ORGANIC MATTER DISTRIBUTION AND TURNOVER ALONG A GRADIENT FROM FOREST TO TIDAL CREEK

A Thesis

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Many coastal ecosystems migrate landward under the influence of rising sea level. Typical zonation of plant communities along coastal shorelines consists of tidal marshes, a transition zone, and adjacent upland or wetland forest. This study examined organic matter distribution along this gradient. I hypothesized that total above and belowground organic carbon mass would follow the pattern: forest > transition > high marsh = mid marsh > low marsh > tidal creek. This study was conducted at the upper Phillips Creek study area on the eastern shore of Virginia. A zonation map of the study area was created, and low marsh was divided into two zones based on two growth forms of *Spartina alterniflora.* Sample sites were selected using a stratified random sampling approach. A nested plot design was used to harvest vegetation, obtain soil cores, and collect quantitative data on trees, shrubs and large wood detritus. Unharvested tree and shrub masses were estimated using regression equations. Loss on ignition was determined for vegetation and soils. Organic carbon mass was estimated to be 50% of organic matter. Total above and belowground organic carbon mass (mean (kg/m^2) $\pm$ S.E.) for each zone was: forest 24.3 $\pm$ 2.1, high marsh 14.2 $\pm$ 0.7, transition 12.8 $\pm$ 0.6, LMSS 12.6 $\pm$ 0.8, LMTS 11.3 $\pm$ 0.7, and tidal creek 8.7 $\pm$ 0.3. The greatest loss of carbon occurred in the transformation of forest to high marsh. Organic carbon turnover rates for Phillips Creek were estimated for steep and gentle slopes by projecting an 80-year period of sea level rise at 5 mm/year. After 80 years, marsh and transition zones experienced 100% turnover in both profiles. The forest experienced turnover rates of

25% and 71% in steep and gentle profiles, respectively. Horizontal turnover rates of carbon associated with state change were approximately one order of magnitude lower than those associated with net primary production. However, horizontal turnover of ecosystem states can change coastal landscapes within the time span of a century.

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INTRODUCTION

Eustatic sea level rise has been cited as the major force behind coastal landscape changes that include losses of salt and brackish marshes in low lying coastal areas in the eastern and Gulf Coast states of the USA (Hayden et al. 1991, Reed and Cahoon 1992, Moorhead and Brinson 1995). However, steady sea level rise is not the only force behind changes in coastal landscapes. Crustal subsidence, reduced sedimentation rates, and marsh shoreline erosion may be additional driving forces transforming salt marsh and brackish marshes into unvegetated open water systems (Stevenson et al. 1985, Downs et al. 1994). In addition, storm surges that accompany hurricanes and tropical storms may act as catalysts in the transformation of forest into high marsh (Brinson et al. 1995). Changes in ecosystem state are called “state change” (entire ecosystems replace one another as they move horizontally across the landscape). The type of state change depends on the current state, upland slope, and sediment supply. For mainland marshes, four combinations of sea level induced state changes may occur: (1) where slopes are relatively flat and sediment supplies are abundant, low and high marsh zones encroach on forest by migrating landward and low marsh zones prograde toward the estuary (Redfield 1972); (2) where slopes are flat but sediment supply is low, the low and high marsh zones still migrate overland, but the edge of low marsh erodes becoming subtidal; (3) where slopes are steep and sediment supply is high, the high marsh stalls at the forest margin and the low marsh progrades toward the estuary; and (4) where slopes are steep but sediment supply is low, the high marsh stalls at the forest edge, and the low marsh erodes (Brinson et al. 1995). For many mainland marshes along the eastern shore of Virginia, sediment supply is low. Thus erosion along the banks of tidal creeks and margins of estuaries combined with marsh stalling or marsh overland migration are the more commonly observed responses to relative sea level rise.

Several studies have focused on local and regional processes contributing to area loss of marshes. In Louisiana, relative sea level rise, due principally to deep subsidence of the Mississippi River deltaic plain, is the major cause for the rapid deterioration of salt marshes despite high sediment accretion rates. Die-off of saltmarsh vegetation due to conditions associated with long-duration flooding, rather than shoreline erosion, has transformed the marshes into unvegetated open water areas (Reed and Cahoon 1992). In the Chesapeake Bay, a Maryland brackish marsh system has experienced extensive erosion of 2300 ha in a 40 y time span. This was largely due to a net loss of mineral sediment coupled with sea level rise exceeding organic accretion rates (Stevenson et al. 1985). In southeastern North Carolina, a loss of lagoonal salt marshes has been attributed to relative rise in sea level and inadequate sediment deposition due to coastal inlet dredging (Hackney and Cleary 1987). On the other hand, in North Inlet, South Carolina, Gardener et al. (1992) reported on the landward migration of salt marsh where relative sea level rise was believed to cause low-lying forest and high marsh to move overland.

At the Long-Term Ecological Research (LTER) site on the Virginia Coast Reserve, (VCR), the effects of relative sea level rise and storm surges on the wetlands and adjacent uplands are being studied. The process is believed to involve transgression of marshes landward that caused mainland areas of low land surface elevation to undergo a series of changes in plant community composition. For instance, wrack deposition in the high marsh, which occurs as a result storm tidal surges, reduces the productivity of most salt marsh species. *Juncus roemerianus* Scheele patches were found to be susceptible to replacement by other high marsh species following wrack disturbance (Tolley and Christian 1999). State change is believed to arise from vertical changes in at least one of three surfaces: the land, the sea, and the freshwater table. At the VCR, even small changes in the relationship between land surface and sea level may result in ecosystem state change (Hayden et al. 1991, Hayden et al. 1995). For example, from 1938 to 1990 Phillips Creek marsh (on the VCR mainland) had gained approximately 27.3 ha of marsh, primarily from high marsh encroachment on uplands (Kastler and Wieberg 1996).

While the slope of the land should regulate the rate of transgression under constant sea level rise, other factors may be involved. Resistance to state change may be an important property that regulates the rate of landward migration. For instance, the transition from high marsh to intertidal low marsh is impeded by the structure of clonal saltmarsh plants, and the accumulation of organic matter in the form of peat elevating the marsh surface above intertidal elevations (Bertness 1988). A six-year study by Brinson and Christian (1999) found that the clonal species *J. roemerianus* maintained stable patches in a high marsh, despite wrack disturbance and marsh subsidence. In addition, transition from low marsh to subtidal creek and intertidal mud flat is impeded by *Spartina alterniflora* Loisel, a creekside plant whose aerial stems facilitate sediment accumulation (Christiansen 1998). Possible mechanisms for change, and components involved in maintaining each ecosystem state from low marsh to the forest, are illustrated in Figure 1, a conceptual state change model created by Brinson et al. (1995). Two of the important components, total aboveground and belowground organic matter, along a continuum from tidal creek to upland forest, have not been quantitatively

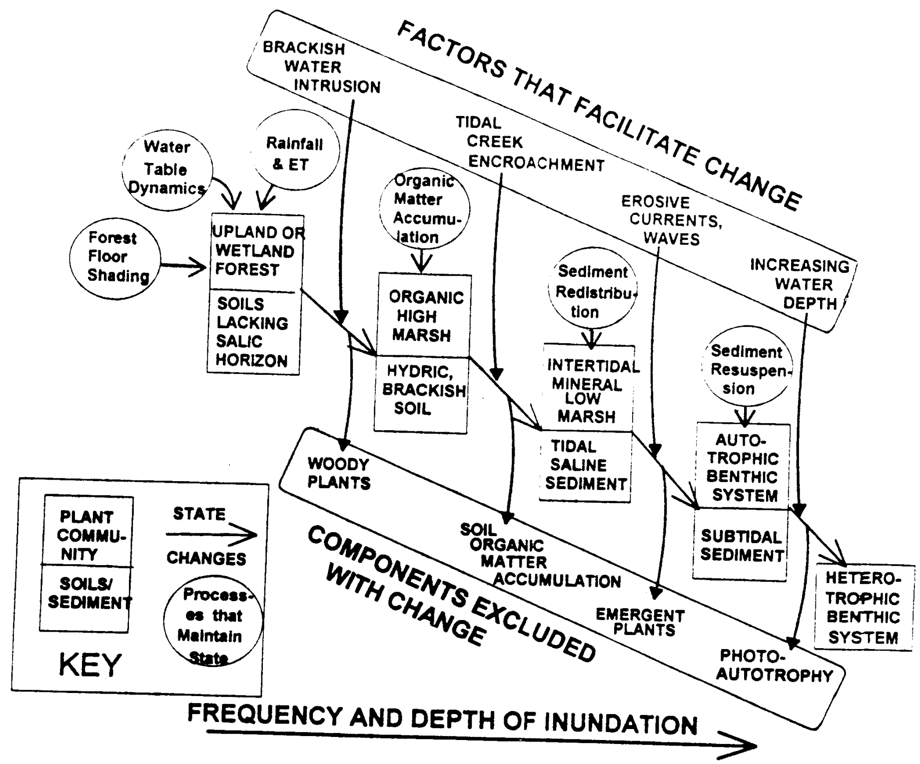

Figure 1. Conceptual model of the five states and four transitions from terrestrial forest to subtidal heterotrophic sediment. Factors that facilitate change appear at the top and components excluded with state change appear at the bottom. Taken from Brinson et al. (1995)

measured on a mainland coast. Although there have been a substantial number of saltmarsh plant studies conducted along the Atlantic and Gulf coast states (Kruczynski et al. 1978, Stout 1978, Smith et al. 1979, Roman and Daiber 1984, Bellis and Gaither 1985), their focus have been on saltmarsh species productivity and biomass at a particular locale without relation to sea level rise. On the other hand, studies by Stevenson et al. (1985), Hackney and Cleary (1987), and Reed and Cahoon (1992) addressed processes involved in the conversion of salt/brackish marshes to subtidal lagoons, and Gardner's study (1992) focused on landward migration of high marsh displacing forest. However, none of these studies addressed the quantity or quality of total organic matter, above and belowground, involved in transitional changes from marsh to open water, or from upland forest into high marsh.

With the change from one ecosystem state to another, there are losses of certain ecosystem components and gains in others (Brinson et al. 1995). Therefore, the purpose for this quantitative study is to estimate the magnitude of above and belowground organic matter, consisting primarily of woody and herbaceous vegetation and soil organic matter. In turn, these estimates will enable me to evaluate the magnitude of gains and losses of organic matter and organic carbon over long time scales. Although this study will not explain the mechanisms responsible for organic carbon changes, it will provide the foundation upon which those processes can be studied.

Based on literature and field observations, I reasoned that forest would exceed the high marsh in total organic matter due to the magnitude of mature tree mass that would compensate for having less belowground organic matter than the high marsh. In addition, I expected high marsh and mid-marsh with organic rich soil to exceed the low marsh in total organic matter.

In summary, the goals of this study were to quantify and characterize above and belowground organic matter for each ecosystem state in Phillips Creek. I compare my findings with other coastal ecosystem studies of the Atlantic and Gulf Coast states in the USA. I expect the to find the following pattern for total organic matter (kg/m^2): Forest > Transition > High marsh = Mid-marsh > Low marsh > Tidal creek.

SITE DESCRIPTION

Phillips Creek is a saltwater tidal creek located on the eastern shore of Virginia in Northampton County within the Brownsville area of the Virginia Coast Reserve (VCR), (Figure 2). The VCR, owned by The Nature Conservancy, is one of the Long-Term Ecological Research sites (LTER) supported by the National Science Foundation.

In the earlier part of this century, the upper region of Phillips Creek (37^{o}26' N, 75^{o}52' W) was used as pasture. In the present day, this former use is clearly visible in weathered fence posts that dissect the high marsh, remnants of a former fence line. Also, a piece of rusting plow equipment is partially buried in the sediment of the present day high marsh.

The northern end of Phillips Creek contains a gently sloping, broad expanse of marsh surrounded on three sides by loblolly pine (*Pinus taeda*) forests and upland agricultural fields (Figure 2). This configuration forms the basis for a complex of six ecosystem states beginning with a tidal creek and an intertidal or low salt marsh, followed by a mid-marsh, then grading inland to a brackish high marsh, marsh-forest transition, and adjacent forest.

The predominant soil types are Chincoteague in the low, mid, and high marshes, and Magotha in the transition zones, which are very poorly drained and poorly drained, respectively. Nimo, Munden, and Dragston are the soil types present in the forested areas (USDA Soil Conservation Service 1989). All of these soils are found on gentle slopes ranging from 0 to 2%. Hmieleski (1994) previously described these soils, except for Dragston, as the principal soil types of Phillips Creek and of Northampton County.

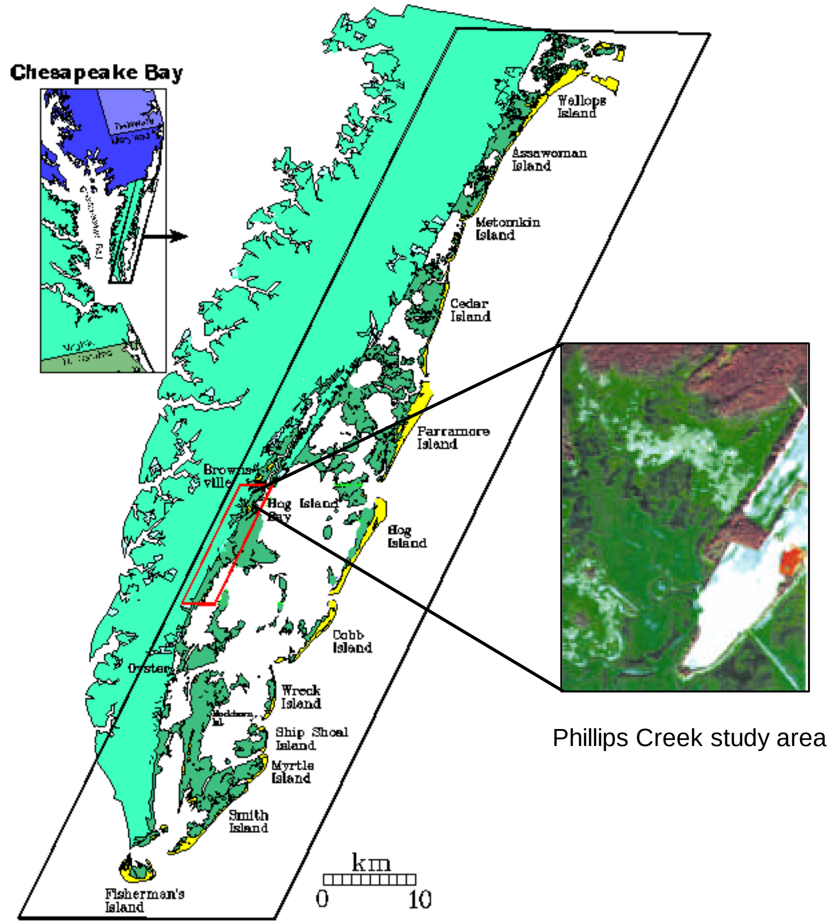

Figure 2. Phillips Creek study area is located within the Virginia Coast Reserve Long-Term Ecological Research complex. This complex is situated on the eastern shore of Virginia on the Delmarva Peninsula. Mainland marshes (small rectangle) are attached to the major land mass in contrast to lagoonal and back barrier marshes to the east.

The Dragston soil is found along drainages, while the Nimo is found in depressions and flats. Both soil types support wetland forest, and they are described as poorly drained to somewhat poorly drained, respectively. The Munden soil, found on upland flats, is moderately well drained, and is the principal soil type for the upland forest (USDA Soil Conservation Service 1989).

The vegetation within the zones follows a salinity gradient. The forest contains an approximately 55-year old stand of loblolly pine (*Pinus taeda* L.), a mixture of hardwoods, and an understory of salt intolerant vegetation. In the transition zone, *Juniperus virginiana* L. is the dominant tree species, and is considered to be an indicator of forest transition. *P. taeda* trees, approximately 45 years old, also inhabit the forest transition. Shrubs that commonly occur in the transition zone are *Iva frutescens* L., *Baccharis halimifolia* L., and *Myrica cerifera* L. Herbaceous species are comprised of a mixture of freshwater and saltmarsh graminoid species, such as *Panicum virgatum* L., *Setaria genticulata* Beauv., *Spartina patens (*Aiton) Muhl, *Distichlis spicata* (L.) Greene and *Juncus roemerianus* Scheele. The same species are also commonly found in transition zones along the eastern shore of Virginia (Ricker 1999). The high marsh is dominated by the saltmarsh graminoids, *J. roemerianus*, *S. patens*, and *D. spicata*. Also occurring in the high marsh is *Spartina alterniflora* Loisel, commonly found in microtopographic depressions. This distribution coincides with areas of high marsh that are losing elevation and becoming devoid of emergent vegetation. The low marsh is dominated by *S. alterniflora*, both tall and short forms, with the tall form occurring along creekbanks. Lastly, the creek channels are devoid of emergent vegetation.

In 1991, three water level recorders were established on Phillips Creek Marsh to capture the variations in hydroperiod along a continuum from creekbank to adjacent forest. Stasavich (1998) described the main water input for each ecosystem along this continuum. The low marsh experiences diurnal tides. The mid-marsh, due to an increase in elevation or distance from the tidal creek, relies on spring tides as the principal water source, while precipitation and storm tides are secondary. Again, due to elevation or distance to the creek, the high marsh, transition and forest zones are dependent on rainfall as a major water source. In addition, the high marsh and transition experience tidal inundation during storm surges. The forest, on the other hand, experiences tidal inundation only during infrequent events, such as northeaster storms and hurricanes.

METHODS

Field Map and Sampling Design

In order to comparatively study above and belowground organic matter of the marsh ecosystem zones, I created a map that depicts the approximated zone boundaries (Figure 3a). Boundaries of zones were approximated by visually assessing vegetation composition on a 1990 USDA black and white aerial photograph enlarged to a scale of 2.54 cm:100 m, a 1990 USDA infrared photograph at an approximate scale of 2.54 cm:200 m, and ground observation. Because the tall and short forms of *S. alterniflora* displayed a recognizable zonation pattern on the aerial photographs, the low marsh was divided into two zones based on growth forms. For zones that could not be defined by aerial photography, field measurements of distance and direction were taken using a meter tape and a compass. These measurements were then converted onto the map as approximated zone boundaries. On the map, drawn boundary lines gave zones the appearance of polygons with variable size and shape.

