984 1361.81     9.72  2265.26     3.43  1150.92     963.86
      2922.18     55.59 53.89 4088.74     14    8975  9870  5.55
      21.225      20.51648267 74.5838     0     28    4     8
      12410 6.2   11030 31.4  15.73 1.063
Nan   N10E  1     1     30.71 7.38  0.845503646 49.3  594.4 12176
      1167.43     7.74  1770.51     2.29  1062.77     808.98
      2094.03     79.35 36.6  2387.17     16.15 5637.5      6062.5
      3.275 22.05 18.37146703 32.6605     0     24    4.3   12
      8865  5.1   9095  31.3  14.28 1.092
Nan   N15E  1     1     36.8  7.34  0.915513587 44.9  608.4 11512
      958.17      7.21  2012.72     1.46  1118.86     710.17
      2198.46     259.94      25.14 2067.44     17.92 3942  4350.75
      2.375 21.775      17.88297173 31.7475     0     20.9  4.4   14
      3356.5      1.7   3282  25.95 12.52 1.088
Nan   N19E  1     1     18.9  7.27  0.923484971 42.1  692.04
      14488 1204.6      8.75  2228.36     2.59  1261.97     591.27
      2412.99     96.6  38.41 3106.49     17.54 2747.75     3012.75
      1.525 21.575      20.40344489 36.1714     0.31  30.6  4.2   24
      4151.5      2.35  4360.5      25.7  18.72 1.412
Nan   N25E  2     1     31.07 7.24  1.102278453 40.3  761   4232
      903.65      4.32  1793.87     1.53  934.79      349.4 1627.42
      212.23      29.04 910.65      24.3  2153.75     2396.5
      1.275 22.475      12.61498029 21.9618     1.12  16.1  4.8   27
      2827  1.6   2991.5      27.65 10.54 0.96
```

```
Nan   N27W  2     1     28.18 7.09  1.103624074 35    750.6 8756
      1083.67     5.45  2132.29     2     1184.63     429.54
      1932.08     107.42      34.05 2377.36     29.6  1190  1249.75
      0.625 23.675      21.23634426 37.5077     0     28.8  4.3   38
      1784  0.9   1779.5      26.55 17.64 1.594
Nan   N30E  2     1     58.25 7.05  0.95852484  33    595.56
      15280 1277.43     4.83  2095.92     2.86  1747.88     292.86
      2186.61     301.27      20.29 3736.61     54.97 1448.5
      1577.5      0.8   22.725      24.1453422  38.4622     0
      26.5  3.7   18    1759.5      1     1879.05     28.25 16.06
      1.438
Nan   N33W  2     1     32.85 7.13  1.645445731 30.1  691.52
      7552  1310.86     5.17  2528.54     2.21  1368.66     263.17
      1536.69     209.08      34.28 1876.98     44.97 532.825
      563.425     0.275 23.05 24.19308191 36.7441     0.19  30.4
      4.1   19    311.1 0.15  306.4 25.65 17.31 1.673
Nan   N35W  3     1     38.39 7.21  1.693138624 27.5  852.68
      6488  1253.67     5.38  2619.15     5.33  1316.3      213.95
      1546.92     196.5 42.75 882.7 37.91 715.875     792.525
      0.4   21.5  28.88539663 31.0088     1.03  45.3  4.2   31
      781.15      0.4   830.8 117.55      26.35 2.463
Nan   N40W  3     1     17.5  7.25  2.375408292 24.9  820.48
      5668  1452.07     4.03  3127.13     5.55  1179.3      213.69
      1316.46     141.41      46.1  758.23      51.16 311.925
      331.1 0.15  20.45 31.18906006 30.0543     2.35  49    4.5   34
      152.2 0.1   158.45      26.15 28.38 2.559
Nan   N42E  3     1     34.6  7.22  3.818584172 19    986.4 3636.92
      1283.5      4.41  3330.34     5.04  1471.36     237.8 872.14
      348.36      43.66 256.91      50.88 130.9 134.75      0.1
      23.95 26.09489051 43.0355     3.3   46.5  4.8   20    131.35
      0.1   124   26.4  26.42 2.574
Nan   N45E  3     1     27.48 7.29  3.580257131 15    865.16
      6512  1561.03     5.08  3720.46     9.45  1574.18     209.72
      1039.16     159.22      46.95 642.97      67.59 123.6 123.175
      0.1   24.55 37.17231495 32.1127     1.31  61.1  4.7   26
      117.05      0.1   120.6 25.95 35.62 3.216
Nan   N49W  3     1     42.83 7.29  4.775686727 10    984.24
      4928  1499.58     6.41  3644.04     8.45  2081.83     398.26
      763.04      154.16      64.34 594.17      71.28 124.3 129.65
      0.1   22.975      28.94619199 46.1978     1.14  55.3  4.6   17
      134.5 0.1   121   26.35 31.83 2.849
Nan   N55W  3     1     33.42 7.41  4.753128259 6     827.4 4100
      1615.68     5.12  2370.29     8.5   1458.11     278.09
      498.68      159.53      73.8  327.64      109.93      135.325
      143.725     0.1   21.425      32.4993957  34.5612     1.51
      51.6  4.6   25    130.7 0.1   129.2 25.05 29.39 2.689
Nan   N56W  3     1     47.32 7.39  4.500587162 0     821.6 3443.08
      1603.3      4.38  1801.27     3.75  1852.13     248.37
      400.23      273.4 48.21 315.43      116.2 130.425     132.6
      0.1   23.625      26.0345667  32.3617     2.53  36.4  4.6   26
      106.4 0.1   106.95      24.65 22.62 2.139
Nan   N00W  1     2     4.45  7.33  0.66143642  55.9  638.64
      9976  940.94      11.18 1737.19     3.45  1322.06     908.36
      2626.39     31.63 37.18 3475  11.94 12245 13760 7.925 19.4
      18.61768759 31.9052     0     29.8  4     11    17210 8.7
      15180 31.8  16.73 1.189
```

```
Nan     N05W    1       2       11.75   7.49    0.775195231     54.5    518.12
        10984   1361.81         9.72    2265.26         3.43    1150.92         963.86
        2922.18         55.59   53.89   4088.74         14      8975    9870    5.55
        21.225          20.51648267     74.5838         0       28      4       15
        12410   6.2     11030   31.4    15.73   1.063
Nan     N10E    1       2       30.71   7.38    0.845503646     49.3    594.4   12176
        1167.43         7.74    1770.51         2.29    1062.77         808.98
        2094.03         79.35   36.6    2387.17         16.15   5637.5          6062.5
        3.275   22.05   18.37146703     32.6605         0       24      4.3     16
        8865    5.1     9095    31.3    14.28   1.092
Nan     N15E    1       2       36.8    7.34    0.915513587     44.9    608.4   11512
        958.17          7.21    2012.72         1.46    1118.86         710.17
        2198.46         259.94          25.14   2067.44         17.92   3942    4350.75
        2.375   21.775          17.88297173     31.7475         0       20.9    4.4     17
        3356.5          1.7     3282    25.95   12.52   1.088
Nan     N19E    1       2       18.9    7.27    0.923484971     42.1    692.04
        14488   1204.6          8.75    2228.36         2.59    1261.97         591.27
        2412.99         96.6    38.41   3106.49         17.54   2747.75         3012.75
        1.525   21.575          20.40344489     36.1714         0.31    30.6    4.2     22
        4151.5          2.35    4360.5          25.7    18.72   1.412
Nan     N25E    2       2       31.07   7.24    1.102278453     40.3    761     4232
        903.65          4.32    1793.87         1.53    934.79          349.4   1627.42
        212.23          29.04   910.65          24.3    2153.75         2396.5
        1.275   22.475          12.61498029     21.9618         1.12    16.1    4.8     29
        2827    1.6     2991.5          27.65   10.54   0.96
Nan     N27W    2       2       28.18   7.09    1.103624074     35      750.6   8756
        1083.67         5.45    2132.29         2       1184.63         429.54
        1932.08         107.42          34.05   2377.36         29.6    1190    1249.75
        0.625   23.675          21.23634426     37.5077         0       28.8    4.3     45
        1784    0.9     1779.5          26.55   17.64   1.594
Nan     N30E    2       2       58.25   7.05    0.95852484      33      595.56
        15280   1277.43         4.83    2095.92         2.86    1747.88         292.86
        2186.61         301.27          20.29   3736.61         54.97   1448.5
        1577.5          0.8     22.725          24.1453422      38.4622         0
        26.5    3.7     19      1759.5          1       1879.05         28.25   16.06
        1.438
Nan     N33W    2       2       32.85   7.13    1.645445731     30.1    691.52
        7552    1310.86         5.17    2528.54         2.21    1368.66         263.17
        1536.69         209.08          34.28   1876.98         44.97   532.825
        563.425         0.275   23.05   24.19308191     36.7441         0.19    30.4
        4.1     20      311.1   0.15    306.4   25.65   17.31   1.673
Nan     N35W    3       2       38.39   7.21    1.693138624     27.5    852.68
        6488    1253.67         5.38    2619.15         5.33    1316.3          213.95
        1546.92         196.5   42.75   882.7   37.91   715.875         792.525
        0.4     21.5    28.88539663     31.0088         1.03    45.3    4.2     30
        781.15          0.4     830.8   117.55          26.35   2.463
Nan     N40W    3       2       17.5    7.25    2.375408292     24.9    820.48
        5668    1452.07         4.03    3127.13         5.55    1179.3          213.69
        1316.46         141.41          46.1    758.23          51.16   311.925
        331.1   0.15    20.45   31.18906006     30.0543         2.35    49      4.5     30
        152.2   0.1     158.45          26.15   28.38   2.559
Nan     N42E    3       2       34.6    7.22    3.818584172     19      986.4   3636.92
        1283.5          4.41    3330.34         5.04    1471.36         237.8   872.14
        348.36          43.66   256.91          50.88   130.9   134.75          0.1
        23.95   26.09489051     43.0355         3.3     46.5    4.8     22      131.35
        0.1     124     26.4    26.42   2.574
```