This map formed the basis for the stratified random sampling design from which sampling points were selected. Because most zones (forest, high marsh and low marsh) were represented by multiple polygons that were often not contiguous, a stratified random approach was chosen to increase the possibility of an even dispersal of sampling points across each zone. The stratified zones are displayed in Figure 3a with the zone indicated by a capital letter followed by the stratum in a lower case letter. Potential sampling points were plotted on the stratified zone map, using intersection points on a 28 m grid for most stratified zones. For the large forested area (stratum Fb), a 55 m grid provided ample sampling points (Figure 3b). Points were numbered within

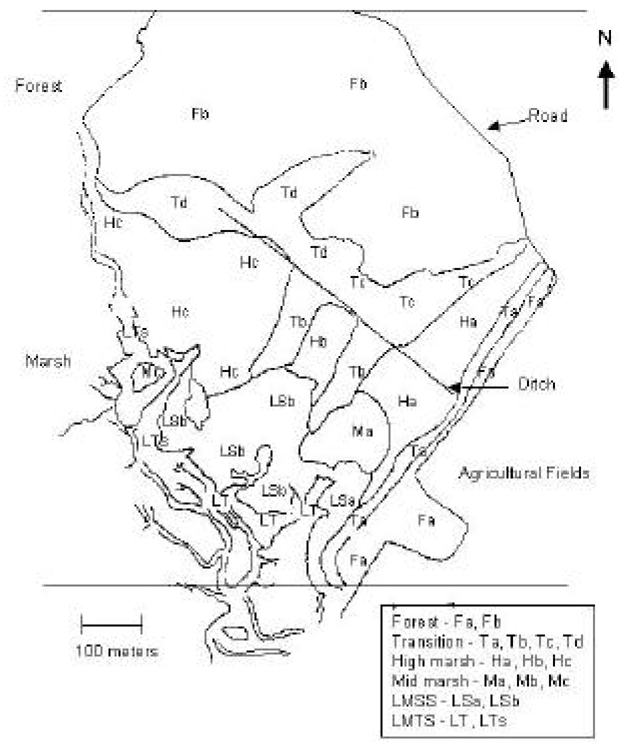

Figure 3a. Map of Phillips Creek shown with zone boundaries and stratification scheme. Capital letters denote zones and small case letters denote strata. LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *Spartina alterniflora*.

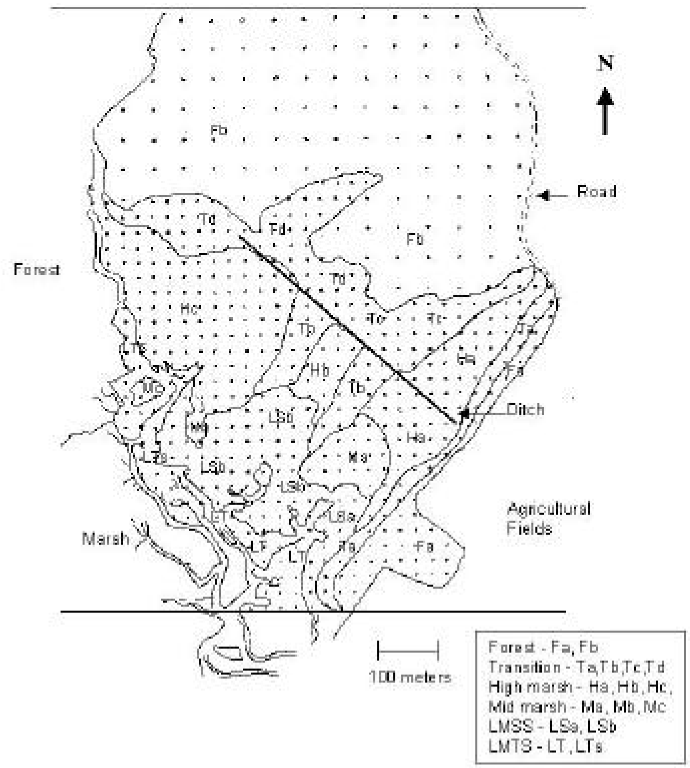

Figure 3b. Map of Phillips Creek displays spatial scale of the grid used to plot potential sampling points across zones. Legend shows stratification of zones. Legend abbreviations: LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *Spartina alterniflora*

each stratum for random selection. I used the numbered points to separate strata that were not separated by a boundary line. An example was the transition strata Tc and Td. The sampling intensity I chose was based on variability of vegetation and soils within each zone, and the field time required to sample points. I expected the transition, mid, and high marsh zones to be the most variable zones, and the forest and low marsh tall and short *Spartina* zones to be the most homogenous. I selected a sampling intensity of 10 % for all strata except the forest, because that intensity would have provided too many forest sample points for the limited field time. I decided to begin with five forest points, two in Fa and three in Fb, and to select more points at a later date if needed and time allowed. In contrast, the mid marsh zone contained two strata with fewer than ten potential sampling points, so I randomly selected one point for each stratum to ensure sampling within all strata.

All sampling points on the map were located in the field using map, compass, and meter tape. However, some randomly selected points could not reached. This occurred several times in the low marsh tall *Spartina alterniflora* zone where many small creek channels, not visible on map, barred access. Therefore, I chose a substitute that was the nearest accessible sample point to the unreachable one. A PVC pipe stake was driven into the ground, and labeled to mark each point. This enabled me to make recurring visits to points until harvesting and data gathering were complete. For the remainder of the study, I will refer to these established sampling points as sample sites.

After several months of field sampling, several changes were made in the zone assignment of sample sites. Because mid-marsh and high marsh were indistinguishable in vegetation and soil characteristics, all mid-marsh sample sites were assigned to the high marsh, except one; that mid-marsh site was assigned to the low marsh short-form

Spartina alterniflora zone. In addition, three transition zone sites were assigned to the high marsh. I decided the eastern transition “finger”, which extended as a peninsula into the high marsh, had completed its transition to high marsh due to low shrub density, and its disconnection from the forest. A second transition “finger” remains, except that it was reduced in area from that previously mapped (Figure 4). This transition area is comprised of *Iva frutescens* shrubs and *Juniperus virginiana* snags, and is an extension of an inland transition comprised of scattered trees (*J. virginiana* and *P. taeda*), and mixed shrubs species (*I. frutescens* and *Baccharis halimifolia*). Thus, the final number of sample sites per zone is as follows: 5 forest, 14 transition, 25 high marsh, 9 low marsh short-form *S. alterniflora*, and 7 low marsh tall-form *S. alterniflora*.

GPS Survey

A global positioning system was used to determine coordinates and elevation of all sample sites. The roving unit was set up next to or within 1 m of the PVC stake marking the site. Static readings of 8 to 10 min duration were taken for the marsh zones, and 20 to 30 minute static readings were taken for the transition and forest sites to ensure accurate elevation readings (< 1.0 cm error). The main purpose of the GPS survey was to display the location and the relative elevation of all sites. The GPS receiver used was a Trimble 4000 SE unit (L1 only) and the software used to process GPS data points was GPS Survey version 3.20a. The GPS data generated (position coordinates and elevation) were tied to VCR1, a permanent bench mark that was established as a cignet global network tie. Elevations are tied into mean sea level based on the 1929 National Geodetic Survey. Due to the high precision of VCR1, position coordinates and elevation above mean sea level are accurate to the nearest centimeter. Further information

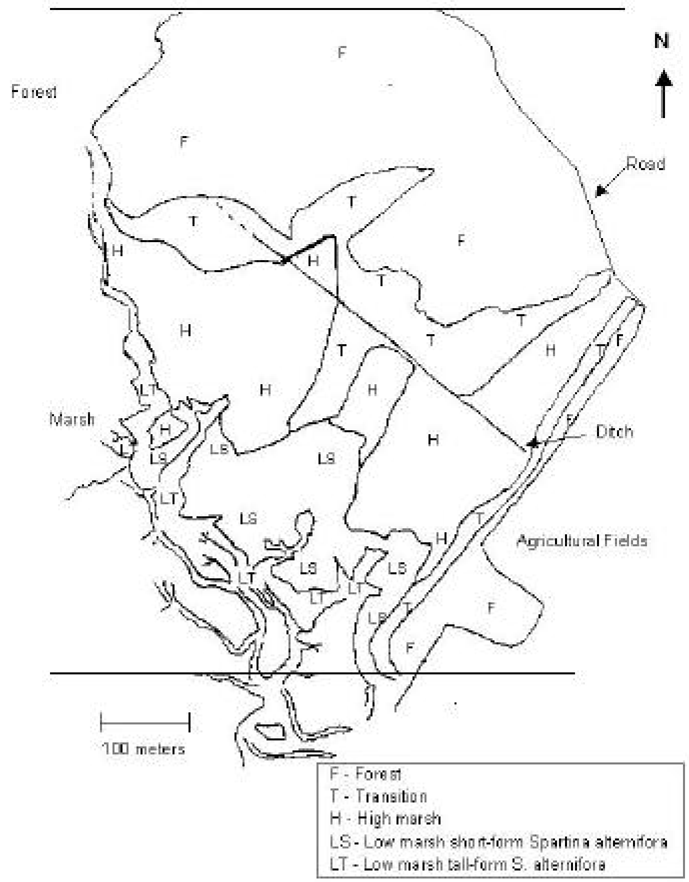

Figure 4. Revised map of Phillips Creek shown with adjusted zone boundaries.

concerning the VCR1 benchmark can be obtained at the internet address: www.vcrlter.virginia.edu/~crc7m/gps.html.

Aboveground Organic Matter

Sampling Techniques

Marsh vegetation was harvested in early October 1997 from all marsh zones. Before harvesting, percent species composition and percent groundcover (Daubenmire 1959) were visually assessed within a 1 m^2 quadrat at each site. From a 0.0625 m^2 quadrat (25 x 25 cm) area within the 1 m^2 quadrat, all graminoid vegetation was clipped and surface litter collected, and placed in labeled plastic bags.

Sampling within transition and forest zones was more complex. Because of the presence of shrubs, trees, vines, and forbs, a nested sampling design was used. Trees were measured within a fixed 10 m radius plot and shrubs within a 5 m radius plot. Small woody vegetation < 1 m height, forbs, fruits and cones and small wood detritus, was harvested within 1 m^2 quadrats. Graminoid vegetation and herbaceous litter were harvested within 0.0625 m^2 quadrats. For trees and shrubs $\geq$ 2.54 cm dbh, species-specific regression equations were used to determine biomass (explained below).

The following data were collected at transition and forest sample sites: (1) diameter at breast height (dbh) at 1.4 m from tree base for *J. virginiana*, *P. taeda*, and hardwood tree species, (2) basal diameter, height, and average crown diameter of shrub species, (3) species, height, dbh, and decay class of all standing snags leaning less than 45 degrees, (4) species, length, decay class, and diameter at mid length of large wood (LW), defined as dead stems greater than 10 cm diameter lying prostrate or leaning greater than 45 degrees from vertical, (5) number and species identification of woody vines, (6) tree age estimate of *P. taeda* and *J. virginiana* by obtaining increment cores from two of the largest trees of each species per plot, and (7) percent groundcover and percent herbaceous species composition within five-1 m^2 quadrats.

In the transition zone, graminoids, small wood (SW) (defined as dead stems < 10 cm diameter lying on the ground), vegetation less than 1 m in height and less than 2.54 cm in diameter, and fruits and cones were harvested within 1 m^2 quadrats at five points, equidistant, along a north-south directed transect within a 10 m radius plot. Graminoids and surface litter were harvested within a 0.0625 m^2 quadrat (25 x 25 cm right corner of a 1 m^2 quadrat). The remaining vegetation categories were harvested within the 1 m^2 quadrat. Forest vegetation and detritus were harvested in the same fashion, except that herbaceous species were harvested within a 1 m^2 quadrat. All collected samples were stored in labeled plastic bags and later refrigerated.

In the fruit and cones category, only pine cones were found and their mass was later included in the SW category. Also, a variation in plot size occurred at one transition site. Because this site was comprised of shrubs and lacked trees, a 5 m radius plot with three 1 m^2 quadrats was used.

<u>Processing of Vegetation and Detritus</u>

Marsh vegetation was sorted by species, except for litter, and live and dead plants were separated. Totally brown plants were considered dead. Plant fragments that could not be identified to species were added to the surface litter category. In contrast, herbaceous vegetation samples from transition and forest sites were not separated by species. All vegetation and detritus samples were placed in labeled paper bags and dried at 85^{o}C in a drying oven to a constant weight. After drying, bags with vegetation were weighed to the nearest 0.01 g. Bag weight was subtracted to obtain dry weight of plant material. Selected dried samples were ground using a Wiley mill with a 40-mesh screen, and stored in labeled plastic bottles until loss on ignition (LOI) analysis.

Qualitative Vegetation Analysis

Species dominance was derived from percent herbaceous species composition within the 1 m^2 quadrats. Dominance was assigned to one or two species that comprised 50% or more of the area. Because the transition and forest sites had five-1 m^2 sampling points, in addition to determining species dominance within each quadrat, another step was taken to ascertain the dominant herbaceous species for the site. The dominant species of the 1 m^2 quadrats were tallied for frequency of dominant occurrence among the five quadrats. Thus, the species that was dominant in three or more quadrats was considered the dominant site species, or two species occurring with equal frequency shared dominance. Similarly, Daubenmire's (1959) percent groundcover values were averaged for the five replicate quadrats. Dominant species and percent groundcover were used to characterize the different zones.

Mass Estimations

Snags and large wood. Snag and large wood (LW) detritus mass were estimated per species with the following equation: Mass (kg) = Height (m) or length (m) * mean cross-section area (m^2) * wood specific gravity (kg/m^3). Then, snag and LW biomass were summed separately in each sample plot, and converted to kg/m^2. Specific gravity values (g/cm^3) for snags and LW, that had no evidence of decay (class 1), were obtained from Haygreen and Bowyer (1989) for *P. taeda* , *J. virginiana, Prunus virginiana*, and

Nyssa biflora. Because many snags and LW were in various stages of decay, three decay classes were described: Class 1 had bark intact with no evidence of wood decay, class 2 had some missing bark and mild to moderate wood decay, and class 3 had no bark and advanced stages of wood decay.

Because *P. taeda* and *J. virginiana* comprised the bulk of snag and LW categories, specific gravity values for classes 2 and 3 of these species were determined from multiple specimens of dead wood for each decay class. Each specimen was categorized, labeled, and placed in a drying oven at 85^o C until there was no further weight loss. Dry weights were obtained to the nearest 0.01 g. Then specimens were wrapped securely in cellophane using minimal tape to keep them dry. Each wood specimen was submersed in a 1 L graduated cylinder filled with 800 mL of water, and volume displacement was recorded (Haygreen and Bowyer 1989). Specific gravity (g/cm^3) was estimated by calculating the mean measurements in each class per species. Because specific gravity values of class 2 and 3 for *P. taeda* overlapped, their values were pooled for a calculated mean. Specific gravity values (g/cm^3) of four species, for which dead wood mass was calculated, are listed in Table 1.

Woody vines. I did not find regression equations for *Rhus radicans* (poison ivy) or *Campsis radicans* (trumpet vine), the two most common vines growing in the forest and transitions zones. Because of the magnitude of tree biomass in the forest and tree, shrub, and herbaceous plant contribution in the transition, I believed that vine biomass would be inconsequential to the total site biomass. Therefore, woody vine biomass was not estimated. Instead, I characterized their abundance by counting the number of vines of each species occurring on tree trunks within a 10 m radius plot. Then I expressed species abundance as vines/ha.

Table 1. Dry specific gravity (g/cm^3) for large wood detritus and snags. Shown as mean $\pm$ standard deviation for decay classes 2 and 3. Class 1 values were obtained from Haygreen and Bowyer (1989). The specific gravity of *Nyssa sylvatica* was used for *Nyssa biflora* of this study.

Decay Class	*Pinus taeda*	*Juniperus virginiana*	*Prunus virginiana*	*Nyssa sylvatica*
1	0.510	0.470	0.470	0.500
2	0.268 $\pm$ 0.04 (n=6)	0.439 $\pm$ 0.02 (n=2)		
3	0.268 $\pm$ 0.04 (n=6)	0.262 $\pm$ 0.12 (n=4)		

In retrospect, I attempted to estimate vine biomass by using a California study by Gartner (1991) on poison oak (*Toxicodendron diversilobum* L.). The study did not provide a regression equation, but included wood density measurements that I had been unable to find anywhere else. I estimated biomass for the forest only because it had more numerous and larger vines than the transition. I used the wood density of 0.5 g/cm^3 of naturally supported vines and a mean basal diameter of 2 cm from Gartner (1991). Based on my observations at Phillips Creek, I estimated the average vine height to be half of tree height. Therefore, I gave all vines on my forest sites a height of 7 m, determined by taking half of the average tree height in this study. Thus estimated vine biomass was a product of the number of vines in a 10 m radius plot and the assigned vine dimensions. The average contribution of estimated vine biomass to the total biomass of forest sites was 0.4%. The amount of error associated with the vine estimates could not be ascertained. However the 0.4% average contribution was so small that even if it were 1%, vine biomass was unimportant to the overall aboveground biomass of the forest.

<u>Shrub regression equations</u>. A range of size classes of *Myrica cerifera*, *Baccharis halimifolia,* and *Iva frutescens* shrubs were harvested on the eastern shore of Virginia to develop regression equations to estimate biomass from basal and crown diameters and from height. Measurements were recorded for each specimen before cutting. Sometimes basal diameter was not attainable due to multiple basal stems, especially for *Iva*. Shrubs were placed in labeled plastic garbage bags.

At the lab, shrubs were cut to fit into preweighed, labeled paper bags. They were then placed in a large drying oven 85^{o}C for 4 or 5 d until there was no further weight loss. Dried shrubs were weighed to the nearest 0.01 g, and heavier shrubs to the nearest 100 g. A simple linear regression was created for each shrub species using the Microsoft Excel 97 statistical package. Biomass was the dependent variable (y) with height, crown diameter, and basal diameter as the independent variables (x). Biomass was matched with each independent variable to see which one yielded the highest R^2. With *Iva frutescens* only, the regression line was forced through the origin for both independent variables (crown diameter and shrub height), so that the resulting equations would give positive values. Though the regression which used shrub height had the lower R^2 value, its equation gave positive biomass values (g) for smaller shrubs (<75 cm height) (Table 2).

Tree biomass estimations. In my literature review of tree biomass studies, I discovered that multiple regression equations were derived from above-stump biomass of harvested tree species, and that their methods excluded the stump height of 6 to 21 cm (Nelson and Switzer 1975, Clark et al. 1983, Van Lear et al. 1984). Therefore, my tree biomass estimations (kg) using equations from the literature exclude stump biomass. The independent variables used to predict above-stump biomass (kg) are dbh for *J. virginiana* (Schnell 1976), and both dbh and height for *P. taeda* and hardwood species (Nelson and Switzer 1975, Clark et al. 1983)

Tree heights less than 10 m were estimated with a 1.5 m PVC pole by placing the pole against the tree for a sight estimate of the number of pole lengths to the tree top. Taller tree heights were estimated with aid of a clinometer that measured angles in percent degrees at a measured horizontal distance from the tree. Calculations were made using the following formula obtained from a forestry catalogue for level sites: tree height (ft) = (% degree of tree top + % degree of tree base) * distance (ft) from base of tree. For example, at a distance of 85 ft from tree base, the tree top angle is 80%

Table 2. Shrub regressions developed to estimate biomass (kg) of *Myrica cerifera*, *Iva frutescens,* and *Baccharis halimifolia*.

Species	X-variable	Equation	R^2
M. cerifera	BD (cm)	Y = 0.9034X - 1.7367	0.90
I. frutescens	Height (m)	Y = 0.686X	0.63
	CD (m)	Y = 0.9184X	0.69
B. halimifolia	BD (cm)	Y = 0.2806X - 0.3843	0.85
	CD (m)	Y = 1.6608X - 0.4613	0.90

Abbreviations are as follows: BD = basal diameter and CD = crown diameter.

degrees and the base angle is 5% degrees. The equation would yield the following results: (0.80 + 0.05) * 80 ft. = 68 ft.

Biomass estimates for *J. virginiana* came from a study by Schnell (1976) conducted in eastern and middle Tennessee. Since regression coefficients were not included with the regression equation in the publication, Schnell's (1976) table of computed dry weights for a dbh range of 5 to 20 inches were used (Table 3). Because most *J. virginiana* on the study area were between 2 and 7 cm dbh, I harvested three *J. virginiana* trees in that size range from the eastern shore of Virginia. A simple linear regression equation was developed using dbh and biomass data from the harvested trees, and included the biomass of a 5 inch red cedar from Schnell's study (1976). Thus, the biomass of 1 to 5 inch size class was estimated with the following equation: Y (biomass kg) = 3.0318 X (R^2 = 0.77), where X = dbh (cm).

For *P. taeda* biomass estimations, a multiple regression equation was chosen from a study by Nelson and Switzer (1975) performed on 50-year old natural stands of loblolly pine growing on good and poor sites in Mississippi. Nelson and Switzer derived one regression formula for their sites, but the coefficients vary according to site index. Therefore, I used the coefficients for good sites to estimate tree biomass in the forest, and poor site coefficients for trees in the transition zone (Table 4).

For hardwood tree species, I used multiple regression equations from a study by Clark et al. (1983). Their study derived regression equations to predict weight and volume for major Coastal Plain hardwood species of all size classes in the southeastern USA. The two regression equations employed in this study incorporate dbh and total height as the independent variables to predict total tree dry weight (Tables 5 and 6).

Table 3. *Juniperus virginiana* estimated dry mass based on dbh (From Schnell 1976).

Dbh		Tree Mass	
inches	cm	lbs	kg
5	13	109	49.4
6	15	164	74.4
7	18	231	104.8
8	20	310	140.6
9	23	404	183.3
10	25	511	231.8
11	28	770	349.3
13	33	922	418.2
14	36	1090	494.4
15	38	1275	578.3
16	41	1475	669.1
17	43	1693	767.9
18	46	1929	875.0
13	48	2181	990.0
20	51	2452	1112.2

Table 4. *Pinus taeda* regression coefficients and equation for estimating tree biomass. (adapted from Nelson and Switzer,

Coefficients	a	b	c
Good sites	0.0808	2.6774	0.7744
Poor sites	0.0158	2.6435	1.0119
Equation	Log Weight (lbs) = a + b Log dbh (in) + c Log Height (ft) (R^2 = 0.99)		

Antilog of computed answer yields weight (lbs).

Table 5 and 6

Table 5. Hardwood species biomass regression equation and species specific coefficients for species less than 11 inch dbh (adapted from Clark et al. 1983). Coefficients of *Nyssa sylvatica* were used for *Nyssa bilfora* of this study.

Species < 11 in.	a	b
Liquidamber styraciflua	0.13234	0.94165
Nyssa sylvatica	0.16700	0.92799
All species	0.20334	1.90850
Equation	$Y = dbh^2(in) * Height^b(ft)*a$	

Coefficients of determination $R^2 = 0.99$

Table 6. Biomass (lbs) regression equation specific for *Nyssa sylvatica* greater than 11 inches dbh (adapted from Clark et al. 1983). This equation was used to estimate *Nyssa bilfora* biomass (kg) of this study.

Species > 11 in.	a	b	c
Nyssa sylvatica	0.6657	1.11305	0.92799
Equation	$Y = a(dbh^2(in))^b * Height^c$ (ft)		

Coefficient of determination $R^2 = 0.99$

Accuracy of tree biomass estimates. Under and over estimates could have been made on vegetation biomass using regression equations depending on the standard error associated with the equations. Standard errors were listed in the biomass studies by Clark et al. (1983) on coastal hardwoods and Kapeluck and Van Lear (1995) on *P. taeda* roots. Using the standard error terms (0.08 and 0.11 lbs) associated with specific hardwood tree regressions, I calculated the mean standard error (MSE) of hardwood trees at each site. Using the MSE, the upper and lower limit of tree biomass (kg) per site was determined. The MSE associated with hardwood tree biomass was so small that it did not change the tree biomass estimate expressed as kg/m^2 at any site. Unfortunately, regression standard errors were not listed in the biomass study of *P. taeda* (Nelson and Switzer 1975) or in the *Juniperus virginiana* study by Schnell (1976) who also failed to report a R^2 value for the equation. However, the *P. taeda* multiple regression for both good and poor sites has an $R^2 = 0.99$ which would indicate small regression errors. Because *P. taeda* and hardwoods are the most numerous tree species in the forest, the cumulative MSE associated with tree regressions probably remains small. On the other hand, the MSE of transition tree biomass remains unknown, because that zone is only comprised of *P. taeda* and *J. virginiana* tree species. .

Stump biomass of trees was estimated to determine if significant underestimates of tree biomass had been made using the above- stump regressions. Late in my the field study, I had measured basal diameters at 3-8 cm aboveground depending on tree size on a subsample of trees from the forest sites. I calculated differences between dbh and basal diameters of measured trees, and distinguished three categories of differences in basal diameters based on dbh. I added the diameter difference to dbh (i.e., 2 cm to a 3 cm dbh; 4 cm to $\leq$ 25 cm dbh; 12 cm to > 25 cm dbh) to produce a basal diameter for all trees. Based on a study by Clark et al. (1983) that reported stump heights of harvested trees, I assigned tree stump heights (6 cm stump for dbh $\leq$ 12 cm and 15 cm stump for dbh > 12 cm) to all trees in forest and transition zones. I used stump dimensions and specific gravity of tree species to estimate stump biomass for forest and transition sites. The difference between tree biomass (kg/m^2) with and without stump was 2.3% and 2.6% for forest and transition zones, respectively. Because stump contributions did not change tree biomass (kg/m^2), I chose not to add to the regression estimates.

Belowground Organic Matter

Soil organic matter was sampled and processed for macroorganic matter (MOM) > 1 mm, and total soil organic matter (TOM). MOM consisted of herbaceous and woody roots and detritus, depending on zone. Also, MOM (kg/m^2) was comprised of mixed species, except for the majority of sample sites in the low marsh zones where monospecific stands of *Spartina alterniflora* were growing. TOM (kg/m^2) was estimated from cores that were collected at depths that encompassed the majority of soil organic matter and fine roots for each zone. For tidal creek and marsh zones, a 30 cm depth was usually sufficient. In the transition zone which had soils saturated at or near the surface, a 30 cm core depth captured the majority of fine roots, and large root biomass (> 0.6 cm) of *Pinus taeda* was estimated using a regression. For the forest, TOM was the sum of organic matter from 30 cm soil cores, large root biomass (estimated for *P*. taeda), and fine root biomass of 30 to 50 cm MOM cores. For the forest zone, I found that the majority of fine root biomass occurred within 40 cm of the ground surface. The techniques used for extraction and processing of MOM and TOM cores are explained below.

<u>Marsh Zones and Tidal Creek</u>

Soil cores were extracted with a 7.6 cm diameter aluminum corer, similar to the one constructed by Gallagher (1974). Two 30 cm cores per sample site were taken at a depth that would encompass the majority of the rooting depth and soil organic matter. Core length and depth of soil organic matter was measured in the field. When organic rich soil exceeded the depth of 30 cm (which occurred at five sampling points), a McCauley peat sampler was used to determine to what depth it continued. A change in soil texture from the lightweight spongy organic matter to a heavier dark silty layer was considered the cut-off point for soil organic matter depth. Determining the cut-off point was sometimes difficult because a change in texture, interpreted as a silty mineral soil, in some cases proved to be highly decomposed organic rich soil (ascertained from loss on ignition). As a result, depth of soil organic matter was underestimated for approximately five high marsh sites.

Two cores were extracted per sampling point where vegetation previously had been harvested. All cores were measured upon extraction for total length, and depth of soil organic matter. My original intent was to obtain at least 30 cm depth per core. This was not always possible in the marsh zones, because some cores broke off during extraction, and reinsertion of coring device to obtain remainder of core was unsuccessful. On the other hand, six cores, each approximately 30 cm in length, were extracted from a 5 m^2 area within the creek channel at low tide. All cores were wrapped in labeled aluminum foil after measurements were obtained, and subsequently stored in a lab freezer at -4^{o} C until further processing.

Transition and Forest

Two cores were extracted from each of the five, 1 m^2 quadrats where live vegetation and surface litter had previously been harvested. A 6.8 cm bucket auger was used because heavy clay soils would have made coring extremely difficult and time consuming. The auger bucket was marked at 10, 20, 30, and 50 cm intervals to estimate sample depth. Hole depths also were measured for more exact estimates of core length. Core volumes, needed for bulk density calculations, could not be determined using the diameter of the bucket auger. Therefore, diameter and depth measurements were obtained from numerous holes augured to a depth of 30 cm in the transition and forest zones. The hole diameter was measured at 10 cm increments to a depth of 30 cm. The mean diameter was calculated for each depth. An ANOVA was used to calculate the difference between mean hole diameters for all depths. Since differences were insignificant ($p > 0.05$), the mean diameter of 8.2 cm was used to calculate the volume for every augured soil increment.

Bulk density samples were collected to a 30 cm depth at 10 cm intervals, and placed in labeled plastic bags. MOM samples in the transition also were collected to a total depth of 30 cm. This was not the case for the forest, where samples were collected to a total depth of 50 cm to capture most of the fine rooting depth. This was performed at 10 cm intervals to a depth of 30 cm, then followed by a 20 cm (30-50 cm) interval. All soil samples were later stored at -4^{o} C.

In the forest, depth (cm) of the organic horizon (litter layer had been removed) was measured from the sides of the augured holes by using visual and tactile approximation of change in soil texture and a centimeter ruler. This technique was not practical for the transition zone, because the depth of the organic horizon was too great to be assessed in the same manner. Therefore, depth to gray mineral soil was approximated from the augered soil samples. A mean depth was determined for each site by averaging measurements obtained within the five quadrats.

Loblolly Pine Root Regression

Kapeluck and Van Lear (1995) provided the only available regression equations for predicting total below stump dry biomass (kg) of roots > 0.06 cm diameter for *P. taeda*. The study was conducted on an eroded site in the piedmont region of South Carolina. The regression equation, coefficients and correction factor (CF) are: dry root biomass = $a * CF * dbh^{b}$ ($R^2 = 0.95$), where a = 0.0152, b = 2.5535, and CF = 1.0139.

The regression standard error for *P. taeda* tree roots (> 0.6 cm) was 0.07 kg. I calculated the mean standard error for each forest site, and found the error term too small to change the root biomass (kg/m^2) estimate of any forest site. I did not calculate the mean standard error for transition sites, because the *P*. *taeda* tree root biomass (kg/m^2) contributed only 2.8% to the grand total belowground mass of the forest zone. Overall, large root biomass was underestimated for both forest and transition zones for lack of regressions on hardwood species, *J*. *virginiana,* and shrubs, and to what extent is uncertain.

Laboratory Processing of Soil Cores

One core from each sample site within the low and high marsh zones was processed to determine bulk density, total organic matter, and total organic carbon. This core was divided into 10 cm segments (0-10, 10-20, and 20-30 cm). However, some cores fell short of having the full three segments. If a segment was less than 10 cm, it was still processed, and the actual length recorded for volume calculations.

Each segment was placed in a preweighed, numbered aluminum pan, and the sample ID was recorded. Samples were placed in a drying oven at 100°C, or 85°C if sharing the oven with vegetation samples (to prevent charring of vegetation), until which time there was no further weight loss, usually 4-5 d. Oven-dried cores were weighed to 0.01 g, and weights recorded. Core dry weights and volumes were used to determine bulk density (g/cm^3).

Following weighing, the cores were pulverized into a fine powder using a mortar and pestle. Coarse roots were separated from the powder and later ground using a Wiley mill with a 40-mesh screen. This root material was reintroduced to the soil and stirred to create a homogenous sample. This mixture was subsampled and stored in labeled plastic bottles. These samples were analyzed for loss on ignition (LOI) and total organic carbon (TOC).

Transition and forest bulk density samples were treated in the same fashion, except the soil samples had already been separated into segments in the field. Also, the transition samples, 10-20 and 20-30 cm, were partially pulverized and a subsample of 100 ml was taken for grinding into a fine powder. This was done to speed the processing of over 200 samples.

TOC may have been underestimated due to the processing of the soils. Loss of dissolved organic carbon (DOC) found in soil pore water may have occurred during the oven-drying of the soils cores, when it was possible for some of the DOC to volatilize as soil water evaporated. I investigated the possible amount of loss by using data from a study by Aiosa (1996) who measured DOC at Phillips Creek. I used the moisture contents of three high marsh soil samples (0-10 cm) from my study and the DOC value of 55 mg C/L from Aoisa's study (1996) to calculate DOC levels in the soil samples, which is unlikely The estimated quantity of DOC in the three samples ranged from 0.004 - 0.005 kg/m^2. The quantity was minute compared to the TOC content of each sample. The difference in TOC mass would not have exceeded 0.09%, if the total amount of DOC had been lost from the samples.

MOM (Gallagher 1974) was processed from the second core obtained from each sample site in the low and high marsh zones. Each core was divided into 10 cm segments in the same manner as the bulk density samples. Each segment was washed over a 18 mesh (1 mm) brass screen in a laboratory sink until free of sediment. The samples were placed into preweighed, labeled aluminum pan, and dried at 85^{o}C, until no further weight loss occurred, usually 2-3 d.

Forest and transition MOM samples contained pebbles and sand > 1 mm in their mineral soil portion. Thus, an extra washing step was required. This involved placing each washed MOM sample > 10 cm depth into 1 L of water to float the vegetation, and separate the pebbles and sand.

All oven-dried MOM samples were weighed to the nearest 0.01 g, and subsequently ground using a Wiley mill with a 40-mesh screen. Each ground sample was stored in a labeled plastic bottle for LOI analysis.

Laboratory Analyses

Loss on ignition was determined for vegetation and litter, and TOM and MOM samples from all zones. The following procedure was standard for the types of samples mentioned above. Triplicates of ground sample material were weighed to the nearest 0.00001 g. However, some MOM samples were replicated twice or not at all when there was not enough sample material.

Chipped sample material of SW, cones, herbaceous vegetation, all shrub species, and *J. virginiana* underwent LOI. Each component was replicated three or four times, and weighed to the nearest 0.00001 g.

All samples were incinerated at 500^{o}C for 180 min in a muffle furnace, and reweighed to determine ash-free dry weight (AFDW). Percent organic matter (OM) was calculated, and reported.

CHN analyses of soils was necessary to obtain an actual measure of total organic carbon, and thus determine the error in LOI that might have occurred due to loss of structural water in soil samples with high clay content. Fifty soil samples, representative of all zones except the tidal creek, were processed with a Leeman Labs CE 440 CHN analyzer. A simple linear regression was constructed using percent organic carbon (OC) and percent organic matter (OM) from sample data. The slope of the line was 2.09 and $R^2 = 0.99$ with percent OC predicting percent OM. Thus, correction of soil LOI values was not necessary (Figure 5). A curvilinear relationship existed between bulk density (ranging from 0.05-1.75 g/cm^3) and percent OC values obtained from 49 of the CHN samples. This curvilinear relationship was similar to that of Gosselink et al. (1984), except that their study estimated bulk density from OC values. Using SPSS 6.1 statistical program, a regression was formulated using a cubic line as the best fit ($R^2 = 0.91$) (Figure 6). The following cubic regression formula was the result: $Y = a + b_1X + b_2X^2 + b_3X^3$ (SE = 2.7), where Y = percent OC, X = bulk density, a = 39.74, $b_1 = -98.90$, $b_2 = 85.12$ and $b_3 = -23.96$. This equation appears to be useful for predicting percent OC from a wide range of bulk density values.

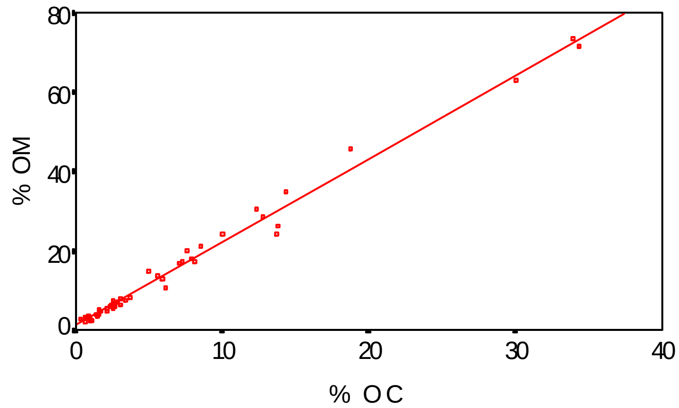

Figure 5. Linear regression of percent organic carbon from CHN analyses plotted against percent organic matter from loss on ignition.

Calculations for Organic and Carbon Mass

For high marsh vegetation, LOI data was similar for *D. spicata*, *S. patens* , *J. roemerianus* (living & dead), and non-woody litter. Therefore, the data were pooled for a mean organic matter (OM) value of 92%. For the low marsh zones, LOI data for *S. alterniflora* (living) had a mean OM value of 83%, and the combination of *S. alterniflora* (dead) and low marsh non-woody litter had a mean OM of 68%. Thus, OM mass (kg/m^2) was the product of mean percent OM and herbaceous vegetation dry mass (kg/m^2). Because herbaceous vegetation and non-woody litter samples from the transition zone did not undergo LOI analyses, the mean of 92% OM for the high marsh was applied to transition herbaceous vegetation and litter. I considered this to be justifiable in that the two zones share many of the same species. Shrubs, forest herbaceous vegetation, and detritus had OM values of 98%. The OM of *J*. *virginiana* was also 98%, and I considered this value to be representative of all tree species.

Total organic matter (TOM) (kg/m^2) for soil samples from all zones was the product of percent TOM, bulk density, and core length. For marsh samples missing an entire 10 cm increment (due to coring difficulties), TOM values (kg/m^2) were assigned that reflected the mean value for zone and depth. Consequently, the following mean TOM values were used: (1) for the high marsh zone, 10-20 cm = 10.95 kg/m^2 and 20-30 cm = 9.25 kg/m^2 (2) for the LMSS zone, 20-30 cm = 7.11 kg/m^2 (3) and, for LMTS, 20 to 30 cm = 6.56 kg/m^2.

MOM oven-dry mass (kg/m^2) equals dry mass (kg) divided by core volume (m^3) and multiplied by core length (m). Subsequently, MOM ash-free dry weight (AFDW) (kg/m^2) was a product of MOM oven-dry mass (kg/m^2) and percent OM. Missing MOM

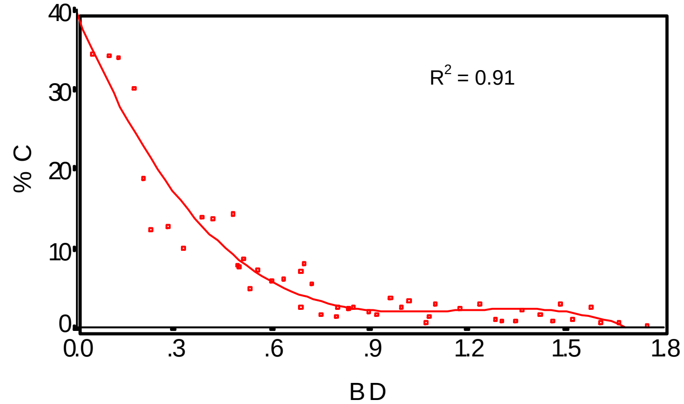

Figure 6. Cubic regression of bulk density predicting percent organic carbon.

increments were dealt with in a similar manner by assigning a mean MOM AFDW value (kg/m^2) based on zone and depth.