```
Nan   N45E  3     2     27.48 7.29  3.580257131 15    865.16
      6512  1561.03     5.08  3720.46     9.45  1574.18     209.72
      1039.16     159.22      46.95 642.97      67.59 123.6 123.175
      0.1   24.55 37.17231495 32.1127     1.31  61.1  4.7   24
      117.05      0.1   120.6 25.95 35.62 3.216
Nan   N49W  3     2     42.83 7.29  4.775686727 10    984.24
      4928  1499.58     6.41  3644.04     8.45  2081.83     398.26
      763.04      154.16      64.34 594.17      71.28 124.3 129.65
      0.1   22.975      28.94619199 46.1978     1.14  55.3  4.6   18
      134.5 0.1   121   26.35 31.83 2.849
Nan   N55W  3     2     33.42 7.41  4.753128259 6     827.4 4100
      1615.68     5.12  2370.29     8.5   1458.11     278.09
      498.68      159.53      73.8  327.64      109.93      135.325
      143.725     0.1   21.425      32.4993957  34.5612     1.51
      51.6  4.6   31    130.7 0.1   129.2 25.05 29.39 2.689
Nan   N56W  3     2     47.32 7.39  4.500587162 0     821.6 3443.08
      1603.3      4.38  1801.27     3.75  1852.13     248.37
      400.23      273.4 48.21 315.43      116.2 130.425     132.6
      0.1   23.625      26.0345667  32.3617     2.53  36.4  4.6   29
      106.4 0.1   106.95      24.65 22.62 2.139