Organic carbon mass (kg/m^2) of all vegetation, detritus, and soil MOM and TOM was considered to be 50% of their AFDW (kg/m^2).

Statistical Analyses

I used Microsoft Excel 97 software for descriptive statistics and to develop simple linear regression equations to estimate biomass of shrubs and small *Juniperus virginiana* (< 13 cm dbh). Later I changed to a statistical program (SPSS 6.1) to analyze the relationships of organic carbon and organic matter and bulk density and organic carbon using simple linear and cubic regression analyses (Figures 5 and 6). The SPSS 6.1 statistical program also had the capacity to run one-way ANOVA tests, Kruskall Wallace non-parametric tests, and independent t-tests.

A one-way ANOVA and least significant difference (LSD) posthoc test were used to compare mean above and belowground biomass, OM, and OC mass (kg/m^2) across zones. I chose the LSD test over Tukey or Bonferonni for detecting mean differences, because it is a more powerful analysis for small sample sizes. With every one-way ANOVA test, I ran a test for homogeneity of variance. If the variance was significant, I followed with a Kruskall Wallace nonparametric test to check the validity of the one-way ANOVA results. In all cases the Kruskall Wallace supported the test results of the one-way ANOVA, so I confidently reported the ANOVA test results.

I used independent t-tests to compare mean mass of vegetation components sampled only in the forest and transition zones, such as shrubs, large and small wood detritus, and snags.

RESULTS

GPS Survey

A GPS survey of all sample sites, except the tidal creek, provided coordinates and elevation that were incorporated into a digitized georeferenced aerial photo of the study area (Figure 7). Elevations relative to mean sea level for sites in the five zones were as follows: the five forest sites ranged from 1.20-2.96 m; the 14 transition sites ranged from 0.73-1.24 m; the 25 high marsh sites ranged from 0.70-1.23 m; the nine low marsh short-form *Spartina alterniflora* (LMSS) sites ranged from 0.67-0.85 m; and, the seven low marsh tall-form *Spartina alterniflora* (LMTS) sites ranged from 0.27-0.52 m.

Aboveground Biomass

The organic carbon (OC) mass data of aboveground vegetation, used in one-way ANOVA and independent t-test analyses, were derived from Tables 7a and 7b.
Total aboveground OC mass was highest in the forest and followed by transition, high marsh, LMTS, and LMSS. The tidal creek zone is assumed to be zero because plants were absent. Not surprisingly, the forest OC mass was significantly greater than all other zones, and likewise the transition was significantly greater than the marsh zones ($F_{(4,55)}$, $p = 0.000$). Organic carbon mass was not significantly different among the marsh zones (Figure 8a). The mean OC mass of herbaceous vegetation exhibited a different pattern. The high marsh contained the highest mass followed by transition, LMTS, LMSS, and forest. The forest was significantly less than all zones, except LMSS.

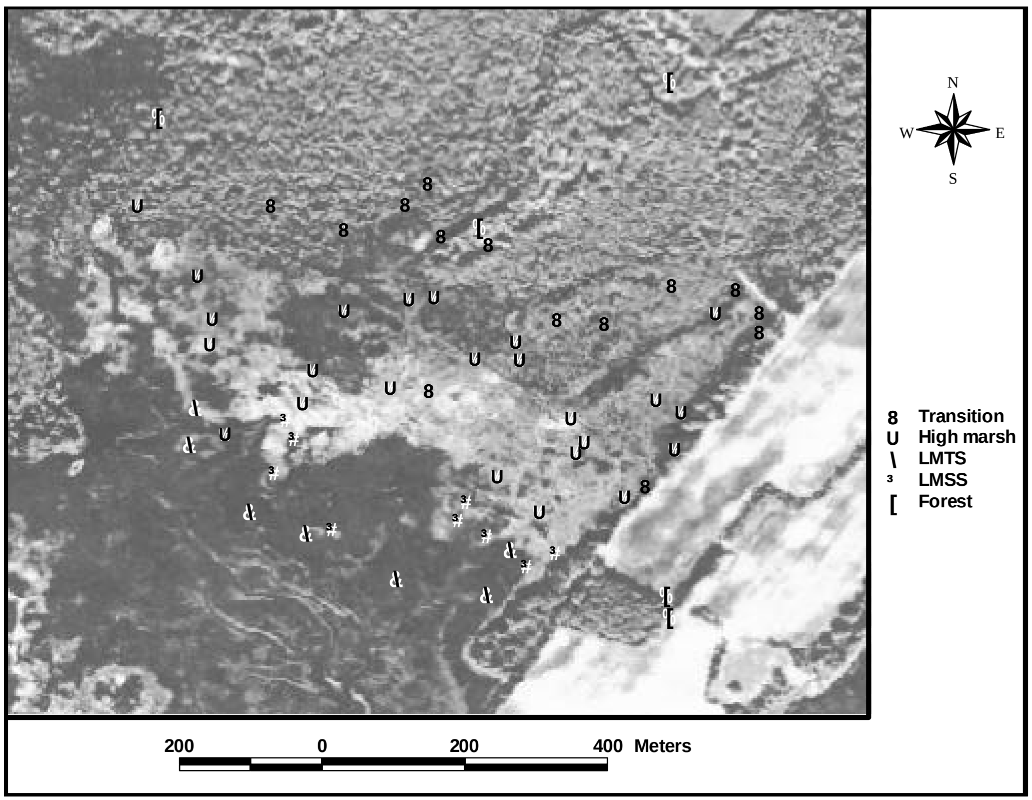

Figure 7. Georeferenced USDA (1990) aerial photograph of Phillips Creek study area displaying sample sites within all zones, except the tidal creek.

Table 7a. Organic carbon mass (kg/m^2) of aboveground vegetation for forest and transition sites shown as mean $\pm$ standard error. Abbreviations: LW = large wood detritus and SW = small wood detritus.

Zone	Site	Trees $\geq$ 2.54 cm dbh	Woody veg. <2.54 cm dbh	Shrubs	Snags	LW	SW	Cones	Herb. Veg.	Herb. Litter	Total
Forest	Fa18	9.04	0.00	0.00	0.00	0.138	0.22	0.075	0.046	1.20	10.73
Forest	Fa30	15.06	0.00	0.00	0.00	0.012	0.06	0.040	0.003	0.90	16.07
Forest	Fb29	9.64	0.00	0.10	0.05	0.000	0.21	0.030	0.015	0.39	10.44
Forest	Fb47	11.59	0.00	0.00	0.65	0.000	0.36	0.023	0.004	0.91	13.54
Forest	Fb65	9.64	0.00	0.09	0.17	0.000	0.19	0.065	0.023	0.85	11.03
Mean		11.0 $\pm$ 1.1	0.00	0.1 $\pm$ 0.1	0.4 $\pm$ 0.3	0.06 $\pm$ 0.06	0.42 $\pm$ 0.09	0.10 $\pm$ 0.02	0.02 $\pm$ 0.01	0.9 $\pm$ 0.1	12.4 $\pm$ 1.1
Transition	Ta1	0.09	0.000	0.02	0.09	0.000	0.001	0.000	0.50	0.14	0.84
Transition	Ta4	0.15	0.000	0.01	0.01	0.050	0.000	0.000	0.56	0.21	0.98
Transition	Ta13	0.11	0.027	0.10	0.03	0.000	0.011	0.001	0.41	0.16	0.84
Transition	Tb29	0.00	0.000	0.11	0.00	0.000	0.000	0.000	0.72	0.07	0.89
Transition	Tc2	0.14	0.000	0.02	0.01	0.000	0.007	0.000	0.45	0.15	0.77
Transition	Tc8	2.58	0.003	0.48	0.09	0.025	0.129	0.001	0.28	0.32	3.90
Transition	Tc18	1.30	0.000	0.39	0.08	0.005	0.051	0.000	0.52	0.10	2.45
Transition	Tc31	0.31	0.000	0.02	0.20	0.012	0.076	0.000	0.25	0.11	0.98
Transition	Td2	1.80	0.000	0.26	0.15	0.105	0.158	0.006	0.37	0.23	3.09
Transition	Td9	1.49	0.000	0.27	0.51	0.041	0.020	0.000	0.53	0.11	2.97
Transition	Td15	2.44	0.000	0.03	0.03	0.093	0.006	0.000	0.45	0.07	3.12
Transition	Td33	0.37	0.000	0.00	0.03	0.000	0.010	0.000	0.47	0.13	1.01
Transition	Td39	2.25	0.000	0.06	0.20	0.093	0.104	0.000	0.37	0.26	3.34
Transition	Td50	0.22	0.000	0.06	0.02	0.000	0.020	0.000	0.74	0.53	1.60
Mean		1.0 $\pm$ 0.3	0.00	0.3 $\pm$ 0.1	0.2 $\pm$ 0.1	0.06 $\pm$ 0.02	0.08 $\pm$ 0.03	0.00	0.47 $\pm$ 0.04	0.3 $\pm$ 0.1	1.9 $\pm$ 0.3

Table 7b. Organic carbon mass (kn/m^2) of aboveground vegetation for sites within the marsh zones shown as mean $\pm$ standard error. Abbreviations are LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *S. alterniflora.*

Zone	Site	Herb. Veg.	Herb. Litter	Total OC
High Marsh	Ha5	0.58	0.13	0.71
High Marsh	Ha14	0.57	0.14	0.71
High Marsh	Ha19	0.33	0.30	0.63
High Marsh	Ha21	0.22	0.16	0.38
High Marsh	Ha36	0.47	0.19	0.66
High Marsh	Ha41	0.42	0.10	0.53
High Marsh	Ha52	0.21	0.01	0.22
High Marsh	Hb1	0.39	0.26	0.65
High Marsh	Hb4	0.49	0.17	0.66
High Marsh	Hc1	0.66	0.11	0.77
High Marsh	Hc30	1.18	0.24	1.42
High Marsh	Hc37	0.02	0.01	0.03
High Marsh	Hc41	0.21	0.23	0.44
High Marsh	Hc42	1.26	0.23	1.50
High Marsh	Hc48	0.69	0.13	0.82
High Marsh	Hc72	0.48	0.11	0.59
High Marsh	Hc75	0.82	0.17	0.99
High Marsh	Hc84	0.32	0.21	0.53
High Marsh	Hc92	0.30	0.15	0.45
High Marsh	Ma1	1.25	0.14	1.38
High Marsh	Ma15	0.70	0.14	0.84
High Marsh	Mc2	0.22	0.08	0.29
High Marsh	Tb4	0.44	0.06	0.50
High Marsh	Tb14	0.37	0.16	0.53
High Marsh	Tb23	0.60	0.12	0.72
Mean		0.53 + 0.06	0.15 + 0.01	0.68 + 0.07
LMSS	LSa8	0.15	0.03	0.18
LMSS	LSa12	0.29	0.04	0.33
LMSS	LSb2	0.22	0.03	0.25
LMSS	LSb16	0.34	0.01	0.35
LMSS	LSb17	0.34	0.14	0.48
LMSS	LSb46	0.25	0.14	0.39
LMSS	LSb53	0.23	0.04	0.27
LMSS	LSb55	0.27	0.06	0.33
LMSS	Mb4	0.17	0.11	0.28
Mean		0.25 + 0.02	0.07 + 0.02	0.32 + 0.03

Table 7b. Completed

Zone	Site	Herb. Veg.	Herb. Litter	Total OC
LMTS	LTS6	0.33	0.00	0.33
LMTS	LTS9	0.43	0.14	0.56
LMTS	LT6	0.67	0.07	0.74
LMTS	LT12	0.61	0.00	0.61
LMTS	LT25	0.46	0.00	0.46
LMTS	LT29	0.22	0.03	0.25
LMTS	LT33	0.48	0.05	0.53
Mean		0.46 + 0.06	0.04 + 0.02	0.50 + 0.06

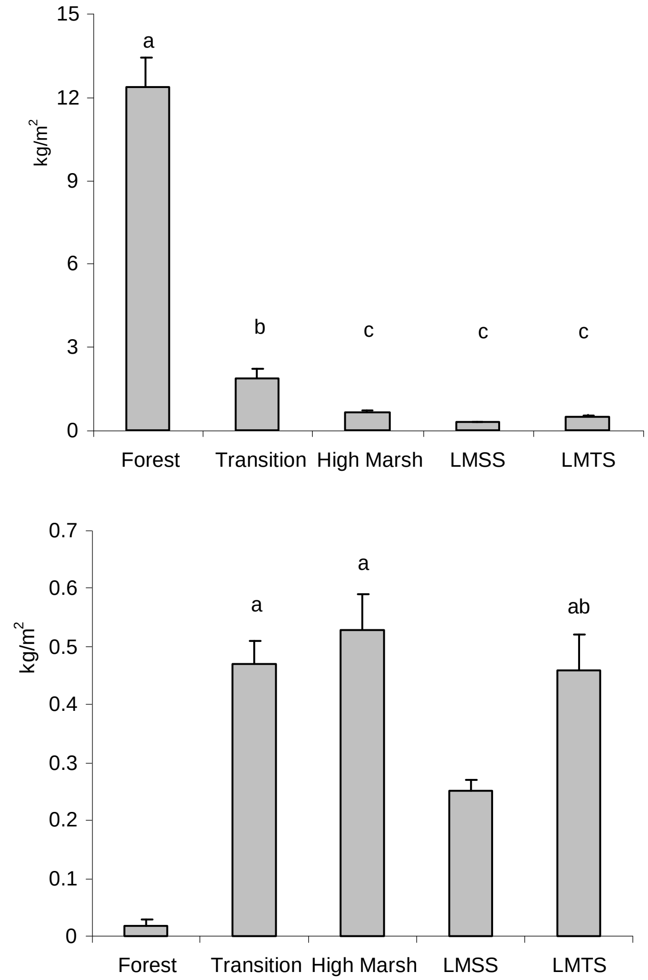

Figure 8. Organic carbon mass of (a) total aboveground vegetation and (b) herbaceous vegetation across zones. Shown with standard error bars. Different letters above the bars indicate significant differences ($F_{(4,55)}$, P = 0.000). LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *S. alterniflora*.

Additionally, the LMSS zone was significantly less than the high marsh and transition ($F_{(4,55)}$, P = 0.000) (Figure 8b).

Shrub OC mass of the transition was higher than the forest, but the difference was insignificant (t (17), P = 0.07) (Figure 9). This result may be due to the fact that eight of the 14 transition sites had few shrubs. Small woody vegetation, comprised of small shrubs (< 2.54 cm basal diameter) harvested at only two transition sites, was not analyzed statistically; however, it was included in the calculation of total aboveground biomass (Table 7a).

Organic carbon mass of herbaceous litter was compared across zones. The forest contained the highest mass followed by transition, high marsh, LMSS, and LMTS. There were significant differences ($F_{(4,55)}$, P< 0.0000) in OC mass (Figure 10). ANOVA results of aboveground vegetation mass compared across five zones were summarized in Table 8.

Organic carbon mass of large wood (LW) and small wood (SW) detritus components was compared between forest and transition zones. The forest exceeded the transition in snag, and snag and LW combined, and the transition was slightly higher in LW. However, the differences were not significant (t-test, 17, P > 0.05), (Figures 11 a, b, and c). In contrast, the forest greatly exceeded the transition in SW (pine cones included) (t-test, 17, P = 0.000) (Figure 12).

The distribution of vegetation mass (kg/m^2) varied across zones (Figure 13). For the forest, the majority of mass was distributed in living trees (90%). Herbaceous litter, SW, and snags combined comprised the remaining 10%. The transition zone was the most evenly distributed: 48% of total biomass in living trees, 28% in herbaceous vegetation, 10% in herbaceous litter, and 12% in the sum of shrubs and snags.

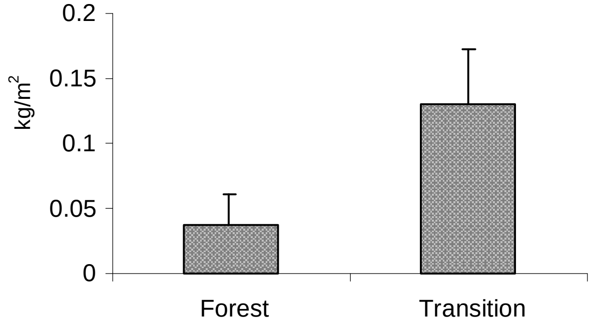

Figure 9. Shrub organic carbon mass of forest and transition zones with standard error bars. The difference is insignificant (t = -1.94, 17, P = 0.07).

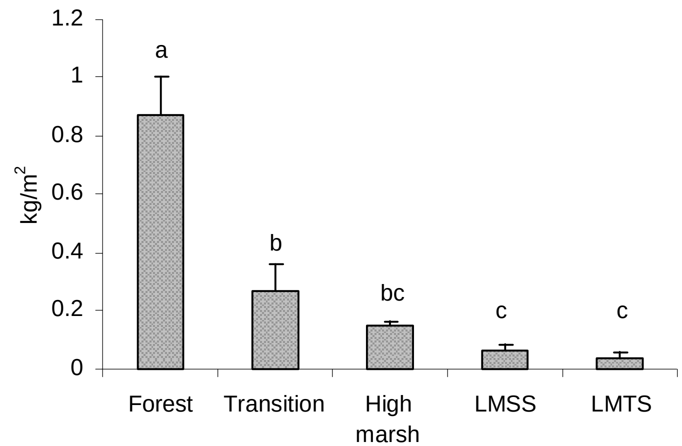

Figure 10. Organic carbon mass of herbaceous litter across zones. Bars with the same letter are not significantly different ($F_{(4,55)}$, p = 0.0000).

Table 8. One-way analysis of variance comparing total vegetation, herbaceous vegetation, and herbaceous litter in three weight categories across five zones.

Factor	Dependent variable	DF_1	DF_2	SS	MS	F	P
Zones 1 to 5[a]	Total vegetation biomass	4	55	2554.82	638.70	189.48	0.0000
	Total vegetation AFDW	4	55	2482.44	620.61	190.54	0.0000
	Total vegetation OC	4	55	620.84	155.21	194.06	0.0000
Zones 1 to 5	Herbaceous vegetation biomass	4	55	6.46	1.61	6.27	0.0003
	Herbaceous vegetation AFDW	4	55	5.60	1.40	6.56	0.0002
	Herbaceous vegetation OC	4	55	1.40	0.35	6.57	0.0002
Zones 1 to 5	Herbaceous litter	4	55	9.97	2.49	42.34	0.0000
	Herbaceous litter AFDW	4	55	10.10	2.53	49.96	0.0000
	Herbaceous litter OC	4	55	2.71	0.68	18.75	0.0000

[a] 1 to 5 refer to the following zones: 1 = forest, 2 = transition, 3 = high marsh, 4 = low marsh short-form *Spartina alterniflora*, and 5 = low marsh tall-form *S. alterniflora*.
Abbreviations: AFDW = ash-free dry weight, OC = organic carbon, DF_1 = degrees on freedom in numerator, and DF_2 = degrees of freedom in denominator.