;

data rich;
set rich;
run;
quit;
proc sort data= rich;
by river;
quit;


proc mixed data=rich;
class group time;
model Richness = group|time / ddfm=satterth outp=resids;
by river;
lsmeans group|time/diff=all adjust=tukey;
ods output lsmeans=lsmean1;
ods listing exclude diffs; ods output diffs=diff1;
ods output tests3=stat1;
quit;

proc plot data=resids vpercent=50;
plot resid*pred/vref=0;
by river;
quit;
Proc univariate data=resids plot normal;
var resid;
by river;
quit;
proc print data=lsmean1;
quit;
proc print data=diff1;
format estimate stderr 6.2;
var river group _group time _time Estimate StdErr Adjp;
quit;
proc print data=stat1;
```

```
quit;
title "";
quit;

ods graphics off;
   ods html close;
   quit;
```

Stepwise Regression Analysis Mid-Domain Effect and Richness Data (Chapter 3)

```
ods html;
   ods graphics on;
title1 'Stepwise Regression Analysis of Models for Empirical versus
RangeModel Data Nanticoke River Full Data Set';
Options ls=70 ps=48 pageno=1;
data stepreg;
input plot$ Group$      Inun BpH  CAMg  DisDown EPAP  EPAS  M3Al
M3B  M3Ca M3Cu M3Fe  M3K  M3Mg  M3Mn  M3P   M3S  M3Zn  MSS MSC   NP
NH4N NO3N  OM  pH  RSC  TC  TN  EmpR RMRich