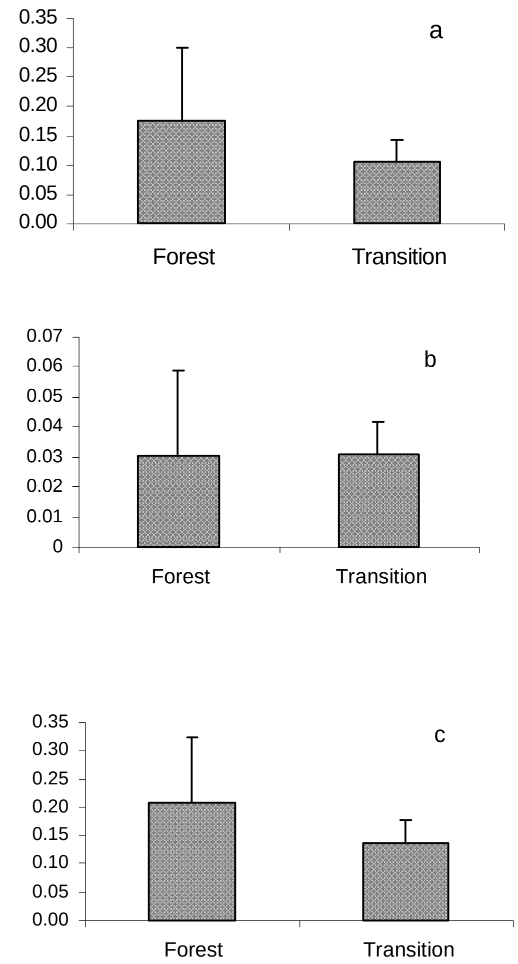

Figure 11. Average organic carbon mass of (a) snags, (b) large wood detritus, and (c) combined snags and large wood detritus of forest and transition zones. Shown with standard error bars. No significant differences with t-tests, df = 17 in all 3 categories.

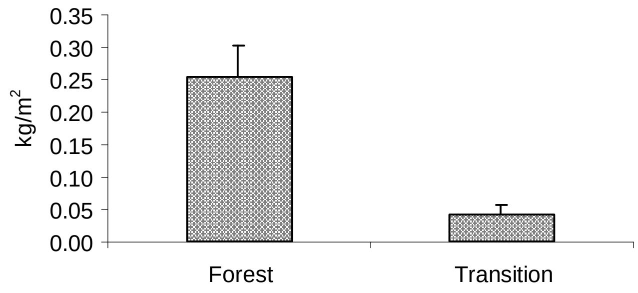

Figure 12. Average organic carbon mass of small wood detritus (pine cones included) compared between two zones. Displayed with standard error bars. Differences were highly significant (t = 5.83, 17, P = 0.000).

As expected for the marsh zones, greater than 75% of total biomass was standing herbaceous vegetation and less than 25% in litter. The high marsh contained the highest mass followed litter, and 12% in the sum of shrubs and snags (Figure 13).

Community Composition

Overall, the forest was dominated by a mature stand of *Pinus taeda*, and an understory of mixed hardwood species. However, two forest sites had hardwood species that shared the canopy with *P. taeda*, and one of these sites was dominated by *Nyssa biflora*. The subcanopy was also comprised of a few scattered *Myrica cerifera* shrubs on wetland sites. The sparse herbaceous layer was dominated by *Smilax* spp. and *Rhus radicans*, and the presence of graminoid species was rare (Table 9). The forest floor was covered by a thick layer of pine needles, leaves, and woody detritus. Bare soil was a rare occurrence.

In general, the transition had few trees limited to *Juniperus virginiana* and *P. taeda*, a frequent occurrence of shrubs relative to other zones, and an abundant mix of brackish and freshwater herbaceous vegetation (Table 9). The transition from forest to high marsh was highly variable among sites. An advanced stage of the transition appeared have high abundance of shrubs with snags but no living trees, or sites with few trees and shrubs situated on hummocks. A less advanced transition were sites dominated by mature *P. taeda* that were stunted, evidenced by a smaller tree dbh and height than *P. taeda* occurring in the forest zone.

Herbaceous species were prevalent throughout the marsh zones. Dominant high marsh species were *Spartina patens*, *Juncus roemerianus,* and *Distichlis spicata*.

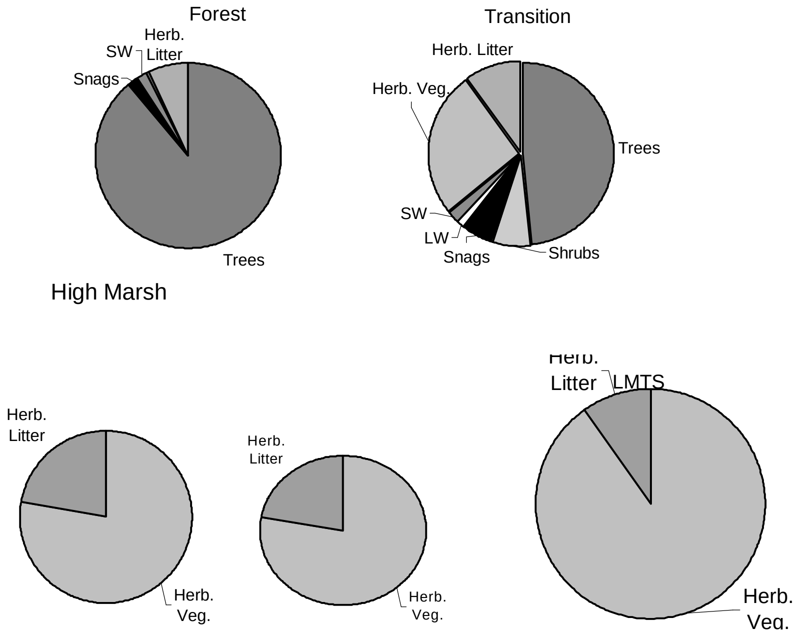

Figure 13. Distribution of vegetation mass within each zone. Any component less than 1% was not represented. LMSS = low marsh short-form S. alterniflora, and LMTS = low marsh tall-form S. alterniflora. SW = small wood detritus, LW = large wood detritus, and Herb.Veg. = herbaceous vegetation.

Table 9. Vascular plant species of Phillips Creek. Zones are designated by: F=forest, T=transition, HM= high marsh, LMSS=low marsh short-form *Spartina*, LMTS= low marsh tall-form *Spartina*. Nomenclature follows Gleason and Cronquist (1991).

		Zone				
Family / Species	Common Name	F	T	HM	LMSS	LMTS
Poaceae						
Panicum virgatum L.	Switch grass	X	X			
Setaria genticulata Beauv.	Saltmarsh foxtail grass		X			
Spartina patens (Aiton) Muhl	Saltmeadow hay		X	X		
Distichlis spicata (L.) Greene	Salt grass		X	X	X	
Spartina alterniflora Loisel	Saltmarsh cordgrass			X	X	X
Phragmites australis (Cav.) Trin.	Reed grass			X		
Asteraceae						
Aster tenuifolius L.	Saltmarsh aster			X		
Solidago spp.	Goldenrod		X			
Borrichia frutescens L.	Sea oxeye			X		
Pluchea purpurascens (SW)DC.	Saltmarsh fleabane		X	X		
Baccharis halimifolia L.	Groundsel tree		X			
Iva frutescens L.	Marsh elder		X	X		
Juncaceae						
Juncus roemerianus Scheele	Black needlerush		X	X	X	
Typhaceae						
Typha augustifolia L.	Narrow-leaved cattail		X			
Smilicaceae						
Smilax bona-nox L.	Fringed greenbrier	X				
Smilax glauca Walt	Sawbrier	X				
Cyperaceae						
Fimbristylis castanea (Michx.) Vahl.	Marsh fimbristylis		X	X		
Scirpus olneyi Gray	AmericanThree-square		X			
Scirpus robustus Pursh	Saltmarsh bulrush		X			
Eleocharis spp	Spike-rush		X			
Gentianaceae						
Limonium carolinianum (Walt.) Britt.	Sea lavender			X		
Chenopodiaceae						
Salicornia europaea L.	Saltwort				X	
Scrophulariaceae						
Agalinis spp.	Gerardia			X		
Myricaceae						
Myrica cerifera L.	Wax myrtle	X	X			

Table 9. Completed.

Family / Species	Common Name	Zone F	T	HM	LMSS	LMTS
Malvaceae						
Hibiscus moscheutos L.	Marsh hibiscus		X			
Kosteletzkya virginica (L.) Perl.	Marsh mallow		X			
Pinaceae						
Pinus taeda L.	Loblolly pine	X	X			
Cupressaceae						
Juniperus virginiana L.	Red cedar	X	X			
Rosaceae						
Prunus serotina Ehrh.	Black cherry	X				
Hamamelidaceae						
Liquidambar styraciflua L.	Sweetgum	X				
Nyssaceae						
Nyssa biflora (Walter) Sargent	Swamp blackgum	X				
Aquifoliaceae						
Ilex opaca Aiton	American holly	X				
Fagaceae						
Quercus phellos L.	Willow oak	X				
Ulmaceae						
Celtis laevigata Willd.	Hackberry	X				
Araliaceae						
Aralia spinosa L.	Hercules' club	X				
Anacardiaceae						
Rhus radicans L.	Poison ivy	X	X			
Bignoniaceae						
Campsis radicans (L.) Seem	Trumpet vine	X				
Rubiaceae						
Mitchella repens L.	Partridge berry	X				
Aceraceae						
Acer rubrum L.	Red maple	X				
Totals	39 Species	17	21	11	3	1

Also found in the high marsh was an occasional occurrence of live and dead shrubs, and tree snags. However, high shrub frequency (44 within a 5 m radius) occurred at one high marsh site. This anomaly may be partly explained by an abundance of fiddler crab burrows that aerate the soil and raised the soil surface elevation. The low marsh zones were dominated by *S. alterniflora,* but other herbaceous species were found there, including a patch of *J. roemerianus* (Table 9).

The transition zone with 21 species was higher in species richness than the forest with 17, but the forest had twice the number of woody species (Table 9). The loss of woody biomass in the transition also was reflected in tree basal area, and tree and woody vine densities. Tree basal area of the forest was 8 times greater, and stem density was 1.5 times greater than the transition (Tables 10 and 11). In addition, *Campsis radicans,* found in all forest sites, was absent in the transition, and *Rhus radicans* vines dropped sharply from a range of 318-2737 to 0-688 vines/ha (Table 12).

Percent cover of herbaceous species was greatest in the high marsh and transition, and lowest in the forest (Table 12). In the high marsh, *S. patens* and *J. roemerianus* were dominant species providing the highest range of cover (98-100% and 85-100%, respectively). On the other hand, *D. spicata* was a dominant species providing the widest range of coverage in the high marsh, 38 to 100%. *S. alterniflora* was the dominant species in the low marsh zones, but also dominated several high marsh sites. The percent cover range of *S. alterniflora* was lowest for LMTS and greatest for LMSS zone.

Table 10. Forest tree stand table represents all living tree species > 2.54 cm dbh.

Species	Density (stems/ ha)	Relative density	Basal area m^2 / ha	Relative dominance	Frequency	Relative frequency	IV
Pinus taeda	306	31.37	32.23	76.81	1.0	21.74	43
Prunus virginiana	115	11.76	0.49	1.17	0.4	8.70	7
Ilex opaca	115	11.76	0.49	1.17	0.8	17.39	10
Liquidambar styraciflua	76	7.84	1.19	2.84	0.4	8.70	6
Quercus phellos	19	1.96	0.03	0.08	0.4	8.70	4
Aralia spinosa	13	1.31	0.01	0.02	0.2	4.35	2
Celtis laevigata	6	0.65	0.00	0.01	0.2	4.35	2
Juniperus virginiana	140	14.38	2.44	5.81	0.6	13.04	11
Nyssa sylvatica	178	18.30	4.83	11.52	0.4	8.70	13
Acer rubrum	6	0.65	0.24	0.58	0.2	4.35	2
Total	974	100.00	41.97	100.00	4.6	100.00	100

Table 11. Transition tree stand table represents all living tree species > 2.54 cm dbh.

Species	Density (stems/ ha)	Relative Density	Basal area m^2 / ha	Relative dominance	Frequency	Relative frequency	IV
Juniperus virginiana	473	68.44	2.77	54.03	1.0	56.52	60
Pinus taeda	218	31.56	2.36	45.97	0.8	43.48	40
Total	690	100.00	5.14	100.00	1.8	100.00	100

Table 12. Percent cover range of dominant herbaceous species from all sample sites. Abbreviations are LMTS = low marsh tall-form *S. alterniflora* and LMSS = low marsh short-form *S. alterniflora*

Species	LMTS	LMSS	High marsh	Transition	Forest
Spartina patens	-	-	98 to 100	68 to 98	-
Distichlis spicata	-	-	38 to 100	68 to 98	-
Spartina alterniflora	15 to 38	38 to 68	68 to 85	-	-
Juncus roemerianus	-	-	85 to 100	68 to 85	-
Smilax spp.	-	-	-	-	15 to 38
Rhus radicans	-	-	-	-	3 to 15
Mitchella repens	-	-	-	-	3 to 15

Belowground Organic Matter

The depth of organic rich soil (below litter layer) varied with zones. In the forest, the organic rich horizon, comprised of humus, roots and detritus, was approximately 4 to 7 cm thick and overlay a mineral horizon. In transition and high marsh zones, a spongy organic layer derived primarily from dead herbaceous root material (frequently referred to as peat) was found, and depths were highly variable. Transition varied from 5 to 20 cm, and the high marsh varied from 5 to greater than 70 cm. The low marsh zones and tidal creek were comprised of mineral sediment without an accumulated layer of organic rich soil.

Macroorganic Matter (MOM)

MOM carbon mass was compared across five zones for each 10 cm increment and total 30 cm depth, and differences were significant for all depths (Table 13). In the top 10 cm, high marsh and LMSS had greater OC mass than forest, transition, and LMTS zones. At 10 to 20 cm, high marsh, LMSS, and LMTS zones were greater than the transition and forest. At the depth of 20 to 30 cm, MOM OC mass was greater in LMTS and high marsh than all other zones (Figure 14a). At a total depth of 30 cm, MOM OC mass had the following trend: high marsh (3.88 $\pm$ 0.29 kg/m^2) > LMSS (3.54 $\pm$ 0.43 kg/m^2) > LMTS (2.46 $\pm$ 0.33 kg/m^2) > transition (1.93 $\pm$ 0.15 kg/m^2) > forest (1.47 $\pm$ 0.22 kg/m^2) (Figure 14b).

Total Organic Carbon (TOC)

TOC mass was calculated as 50% of total organic matter mass (Table 14). TOC was compared across zones for each 10 cm increment of 30 cm soil cores, and

Table 13. One-way analysis of variance of macroorganic matter (MOM) organic carbon mass compared across five zones.

Factor	Dependent variable	$DF_{(1)}$	$DF_{(2)}$	SS	MS	F	P
Zones 1 to 5[a]	0-10 cm depth	4	52	11.20	2.80	9.11	0.0000
Zones 1 to 5	10-20 cm depth	4	52	7.48	1.87	7.18	0.0001
Zones 1 to 5	20-30 cm depth	4	52	1.63	0.41	3.32	0.0171
Zones 1 to 5	0-30 cm depth	4	53	50.22	12.56	9.97	0.0000

[a] 1 to 5 refers to the following zones: 1 = forest, 2 = transition, 3 = high marsh, 4 = low marsh short-form *Spartina alterniflora* and 5 = low marsh tall-form *Spartina alterniflora*

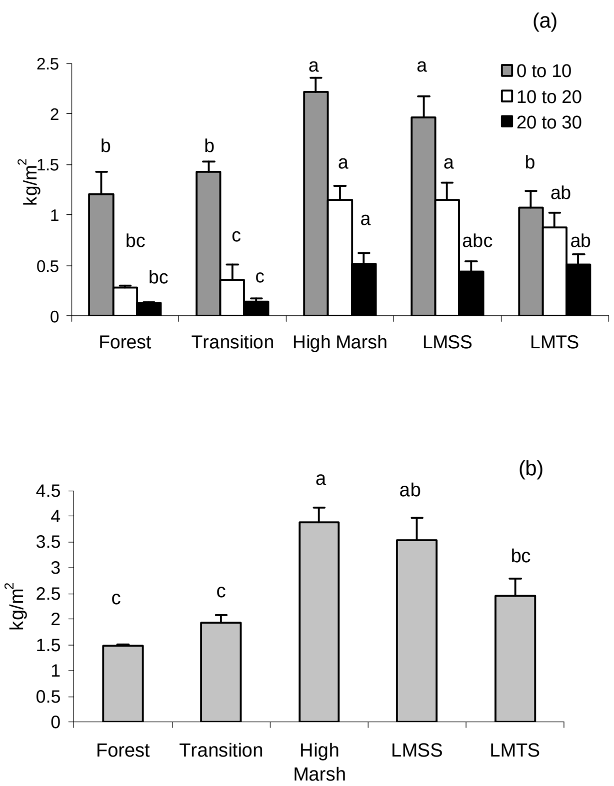

Figure 14. (a) Macroorganic matter (MOM) carbon mass for three soil depths ($F_{(4,52)}$, $P < 0.02$) and (b) MOM carbon mass for total 30 cm depth ($F_{(4, 53)}$, $P = 0.000$). Bar graphs are shown with standard error bars. Significant differences are indicated by different letters above the bars.
LMSS = low marsh short-form *Spartina alterniflora* and
LMTS = low marsh tall-form *S. alterniflora.*

Table 14. Belowground total organic carbon (kg/m^2) in increments of 10 cm expressed as mean $\pm$ standard error for all zones. The grand total includes the carbon mass of woody roots derived from root biomass regression for *Pinus taeda* and forest 30 to 50 cm macroorganic matter samples.

Zone	Site	0 to 10	10 to 20	20 to 30	0 to 30	Woody Roots	Grand Total
Forest	Fa18	4.04	1.93	1.45	7.42	2.37	9.79
Forest	Fa30	6.25	2.64	2.70	11.59	4.14	15.74
Forest	Fb29	4.64	1.71	2.15	8.51	1.60	10.11
Forest	Fb47	4.89	2.65	2.23	9.77	2.43	12.20
Forest	Fb65	5.85	1.86	1.59	9.31	2.75	12.06
Mean $\pm$ SE		5.13 $\pm$ 0.40	2.16 $\pm$ 0.02	2.02 $\pm$ 0.23	9.32 $\pm$ 0.69	2.66 $\pm$ 0.42	11.98 $\pm$ 1.06
Transition	Ta1	4.80	4.41	2.52	15.60	0.00	15.60
Transition	Ta4	4.12	3.64	2.83	10.58	0.00	10.55
Transition	Ta13	5.59	3.65	1.76	11.00	0.00	11.00
Transition	Tb29	7.09	3.38	2.54	13.01	0.00	13.01
Transition	Tc2	4.87	2.87	1.83	9.56	0.01	9.57
Transition	Tc8	5.04	6.08	3.43	14.55	0.68	15.23
Transition	Tc18	4.35	3.60	2.68	10.63	0.01	10.64
Transition	Tc31	4.83	3.27	2.13	10.22	0.00	10.27
Transition	Td2	5.57	3.28	2.12	10.97	0.46	11.43
Transition	Td9	4.43	3.31	1.73	9.46	0.03	9.49
Transition	Td15	3.73	3.04	1.77	8.53	0.11	8.64
Transition	Td33	3.05	3.13	2.71	8.89	0.03	8.92
Transition	Td39	4.11	2.93	2.41	9.44	0.11	9.55
Transition	Td50	3.91	4.88	3.36	12.15	0.02	12.16
Mean $\pm$ SE		4.68 $\pm$ 0.26	3.68 $\pm$ 0.24	2.42 $\pm$ 0.15	10.77 $\pm$ 0.45	0.10 $\pm$ 0.05	10.87 $\pm$ 1.06

Table 14. Continued.