;
datalines;
N00W        1     4.449999809 7.329999924 -0.17951189 55.9
      2.805256128 3.998956442 2.973562002 1.048441768 3.239847422
      0.537819088 3.121251106 2.958257914 3.419359207 1.500099182
      1.570309401 3.540954828 1.077004313 7.925 13760 18.61768723
      1.503861427 0     29.79999924 4     15180 16.72999954
      0.075181857 7     11.0462
N05W        1     11.75 7.489999771 -0.110588901      54.5
      2.714430332 4.040760517 3.13411665  0.987666249 3.355118036
      0.535294116 3.06104517  2.984014034 3.465707064 1.744996667
      1.731508136 3.611589432 1.146128058 5.55  9870  20.51648331
      1.872644544 0     28    4     11030 15.72999954 0.02653325
      11.5  18.939
N10E        1     30.70999908 7.380000114 -0.072884522      49.29
      2.774078846 4.085504532 3.06723094  0.888740957 3.248098373
      0.359835476 3.02643919  2.907937765 3.320982933 1.899546981
      1.563481092 3.377883434 1.20817256  3.275 6062.5
      18.37146759 1.514022827 0     24    4.300000191 9095
      14.27999973 0.038222641 14    24.8548
N15E        1     36.79999924 7.340000153 -0.038335212      44.9
      2.784189224 4.061150551 2.981442451 0.85793525  3.303783417
      0.164352864 3.048775673 2.851362228 3.342118502 2.414873123
      1.400365233 3.315432787 1.253337979 2.375 4350.75
      17.88297081 1.50170958  0     20.89999962 4.400000095 3282
      12.52000046 0.036628921 15.5  29.8686
N19E        1     18.89999962 7.269999981 -0.034570165      42.09
      2.840131283 4.161008358 3.080842733 0.942008078 3.347985268
      0.413299739 3.101048946 2.771785975 3.382555485 1.984977126
      1.584444284 3.492269993 1.244029641 1.525 3012.75
      20.40344429 1.558365345 0.117271274 30.60000038 4.199999809
      4360.5      18.71999931 0.149834678 23    34.7418
N25E        2     31.06999969 7.239999771 0.042291325 40.29
      2.881384611 3.626545668 2.956000328 0.635483742 3.253790855
      0.184691429 2.970714092 2.543322802 3.211499691 2.326806784
      1.462996602 2.95935154  1.385606289 1.275 2396.5
```

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      12.6149807  1.341667891 0.326335847 16.10000038 4.800000191
      2991.5      10.53999996 -0.017728776      28    38.2106
N27W        2     28.18000031 7.090000153 0.042821176 35
      2.875408649 3.942305803 3.034897089 0.736396492 3.328846216
      0.30103001  3.073582649 2.633003712 3.286025047 2.031085253
      1.532117128 3.376095057 1.471291661 0.625 1249.75
      21.23634338 1.574120402 0     28.79999924 4.300000191 1779.5
      17.63999939 0.202488318 41    39.7666
N30E        2     58.25 7.050000191 -0.018396636      33
      2.77492547  4.184123516 3.10633707  0.683947146 3.321374655
      0.456366003 3.242511511 2.466660023 3.339771271 2.478955984
      1.30728209  3.572477818 1.740125775 0.8   1577.5
      24.14534187 1.585034132 0     26.5  3.700000048 1879.050049
      16.05999947 0.157758877 18.5  39.7752
N33W        2     32.84999847 7.130000114 0.21628356  30.1
      2.839804649 3.87806201  3.117556334 0.713490546 3.40286994
      0.34439227  3.136295557 2.420236349 3.186586142 2.3203125
      1.535040855 3.273459673 1.652922869 0.275 563.4249878
      24.19308281 1.565187573 0.07554698  30.39999962 4.099999905
      306.3999939 17.30999947 0.22349593  19.5  39.755
N35W        3     38.38999939 7.210000038 0.228692517 27.5
      2.930786133 3.812110901 3.098183155 0.73078227  3.418160439
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      830.7999878 26.35000038 0.391464412 30.5  39.735
N40W        3     17.5  7.25  0.375738293 24.89 2.914067984
      3.75342989  3.161987543 0.605305076 3.495146036 0.744292974
      3.071624279 2.329784155 3.119407654 2.150480032 1.663700938
      2.879801035 1.708930492 0.15  331.1000061 31.18906021
      1.477906585 0.525044799 49    4.5   158.4499969 28.37999916
      0.408070296 32    38.0928
N42E        3     34.59999847 7.21999979  0.581902385 19
      2.994053125 3.560733795 3.108395815 0.644438565 3.522488594
      0.702430546 3.167718887 2.376211882 2.940586329 2.542028189
      1.640083671 2.409780979 1.706547141 0.1   134.75
      26.09489059 1.633826852 0.633468449 46.5  4.800000191 124
      26.42000008 0.41060853  21    34.6294
N45E        3     27.47999954 7.289999962 0.553914249 15
      2.937096357 3.813714504 3.19341135  0.705863714 3.570596695
      0.9754318   3.197054386 2.321639776 3.016682386 2.201997519
      1.671635628 2.808190584 1.829882383 0.1   123.1750031
      37.17231369 1.506676793 0.363611966 61.09999847 4.699999809
      120.5999985 35.61999893 0.507316053 25    29.7418
N49W        3     42.83000183 7.289999962 0.679035842 10
      2.99310112  3.692670584 3.175969601 0.806858003 3.561583042
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      121   31.82999992 0.454692453 17.5  24.8268
N55W        3     33.41999817 7.409999847 0.676979542 6
      2.917715549 3.612783909 3.208355427 0.709269941 3.374801397
      0.929418921 3.163790226 2.444185257 2.697821856 2.202842474
      1.868056417 2.515396833 2.041116238 0.1   143.7250061
      32.49939728 1.538588762 0.39967373  51.59999847 4.599999905
      129.1999969 29.38999939 0.429590791 28    18.9186
```

```
N56W        3      47.31999969 7.389999866 0.653269172 0
      2.914660454 3.536947012 3.205014706 0.641474128 3.255578756
      0.574031293 3.267671585 2.395099163 2.602309704 2.436798573
      1.683137178 2.498903036 2.065206051 0.1    132.6000061
      26.03456688 1.510031343 0.547774673 36.40000153 4.599999905
      106.9499969 22.62000084 0.330210775 27.5   11.0978


;
proc reg data=stepreg;
      model EmpR = CAMg Inun DisDown MSS NO3N pH RMRich
   / selection=maxr details=summary;

proc reg data=stepreg;
model EmpR = CAMg Inun DisDown MSS NO3N pH RMRich
   / selection=rsquare aic cp tol vif collin;
   quit;

   ods graphics off;
   ods html close;
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