Zone	Site	0 to 10	10 to 20	20 to 30	0 to 30	Grand Total
High marsh	Ha5	7.73	5.44	1.69	14.86	14.86
High marsh	Ha14	6.12	9.29	4.64	20.03	20.03
High marsh	Ha19	1.71	3.40	3.38	8.49	8.49
High marsh	Ha21	3.55	5.48	4.63	13.65	13.65
High marsh	Ha36	4.99	4.80	4.63	14.42	14.42
High marsh	Ha41	5.45	4.45	3.52	13.42	13.42
High marsh	Ha52	4.88	8.36	7.44	20.69	20.69
High marsh	Hb1	4.36	9.71	4.63	18.69	18.69
High marsh	Hb4	4.63	6.44	7.08	18.15	18.15
High marsh	Hc1	5.15	4.82	4.46	14.43	14.43
High marsh	Hc30	3.35	3.90	4.14	11.39	11.39
High marsh	Hc37	3.35	4.02	4.77	12.14	12.14
High marsh	Hc41	3.78	4.53	3.93	12.24	12.24
High marsh	Hc42	4.06	3.80	5.44	13.31	13.31
High marsh	Hc68	4.01	4.54	4.10	12.65	12.65
High marsh	Hc72	3.59	3.72	3.96	11.27	11.27
High marsh	Hc75	5.56	5.24	3.55	14.35	14.35
High marsh	Hc84	4.68	5.84	2.15	12.67	12.67
High marsh	Hc92	5.74	4.97	3.82	14.53	14.53
High marsh	Ma1	3.33	5.24	3.93	13.20	13.20
High marsh	Ma15	3.37	3.55	3.13	10.04	10.04
High marsh	Mc2	5.42	4.03	3.73	13.19	13.19
High marsh	Tb4	3.96	2.41	2.95	9.32	9.32
High marsh	Tb14	3.91	1.71	1.94	7.56	7.56
High marsh	Tb23	4.02	5.00	3.07	12.09	12.09
Mean $\pm$ SE		4.46 $\pm$ 0.25	5.04 $\pm$ 0.39	4.03 $\pm$ 0.28	13.56 $\pm$ 0.67	13.56 $\pm$ 0.67

Table 14. Completed.

Zone	Site	0 to 10	10 to 20	20 to 30	0 to 30	Grand Total
LMSS	LSa8	5.46	4.26	3.56	13.28	13.28
LMSS	LSa12	4.36	3.82	3.56	11.73	11.73
LMSS	LSb2	4.03	4.22	3.89	12.13	12.13
LMSS	LSb16	2.53	2.09	2.44	7.05	7.05
LMSS	LSb17	5.89	3.09	1.96	10.93	10.93
LMSS	LSb46	6.07	4.07	4.06	14.19	14.19
LMSS	LSb53	4.95	3.94	2.77	11.67	11.67
LMSS	LSb54	5.11	4.39	6.23	15.73	15.73
LMSS	Mb4	5.55	4.77	3.56	13.88	13.88
Mean ± SE		4.88 ± 0.37	3.85 ± 0.27	3.56 ± 0.41	12.29 ± 0.82	12.29 ± 0.82
LMTS	LT6	4.20	4.10	3.98	12.28	12.28
LMTS	LT12	3.29	3.71	3.28	10.27	10.27
LMTS	LT25	3.69	2.77	3.46	9.93	9.93
LMTS	LT29	4.41	4.39	3.28	12.08	12.08
LMTS	LT33	2.32	2.94	1.69	6.96	6.96
LMTS	LTS6	4.69	4.02	3.28	11.99	11.99
LMTS	LTS9	4.03	3.99	3.97	11.99	11.99
Mean ± SE		3.80 ± 0.30	3.70 ± 0.23	3.28 ± 0.29	10.79 ± 0.73	10.79 ± 0.73
Tidal Creek	C1	3.49	2.71	2.63	8.83	8.83
Tidal Creek	C2	2.65	3.38	3.16	9.19	9.19
Tidal Creek	C3	3.02	2.27	2.90	8.20	8.20
Mean ± SE		3.05 ± 0.24	2.79 ± 0.32	2.90 ± 0.15	8.74 ± 0.29	8.74 ± 0.29

for total 30 cm depth (Figure 15a). Soil TOC to a 30 cm depth had the following trend (mean ± SE): high marsh (13.6 ± 0.69 kg/m^2) > LMSS (12.3 ± 0.82 kg/m^2) > transition (10.8 ± 0.45 kg/m^2) = LMTS (10.8 ± 0.73 kg/m^2) > forest (9.3 ± 0.69 kg/m^2) > tidal creek (8.7 ± 0.29 kg/m^2).

As mentioned earlier, the grand total of soil TOC was derived from 30 cm soil cores, 30-50 cm forest MOM cores, and regression estimates of *P. taeda* root biomass. TOC grand total had a different zone pattern than the 30 cm total. Expressed as mean ± SE: high marsh (13.6 ± 0.67 kg/m^2) > LMSS (12.3 ± 0.82 kg/m^2) > forest (12.0 ± 1.06 kg/m^2) > transition (11.1 ± 0.47 kg/m^2) > LMTS (10.8 ± 0.73 kg/m^2) > tidal creek (8.7 ± 0.29 kg/m^2) (Figure 15b). Table 15 summarizes the ANOVA results of soil TOC.

Another question pursued was what percentage of TOC is MOM OC (from 30 cm soil cores). The mean percentage was calculated for five zones, which had both TOC and MOM OC estimations. High marsh and LMSS zones were highest at 30 and 29%, respectively. LMTS and transition followed at 23% and 18%, and lastly, forest at 16%. For all zones, the percentage of MOM OC decreased with depth (Figure 16).

Combined Above and Belowground

The total aboveground OC and the belowground grand total were combined for each site. The sum of above and belowground OC mass for each zone expressed as mean ± SE was as follows: forest (24.3 ± 2.11 kg/m^2) > high marsh (14.2 ± 0.65 kg/m^2) > transition (12.8 ± 0.60 kg/m^2) = LMSS (12.6 ± 0.82 kg/m^2) > LMTS (11.3 ± 0.72 kg/m^2) > tidal creek (8.7 ± 0.29 kg/m^2). As expected, forest OC mass greatly exceeded the other zones (Figure 17). These mean values are the estimated present day OC standing stock for each zone at Phillips Creek, and provide the information needed in the state

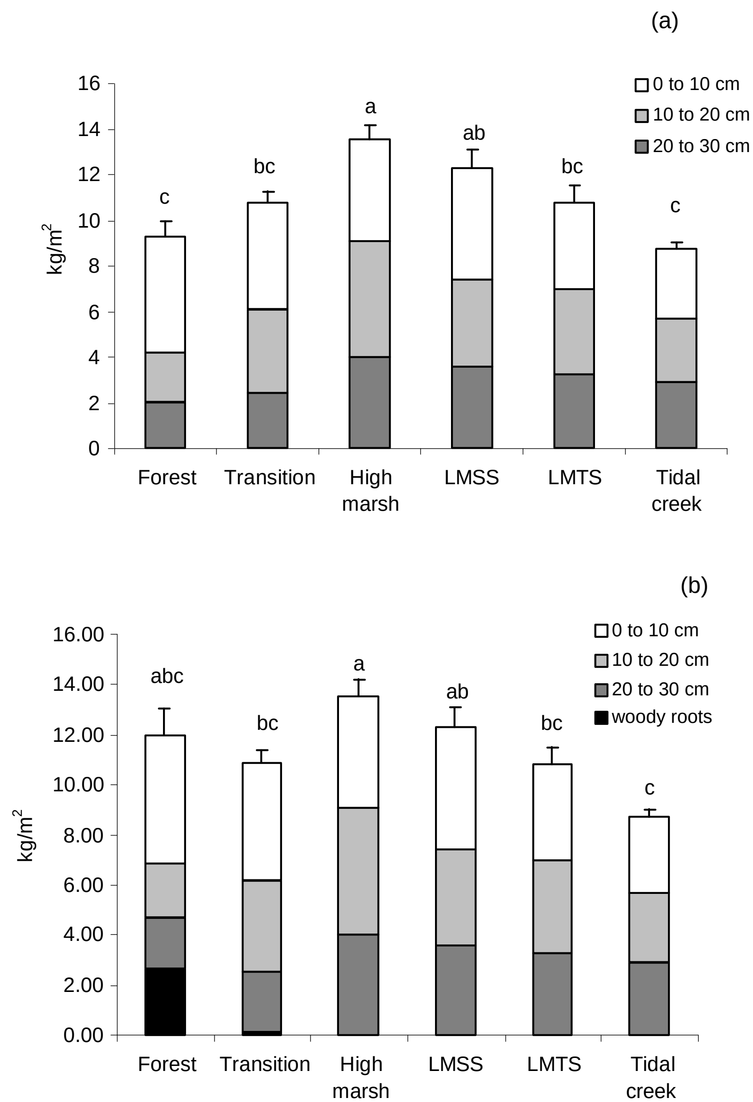

Figure 15. Belowground organic carbon from (a) 30 cm soil depth compared across zones ($F_{(5,56)}$, P = 0.001), and (b) a grand total which is the sum of 30 cm depth and woody roots (derived from *P. taeda* root regression and 30-50 cm MOM cores), ($F_{(5,56)}$, P = 0.009). Significance indicated by different letters above bars.

Table 15. One-way analysis of variance of total soil organic carbon compared across six zones. All depths represented.

Factor	Dependent	$DF_{(1)}$	$DF_{(2)}$	SS	MS	F	P
Zones 1 to 6[a]	0-10 cm depth	5	56	13.46	2.69	2.36	0.0519
Zones 1 to 6	10-20 cm depth	5	56	49.37	9.87	5.43	0.0004
Zones 1 to 6	20-30 cm depth	5	56	33.02	6.60	5.85	0.0002
Zones 1 to 6	Total 0-30 cm	5	56	157.55	31.51	4.81	0.0010
Zones 1 to 6	Grand total	5	56	118.87	23.77	3.46	0.0086

[a] 1 to 6 refers to the following: 1 = forest, 2 = transition, 3 = high marsh, 4 = low marsh short-form *Spartina alterniflora,* 5 = low marsh tall-form *S. alterniflora,* and 6 = tidal

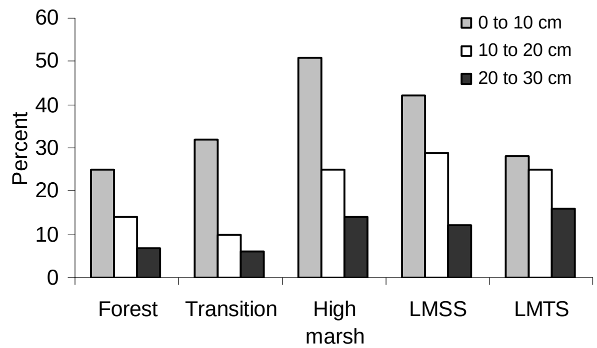

Figure 16. Percent MOM carbon mass of total organic carbon mass from 30 cm soil cores. Shown per unit depth across zones. LMSS = low marsh short-form *S. alterniflora* and LMTS = low marsh tall-form *S. alterniflora.*

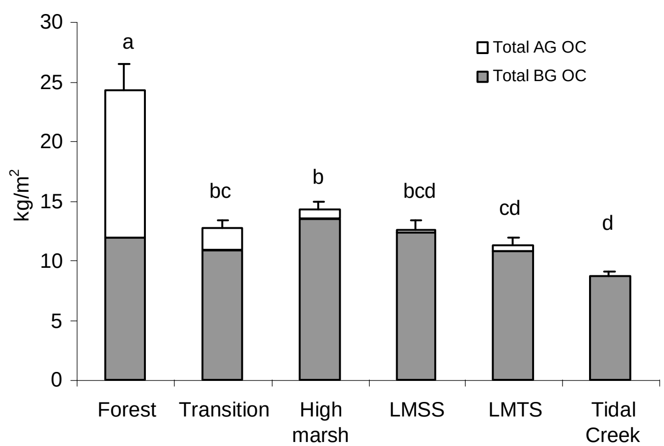

Figure 17. Sum of total above and belowground organic carbon compared across zones. Shown with standard error bars. Significance indicated by different letters above the bars ($F_{(5,57)}$, P = 0.0000). Zone abbreviations are explained in Figure 16.

change model (Brinson et al. 1995) to address changes in organic matter distribution and turnover rates that are influenced by rising sea level.

DISCUSSION

The main objectives of this study were to quantify and characterize above and belowground organic matter within each ecosystem state from forest to tidal creek, and to incorporate the organic carbon estimates into the state change model by Brinson et al. (1995). To achieve this, I quantified aboveground vegetation and detritus using harvest methods, and indirectly using regression equations and dimensional analysis. I also quantified belowground organic matter from soil cores, and by using r egression analyses for woody roots (>0.6 cm) of *P. taeda*.

In this section, I will compare qualitative and quantitative data from this study with other studies, and revisit my original hypothesis for Phillips Creek. Using data gathered in this study, I wi ll estimate gains and losses of organic carbon stock associated with state change. Finally, I will estimate organic carbon turnover rates of ecosystem states for different slope profiles at Phillips Creek. For the remainder of the discussion I will be referring to organic carbon simply as carbon

Comparison With Other Coastal Marshes

The aboveground characteristics of the various states (zones) in the present study are consistent with a study by Ricker (1999) of the Virginia Coast Reserve (VCR) megasite, which consists of an area on the eastern shore of Virginia extending from Cape Charles to Wallops Island. Similar characteristics include: (1) a forest zone with a dominant cover of tree species, few shrubs, and little herbaceous groundcover, (2) a transition that has fewer, smaller trees comprised of two species *P. taeda,* and *J. virginiana*, and more shrubs, snags and halophytic and glycophytic grasses, and (3) marsh zones that are dominated by salt tolerant herbaceous species. Distribution of plant biomass reflects the community composition of each zone. In the forest zone, living trees contribute the majority of biomass (90%). In the transition zone, the percentage of tree biomass declines (48%) and herbaceous vegetation, shrub, and snag mass contributions rise. In the marsh zones, saltmarsh vegetation comprises 100% of the biomass.

Within the 56 ha study area at Phillips Creek, approximately 52% of the land area was forest, 11% transition, 24% high marsh, 7% LMSS, and 6% LMTS and tidal creek combined. The transition area at Phillips Creek was very similar to the average transition area (13%) in Ricker's (1999) study. On the other hand, the high marsh area on the VCR megasite was larger (32% vs. 24%).

Soil organic matter depth and content increased along a continuum from forest to transition and high marsh, which was consistent with findings of Hmieleski (1994) and Ricker (1999). The LMSS and LMTS zones showed a decline in soil organic matter content relative to the high marsh. Belowground macroorganic matter (MOM) mass decreased with depth for all zones. Similarly, Blum (1993) found MOM to be highest in the first 10 cm of soil for short-form *Spartina alterniflora* in the low marsh. In addition, de la Cruz and Hackney (1977) found that 94% of belowground productivity in *Juncus roemerianus* occurred in the top 20 cm. Soil bulk density (BD) values at 0 to10 cm and 10 to 20 cm depths of present study were similar to Hmieleski's (1994) results, except for the upland forest 10-20 cm (Table 16). Average BD values for a 30 cm depth in the LMSS zone were within range of Blum's (1993) results at Phillips Creek, but my average BD values for the LMTS zone were nearly half her values. Similar to these two studies, soil BD increased with depth.

Table 16. Soil bulk density comparison with former Phillips Creek study (Hmieleski 1994) for forest to high marsh zones. Values (g/cm^3) are expressed as mean $\pm$ SE.

Zone	Soil depth	Present study	Hmieleski study
Forest Steep	0 -10	0.50 $\pm$ 0.04	0.51 $\pm$ 0.02
Forest Steep	10-20	1.00 $\pm$ 0.07	0.52 $\pm$ 0.05
Forest Flat	0-10	0.38 $\pm$ 0.04	0.42 $\pm$ 0.11
Forest Flat	10-20	0.75 $\pm$ 0.05	0.60 $\pm$ 0.02
Transition	0-10	0.22 $\pm$ 0.02	0.35 $\pm$ 0.04
Transition	10-20	0.72 $\pm$ 0.04	0.62 $\pm$ 0.03
High marsh	0-10	0.20 $\pm$ 0.04	0.29 $\pm$ 0.03
High marsh	10-20	0.50 $\pm$ 0.10	0.55 $\pm$ 0.03

Mean soil bulk density of forest upland sites (present study) were compared to the forest steep (1994 study). Likewise, forest wetland sites were compared to forest flat (1994 study). High marsh and transition (present study) were compared to the flat transect (1994 study).

Comparison with Other Regions

Aboveground biomass of most saltmarsh species reported in this study were within range of studies conducted on the Atlantic and Gulf Coast regions (Table 17). White et al. (1978) from Louisiana and Stout (1978) from Alabama reported greater biomass of *S. alterniflora* (both forms), *S. patens*, and *D. spicata* than the Atlantic Coast studies. MOM dry mass of the various saltmarsh species in this study was compared to other studies on the Atlantic and Gulf Coasts (Table 18). *S. alterniflora* short-form and *J. roemerianus* had higher MOM mass than those reported by the Alabama and Florida studies. *Spartina patens* of this study had the widest range compared to other studies in Table 18. Overall, I found that aerial and MOM dry mass of saltmarsh species reported in this study fall within the range of variation reported in other studies.

Comparison with Forests and Grasslands Studies

Forest carbon mass estimates at the Phillips Creek study area greatly exceeded that of a *Pinus taeda* forest and a hardwood forest of similar ages (Table 19). Van Lear and Kapeluck (1995) explained that the plantation site in their study had experienced severe soil erosion prior to conversion to forest. Therefore, the lack of soil fertility of the site may explain the low tree biomass. In a hardwood forest study by Whittaker et al.(1974), productivity of the mesophytic forest was low compared to forests of similar environments. Thus, low forest productivity rates may have resulted in low tree biomass. My tree biomass estimates are most similar to the field studies reported by Olson et al. (1983) and that of Phillips and Shure (1990) in southern Appalachia. After comparing forest biomass estimated in this study with other studies, I am confident that the forest carbon estimate falls within normal range. In addition, marsh carbon mass

Table 17. Aboveground biomass (kg/m^2) of saltmarsh species of the Atlantic and Gulf Coast states in the USA.

Location	*S. alterniflora* tall-form	*S. alterniflora* short-form	*Spartina patens*	*Distichlis spicata*	*Juncus roemerianus*	Comments	Reference
Virginia	1.14	0.54	0.77	0.61	1.90	End of season standing crop	Present study
Virginia					1.50-2.70	Harvest within *Juncus* patch	Brinson and Christian (1999)
Virginia			0.80		1.69	1994 harvest	Tolley (1996)
Delaware	1.04	0.55[a] 0.65[b]	0.67[a] 0.73[b]	0.52[b]		Peak live with annual mean	Roman & Daiber (1984)
N. Carolina	1.20[c]					End of season standing crop	Stroud (1976)
N. Carolina				0.96	1.17	Peak live standing crop	Bellis & Gaither (1985)
Florida		0.70[d] 0.33[e]		0.58	1.24[d] 1.06[e]	Peak and end of season standing crop	Kruczynski et al. (1978)
Alabama		1.03			1.45	Peak standing crop with annual mean	Stout (1978)
Louisiana	1.47		2.19	1.16	1.96	Peak live standing crop	White et al. (1978)
Range	1.04 - 1.47	0.33 - 1.03	0.67 - 2.19	0.52 - 1.16	1.06 - 2.70		

[a]Canary Creek marsh, [b] Blackbird marsh, [c] Snow's marsh, [d]lower marsh, [e] upper marsh

Table 18. Belowground macroorganic matter (MOM) dry mass (kg/m^2) from Atlantic and Gulf Coast studies.

Location	Species	MOM Min	MOM Max	MOM Mean	Depth (cm)	Comments	Reference
Virginia	*Spartina alterniflora* (TF)			4.1 - 8.1	30	biomass range	Present Study
	Spartina alterniflora (SF)			4.4 - 13.3	30		
	Spartina patens[a]			5.4 - 16.6	30		
	Juncus roemerianus[a]			7.3 - 11.2	30		
	Distichlis spicata[b]			6.8 - 9.3	30		
Delaware[c]	*Spartina alterniflora* (SF)[d]	13.7	19.3		35		Roman & Daiber (1984)
	S. alterniflora (SF)[e]	9.9	14.3		35		
	S. alterniflora (TF)[d]	4.7	12.4		35		
	S. alterniflora (TF)[e]	4.1	9.4		35		
	Spartina patens[d]	3.5	6.0		35		
	Spartina patens[e]	0.6	4.7		35		
New Jersey	*Spartina alterniflora* (SF)			11.2	30		Smith et al. (1979)
N. Carolina	*Distichlis spicata*			12.1	30		Bellis & Gaither (1985)
	Juncus roemerianus			11.1	30		
N. Carolina	*Spartina alterniflora* (TF)			1.6 - 6.7	30	biomass range	Reader & Craft (1999)
	Spartina alterniflora (SF)			0.9 - 11.2	30	biomass range	
Florida	*Juncus roemerianus*			5.1	20		Kruczynski et al. (1978)
Alabama	*Juncus roemerianus*			4.6	20		Stout (1978)
	Spartina alterniflora (SF)			3.6	20		

[a] MOM dry mass attributed to species included small amounts of *Distichlis spicata*, [b] MOM dry mass attributed to species included small amounts of *Spartina patens*, [c] Canary Creek site, [d] 1975, [e] 1976

Table 19. Aboveground biomass and carbon estimations (kg/m^2) of temperate forests and grasslands.

Forest Region	Vegetation Class	Forest Type	Tree Biomass	Carbon	Data source	Comments	Reference
Atlantic coastal plain, USA	Coniferous evergreen	*Pinus taeda* (successional 55y)	22.4	11.0	Field study		Present study
Southern Piedmont, USA	Coniferous evergreen	*Pinus taeda* (plantation 48 y)	13.2	(6.6)[b]	Field study		Van lear & Kapeluck (1995)
Gulf coastal plain, USA	Coniferous evergreen	*Pinus taeda* (plantation 25 y)	14.6	(7.3)	Field study		Pehl et al. (1984)
New England, USA	Deciduous	Mixed hardwood (natural 50 y)	14.7	(7.4)	Field study		Whittaker et al. (1974)
Southern Appalachia, USA	Deciduous	Mixed hardwood (natural)	21.4	(10.7)	Field study		Phillips and Shure (1990)
Atlantic & Gulf coastal plains, USA	Deciduous	Mixed hardwood on wet flats (natural 60 y)	27.7	(13.9)	Field study		Frederick et al. (1983)
Canada	Coniferous evergreen & deciduous[a]	*	*	12.5	Canadian forest inventories	Computer model	Kurtz and Apps (1999)
International	Coniferous evergreen	*	*	11.4	Field studies		Olson et al. (1983)
International	Coniferous evergreen	*	*	6.0	Global satellite	Computer model	Potter (1999)

Table 19. Completed.

Grassland Region	Vegetation Class	Biomass	Carbon	Data source	Comments	Reference
Atlantic coastal plain, USA	Herbaceous marsh	0.87	0.38	Field study		Present study
International	Grassland	*	0.48	Field studies		Olson et al. (1983)
International	Grassland	*	0.15	Global satellite	NASA-CASA model	Potter (1999)

[a] refers to vegetation class which is my interpretation of the authors' classification terms of hardwood and softwood. * information was not reported. [b] carbon data in parentheses are my calculations from the formula carbon mass = tree biomass x 0.5.

from the present study falls within grassland estimates of Potter (1999) and Olson et al. (1983).

Lastly, I compared total belowground carbon mass from present research with estimates from global studies of grasslands and forests. Marsh belowground carbon to a 30 cm depth in this study (7.0-20.7 kg/m^2) is similar to grassland studies of 1 to 2 m depth in Japan, USA, and Russia (13.3 -26.3 kg/m^2) (Schlesinger 1977). In addition, forest belowground carbon to a 30 cm depth from this study (7.4-11.6 kg/m^2) falls within range (5.6-24.0 kg/m^2) of forest studies (swamp forests not included) encompassing depths of 0.2 to 1.3 m from Europe, Russia, Asia, and the USA (Schlesinger 1977).

Total Above and Belowground Carbon

I had hypothesized that total above and belowground organic matter distribution would have the following trend: forest > transition > high marsh = mid-marsh > low marsh short-form *S. alterniflora* > low marsh tall-form *S. alterniflora* > tidal creek. As mentioned previously, I had combined mid-marsh with high marsh because vegetation and soil characteristics were indistinguishable, and there were only four sample sites. The results of this study for total above and belowground organic matter, expressed as carbon (kg/m^2), revealed the following trend: forest > high marsh > transition > LMSS > LMTS > tidal creek. As expected, the magnitude of aboveground carbon (kg/m^2) of the forest made up for the low belowground carbon compared to other zones, except the tidal creek. The high marsh exceeded that of the transition zone by 2.7 kg/m^2 for total carbon, because of the higher belowground values in the marsh. However, the difference between the two zones was not statistically significant for total carbon.

The pattern of carbon loss or gain in the present study was consistent with the state change model of Brinson et al. (1995) (Figure 1). The forest loses woody vegetation and gains soil organic matter during the transition to high marsh. The high marsh loses soil organic matter during the transition to low marsh, and a total loss of emergent vegetation occurs as low marsh becomes subtidal. The differences in carbon stock of each ecosystem state at Phillips Creek are shown in Figure 18. Both net losses and gains of carbon occur with state change. The greatest aboveground loss of carbon (11.6 kg/m^2; i.e., 10.4 from forest to transition and 1.2 from transition to high marsh) is incurred when forest completes the transformation to high marsh, during which tree material completely disappears except for large roots. When high marsh converts to LMSS, there is a loss of 1.3 kg/m^2 C in soil organic matter to a 30 cm depth. This estimate is conservative considering that the thickness of organic rich soil in some areas of the high marsh is up to 1 m. These greater depths occur west of the transition finger, and include the area of high marsh experiencing extensive breakup and ponding. Also, a creek channel in this region is advancing headward into the high marsh. This region of high marsh is roughly 7 ha, and included 8 out of the 10 sample sites with soils of high organic content (18 to 80 % from LOI) throughout the 30 cm soil depth. If a 1 m^2 area of organic rich soil, 1 m deep, were to completely oxidize, the high marsh would incur a loss of approximately 60 kg/m^2 of carbon. This estimate is based on a soil bulk density of 0.20 g/cm^3 and carbon content of 30%. Thus, the net loss of belowground carbon between high marsh and LMSS can be far greater than previously stated. However, personal observations and the Ricker study (1999) of other marshes in the region indicate that deep peat deposits are not typical.

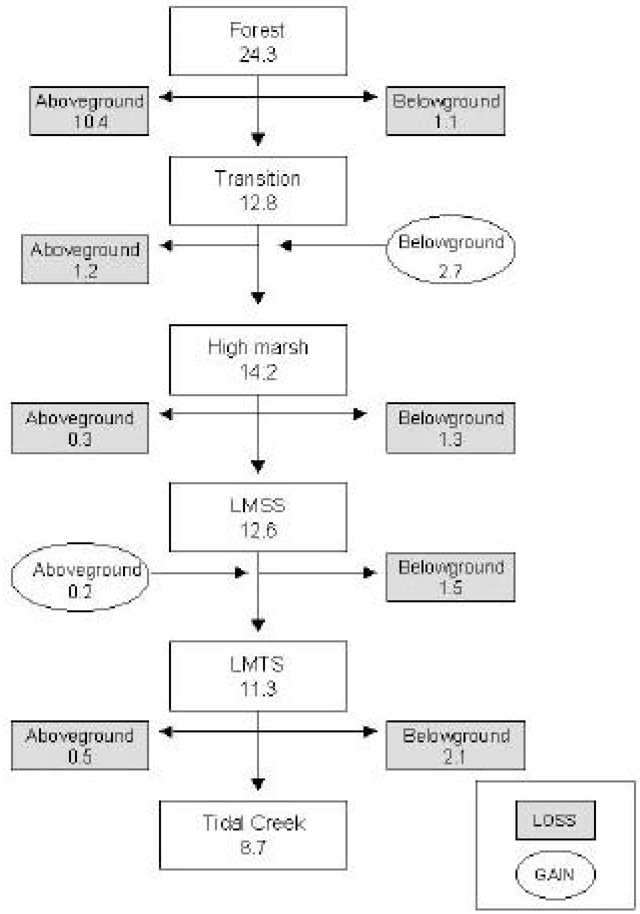

Figure 18. Organic carbon (kg/m²) losses and gains with ecosystem state change along a continuum from forest to tidal creek. LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *S. alterniflora*.

Future Changes

What changes will occur in carbon mass for each zone in response to sea level rise, and at what rate? To address this question, I created two profiles displaying migration of zones at Phillips Creek for high marsh and LMSS zones; one profile depicts a steep slope and the other a very gentle slope. I estimated mean slopes of the LMSS and high marsh zones of this study using distance between sites (measured from a field map) and GPS elevations of those sites. Based on slope data from Hmieleski (1994), Ricker (1999), Blum (1993), and my estimates, the steep profile was assigned a 1.0% slope for the forest and transition, a 0.3 % slope for high marsh and LMSS zones, and a 4% slope for LMTS. In the gentle slope profile, the forest to high marsh continuum uses a 0.05% slope throughout, and the LMSS and LMTS zones remain the same. The elevation ranges of the different zones (obtained in the GPS survey) determined the placement of zones along a 1 m wide transect (Figures 19a and 20a). Using sea level rise (SLR) as the only driving force for state change, I projected Phillips Creek 80 y into the future with a SLR rate of 5 mm/y (0.4 m rise), based on the Intergovernmental Panel on Climate Change (1996) best estimate for future sea level rise. A major assumption in my models is that migration of zones inland is unimpeded by artificial barriers such as roads. In my models, I elevated the zones 0.4 m (Figures 19b and 20b), determined the distance that underwent state change, and estimated the turnover of carbon based on zone carbon stocks from Figure 18. I focused changes in carbon stock and turnover rates for the LMSS to forest zones, and allowed those zone areas to change in response to sea level rise. I held the LMTS zone to a constant area (6 m^2) from the water's edge for the present and future profiles, because tall-form *S. alterniflora* is typically found as a narrow zone along the creekbank, and unlikely to change substantially.

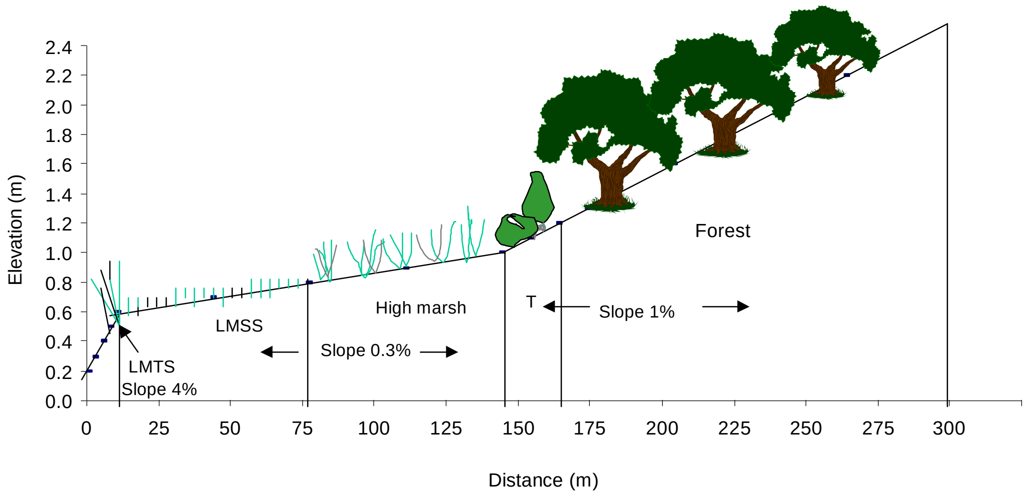

Figure 19a. Profile of Phillips Creek steep slope at present year 2000. LMTS = low marsh tall-form *Spartina alterniflora*, LMSS = low marsh short-form *S. alterniflora*, and T= transition.

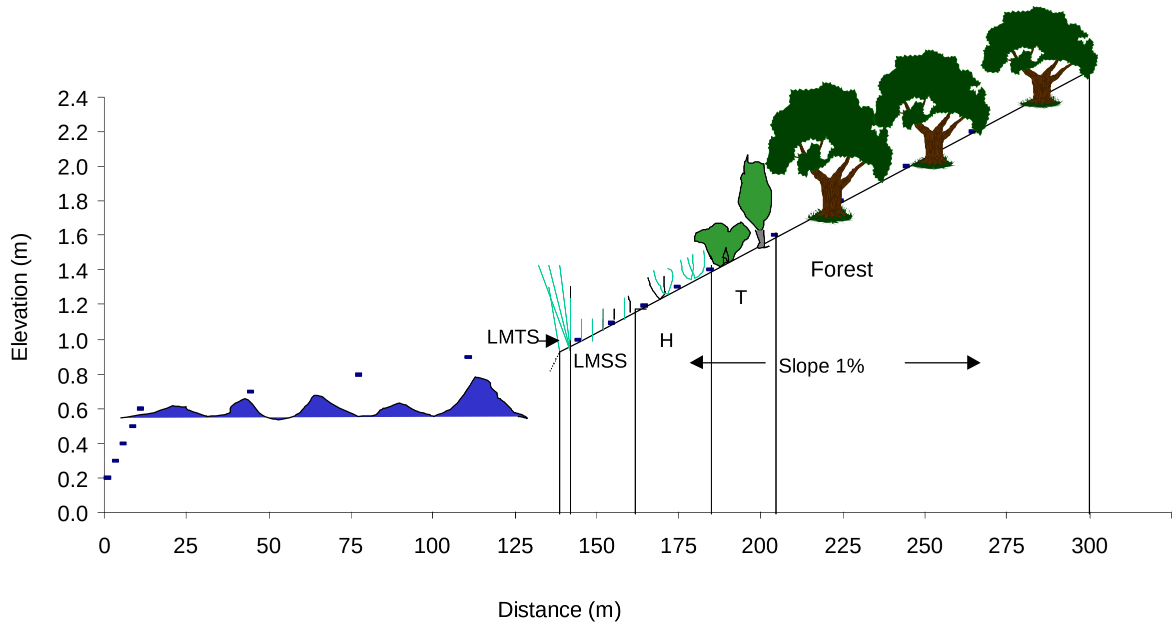

Figure 19b. Profile of Phillips Creek steep slope at year 2080 after a 5 mm/y sea level rise. Zone abbreviations: H = high marsh, LMSS = low marsh short-form *Spartina alterniflora*, and LMTS = low marsh tall-form *S. alterniflora*.

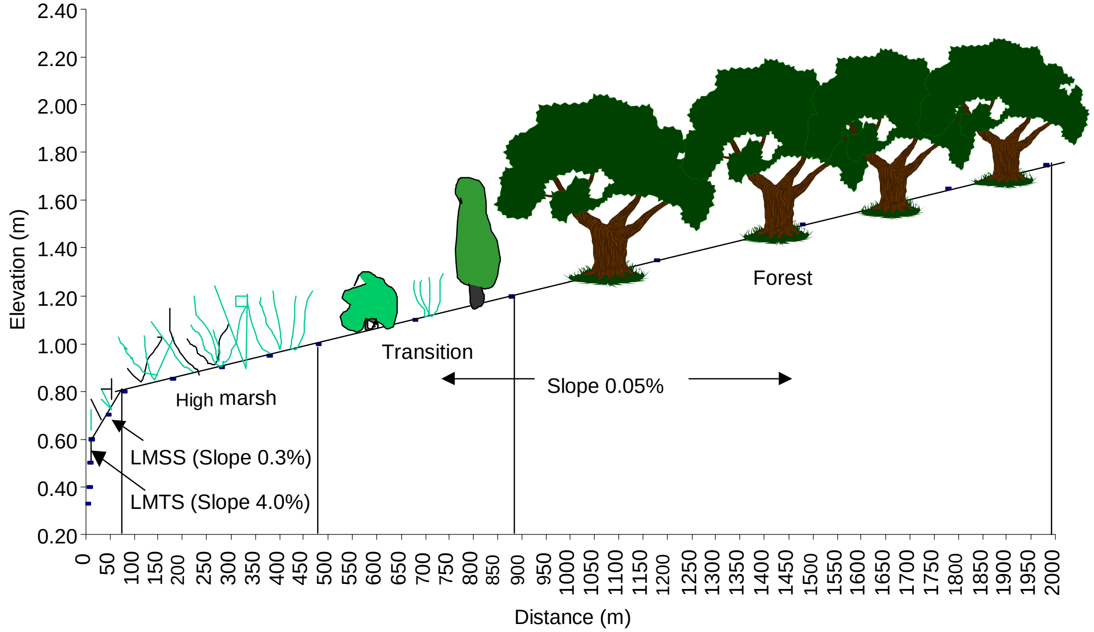

Figure 20a. Profile of Phillip Creek gentle slope at present year 2000. Zone abbreviations: LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *S. alterniflora*.

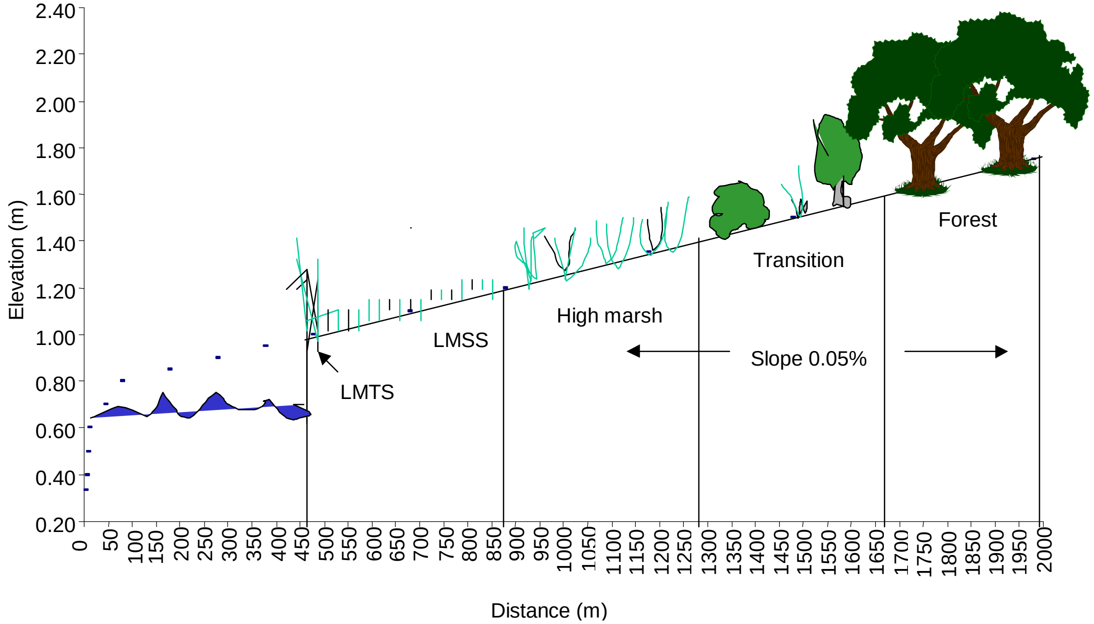

Figure 20b. Profile of Phillips Creek gentle slope at year 2080 after a 5 mm/y sea level rise. Zone abbreviations: LMSS = low marsh short-form *Spartina alterniflora* and LMTS = low marsh tall-form *S. alterniflora*.

Changes occurred in the area of the zones following an 80 y period of marsh migration, and the following profiles show the influence of the terrestrial margin slope on the future loss or gain of marsh area. In the steep profile, the marsh zones experienced a large shift where LMSS replaced the transition zone, and high marsh and transition replaced a forest edge. The LMSS and high marsh experienced a loss of zone area, because they migrated from a 0.3% to a 1% upland slope. In contrast, migration of transition and forest zones across the same slope retained the same amount of area (Figure 19b). In the gentle slope profile, the LMSS zone expanded, because the upland slope to which it migrated was less steep (from 0.3% to 0.05%) (Figure 20b).
High marsh to forest retained the same amount of area after migration, as slope was held constant.

In both steep and gentle profiles of Phillips Creek, there was 100% turnover of carbon for all zones, except the forest by the year 2080 (Tables 20 and 21). The forest of the steep slope profile had only a 25% turnover (Table 20). In contrast the forest in the gentle slope profile experienced a 71% turnover, being replaced by high marsh and transition zones (Table 21). Future zone carbon stocks were reflected in the losses and gains of zone area. Carbon standing stock per zone was determined with the following formula: kg C/zone = zone distance (m) * 1 m zone width * initial carbon standing stock (kg/m^2) (Tables 20 and 21). In the steep profile, the migration of LMSS which began with 844 kg C/zone was reduced to 252 kg C/zone following an 80 y migration, and high marsh experienced a loss of 653 kg carbon standing stock (Figure 21). In contrast for the gentle slope profile, the LMSS carbon standing stock increased from 844 to 5040 kg/zone as it migrated from a 0.3% to a 0.05% slope (Figure 22).

Table 20. Phillips Creek steep slope profile (1 m wide transect) with organic carbon turnover projected to occur due to state change over an 80 y period with a 5 mm/y sea level rise. Abbreviations: C = carbon, LMTS = low marsh tall-form *Spartina alterniflora* and LMSS = low marsh short-form *S. alterniflora.*

Zone	Initial C standing stock (kg/m^2)	Distance (m)	Original zone C stock (kg/zone)	C (kg) loss per zone in 80y	% C turnover of zone/ 80y	C turnover rate %/y	Zone replacement	Future C standing stock (kg/m^2)	Distance (m)	C (kg/zone) *Original/	Future	Future zone C stock (kg/zone)
LMTS	11.3	6	68	68	100	1.25	Tidal creek	8.7	6	0	52	52
LMSS	12.6	67	844	844	100	1.25	Tidal creek	8.7	67	0	583	583
High marsh	14.2	66	937	937	100	1.25	Tidal creek /	8.7	60	0	522	522
							LMTS	11.3	6	0	68	68
Transition	12.8	20	256	256	100	1.25	LMSS	12.6	20	0	252	252
Forest	24.3	161	3912	978	25	0.31	High marsh /	14.2	20	0	284	284
							Transition	12.8	20	0	256	256
							Forest migration	24.3	40	2934	978	3912

* Original represents the residual carbon from the previous ecosystem state. Zeros for all but the forest indicate that all original carbon was removed.

Table 21. Phillips Creek gentle slope profile (1 m wide) with organic carbon turnover projected to occur due to state change over an 80 y period with a 5 mm/y sea level rise. Abbreviations: C = carbon, LMTS = low marsh tall-form *Spartina alterniflora* and LMSS = low marsh short-form *S. alterniflora.*

Zone	Initial C standing stock (kg/m^2)	Distance (m)	Original zone C stock (kg/zone)	C (kg) loss per zone in 80y	% C Turnover of zone/ 80y	C Turnover rate %/y	Zone replacement	Future C standing stock (kg/m^2)	Distance (m)	C (kg /zone) Original/Future		Future zone C stock (kg/zone)
LMTS	11.3	6	68	68	100	1.25	Tidal Creek	8.7	6	0	52	52
LMSS	12.6	67	844	844	100	1.25	Tidal Creek	8.7	67	0	583	583
High marsh	14.2	400	5680	5680	100	1.25	Tidal Creek/	8.7		0	3489	3489
							LMTS	11.3401	6	0	68	68
Transition	12.8	400	5120	5120	100	1.25	LMSS	12.6	400	0	5040	5040
Forest	24.3	1120	27216	19323	71	0.89	High marsh/	14.2	400	0	5680	5680
							Transition	12.8	400	0	5120	5120
							Forest migration	24.3	1120	7893	19323	27216

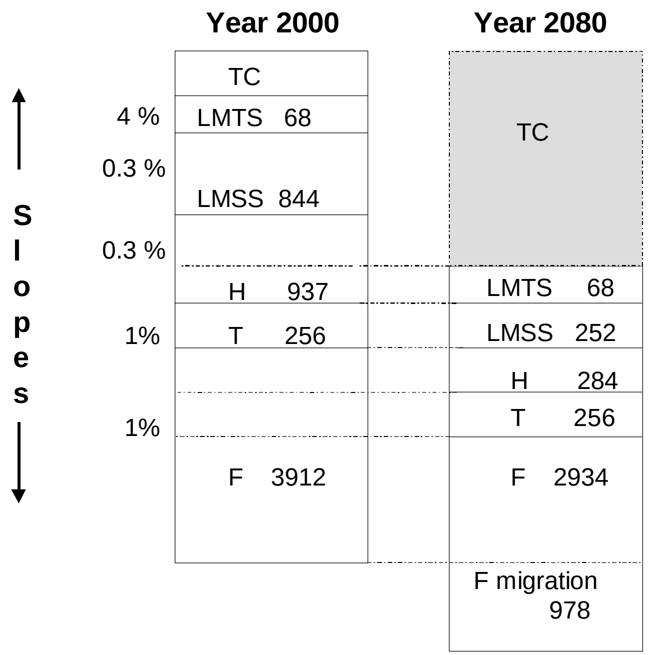

Figure 21. Projected state change following 80 y of 5 mm/y sea level rise for Phillips Creek steep profile. Original and future carbon stocks (kg/zone) are shown for marsh to forest zones along a 1 m wide transect. All zones migrate, but LMSS and H migrate up a steeper slope and loss of zone area occurs. Approximately 25% of the old forest stock has turned over. TC = tidal creek, LMTS = low marsh tall-form *Spartina alterniflora*, LMSS = low marsh short-form *S. alterniflora*, H = high marsh, T = transition, and F = forest.

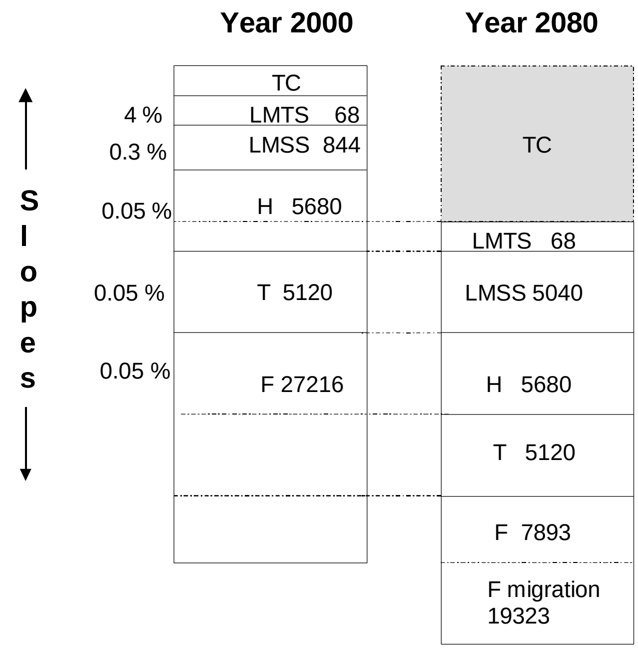

Figure 22. Projected state change following 80 y of 5 mm/y sea level rise for Phillips Creek gentle slope profile. Original and future carbon stocks (kg/zone) are shown for marsh to forest zones. All zones migrate landward, and LMSS expands in area as it migrates across a less steep slope. Approximately 71% of the original forest stock has turned over. Abbreviations are explained in Figure 21.

Next, I compared horizontal carbon turnover rates associated with state change and vertical carbon turnover rates (net primary productivity (NPP) rate/ standing stock) of forest and marsh zones that occur in a normal growing season (Table 22). These NPP data are based on mean values of data from Tables 23a and 23b (except for the forest), and carbon standing stock values from Figure 18. To convert the oven-dry mass from these studies to carbon mass, I used the carbon mass to oven-dry mass ratios from this study (high marsh: 46% aerial biomass and 45% MOM; low marsh zones: 41% for both aerial biomass and MOM). The forest values are the sum of aboveground production of temperate evergreen forests (Barbour et al. 1980) and woody root production (Whittaker and Woodwell 1969). Horizontal carbon turnover rate (%/y) = carbon loss (kg/zone/y) / carbon standing stock (kg/zone) * 100. In comparison, horizontal carbon turnover rates that occurred in both profiles as a result of state change are an order of magnitude lower than vertical carbon turnover rates associated plant production during the growing season (Table 22). If the estimated carbon standing stocks (kg/m^2) for each ecosystem state were over or under estimated, how would horizontal carbon turnover rates be affected? Because carbon standing stock (kg/m^2) are in both numerator and denominator of the horizontal turnover equation, under or over estimates have no effect. Having compared above and belowground biomass and carbon estimates from this with others, I have found my estimates to be in range with most other studies. Therefore, I am confident that the estimated carbon standing stocks (kg/m^2) of ecosystem states at Phillips Creek are valid, and may be useful estimates for other coastal areas of similar geomorphology.

Table 22. Comparison of horizontal organic carbon turnover rate due to state change and vertical carbon turnover (net primary production/ standing stock) in marsh and forest zones. Steep and gentle refer to the two state change profiles for Phillips Creek. Abbreviations: LMTS = low marsh tall-form *Spartina alterniflora* and LMSS = short-form *S. alterniflora*.

Zone	Horizontal Turnover (%/y) Gentle	Steep	Standing Stock (kg/m^2)	Net Primary Productivity $kg/m^2/y$	Vertical turnover (%/y)
LMTS	1.25	1.25	11.30	1.66[a]	14.69
LMSS	1.25	1.25	12.60	1.55[a]	12.30
High marsh	1.25	1.25	14.20	2.01[a]	14.15
Forest[b]	0.31	0.89	24.30	0.78	3.21 steep 3.21 gentle

[a] Net primary production is the sum of mean aerial and MOM organic carbon values from Tables 23 a and b.
[b] Forest net primary production - Sum of aboveground from Barbour et al. (1980) and belowground from Whittaker and Woodwell (1969).

Table 23a. Aerial net primary production ($kg/m^2/y$) of marsh plants

Zone	Species	Net Primary Production $kg/m^2/y$	NPP C mass $kg/m^2/y$	Methods	Reference
LMTS	*S. alterniflora*	0.96	0.38	Harvest	Thomas (1998)
LMTS	*S. alterniflora*	1.04	0.42	Smalley	Roman and Daiber (1984)
LMTS	*S. alterniflora*	1.47	0.59	Smalley	White et al. (1978)
Carbon mean ± SE			0.46 ± 0.06		
LMSS	*S. alterniflora*	0.55	0.22	Smalley	Roman and Daiber (1984)
LMSS	*S. alterniflora*	0.65	0.26	Smalley	Roman and Daiber (1984)
LMSS	*S. alterniflora*	0.52	0.21	Milner Hughes	Smith et al (1979)
LMSS	*S. alterniflora*	0.43	0.17	Milner Hughes	Smith et al (1979)
LMSS	*S. alterniflora*	0.70	0.28	End of season harvest	Kruczunski et al. (1978)
LMSS	*S. alterniflora*	0.33	0.13	End of season harvest	Kruczunski et al. (1978)
LMSS	*S. alterniflora*	1.03	0.41	Smalley	Stout (1978)
Carbon mean ± SE			0.24 ± 0.03		
High marsh	*S. patens*	0.67	0.31	Smalley	Roman and Daiber (1984)
High marsh	*S. patens*	0.73	0.34	Smalley	Roman and Daiber (1984)
High marsh	*S. patens*	2.19	1.01	Smalley	White et al. (1978)
High marsh	*D. spicata*	0.52	0.24	Smalley	Roman and Daiber (1984)
High marsh	*D. spicata*	0.58	0.27	End of season harvest	Kruczunski et al. (1978)
High marsh	*D. spicata*	1.16	0.53	Smalley	White et al. (1978)
High marsh	*J. roemerianus*	1.24	0.57	Smalley	Kruczunski et al. (1978)
High marsh	*J. roemerianus*	1.06	0.49	Smalley	Kruczunski et al. (1978)
High marsh	*J. roemerianus*	1.45	0.67	Smalley	Stout (1978)
High marsh	*J. roemerianus*	1.96	0.90	Smalley	White et al. (1978)
Carbon mean ± SE			0.53 ± 0.08		

Table 23b. Macroorganic matter (MOM) productivity studies of the Atlantic and Gulf Coast states. Abbreviations: LMTS = low marsh tall-form *Spartina alterniflora* and LMSS = low marsh short-form *S. alterniflora*.

Zone	Species	Net Primary Productivity kg/m^2/y	Net Carbon Productivity kg/m^2/y	Reference
LMTS	*Spartina alterniflora*	6.50	2.67[a]	Roman & Daiber (1984)
LMTS	*Spartina alterniflora*	0.68	0.28	Blum (1993)
LMTS	*Spartina alterniflora*	2.11	0.87	Gallagher et al. (1980)
LMTS	*Spartina alterniflora*	2.46	1.01	Dame and Kenny (1986)
Carbon mean $\pm$ SE			1.20 + 0.51	
LMSS	*Spartina alterniflora*	5.45	2.23	Dame and Kenny (1986)
LMSS	*Spartina alterniflora*	2.02	0.83	Gallagher and Plumley (1979)
LMSS	*Spartina alterniflora*	5.00	2.05	Roman & Daiber (1984)
LMSS	*Spartina alterniflora*	2.30	0.94	Smith et al. (1979)
LMSS	*Spartina alterniflora*	2.14	0.88	Blum (1993)
Carbon mean $\pm$ SE			1.31 $\pm$ 0.27	
High marsh	*Spartina patens*	3.30	1.49	Roman & Daiber (1984)
High marsh	*Juncus roemerianus*	1.36	0.61	De La Cruz & Hackney (1977)
High marsh	*Juncus roemerianus*	7.58	3.41	Stout (1978)
High marsh	*Distichlis spicata*	0.90	0.41	Bellis & Gaither (1985)
High marsh	*Distichlis spicata*	3.25	1.46	Bellis & Gaither (1985)
Carbon mean $\pm$ SE			1.48 $\pm$ 0.44	

[a] Net primary production of MOM was converted to net carbon production by using the mean ratios of MOM carbon mass to MOM dry mass obtained from data in present study (Appendix F). The ratios were 0.41 for *S. alterniflora* and 0.45 for all other marsh species.

These carbon turnover rates presented are based the effects of sea level rise (5 mm/y) alone. Factors that can accelerate state change (storm frequency, fires, erosion and land subsidence) and factors involved in the resistance to state change (vertical accretion of sediment and organic rich soils, structures of plant community) were held constant. Based on sea level rise, this study offers insight into the temporal and spatial scales of carbon turnover for different landscape slopes, and can be fine-tuned with addition of factors mentioned above.

Ecosystem state change is a spatial process involving the transformation of coastal landscapes with noticeable changes within the span of a century. The major assumption presented, that no restrictions to overland migration of marsh and forest exist, is unrealistic. In many regions, human development of coastal areas with construction of structures (buildings, parking lots, and roads) can prevent the migration of marshes and forests, and contribute to their demise. Possible exceptions are areas that are protected, such as wildlife refuges and the Virginia Coast Reserve where this study occurred. In these protected areas overland migration may occur unimpeded within the confines of their land areas. High production of plant biomass in these coastal ecosystems provides food and habitat for a wide array of organisms. Unfortunately, protected coastal land areas are not abundant, and major losses of ecologically important coastal ecosystems may be inevitable.

SUMMARY

Carbon standing stock (kg/m^2) was estimated for each ecosystem state along a continuum from forest to tidal creek, and inserted into the state change model (Brinson et al. 1995). Forest was higher compared to all other zones, followed by high marsh, transition, low marsh short-form *Spartina alterniflora*, low marsh tall-form *S. alterniflora* and tidal creek. During the process of ecosystem state change, carbon losses generally exceeded gains. For both gentle and steep slope migration profiles, the marsh and transition zones underwent an estimated 100% carbon turnover (i.e., complete replacement) following 80 y of sea level rise. In the same time period, forest turnover was 25% and 71% for the steep and gentle slope profiles, respectively.

Yearly turnover rates associated with net primary production were called “vertical turnover”, because the exchange of carbon is a vertical process that occurs between the atmosphere and plant community within an ecosystem. Whereas, “Horizontal turnover” is associated with state change where one ecosystem replaces another as it moves horizontally across the landscape. Vertical turnover rates of carbon range between 3.1%/y for the forest and 14.7%/y for the LMTS zone. In comparison, horizontal carbon turnover rates for all zones are slower by approximately one order of magnitude than vertical turnover rates. Though slower, horizontal turnover is a spatial process that can change the face of coastal landscapes within the span of a century.

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APPENDIX A. OVEN-DRY MASS (KG/M^2) OF ABOVEGROUND VEGETATION COMPONENTS SUMMED FOR ALL SITES.

Zone	Site	Trees	Shrubs	Woody veg	Snags	Large wood	Small wood	Cones	Herb.Veg.	Herb. Litter	Total
Forest	Fa18	18.45	0.00		0.002	0.282	0.454	0.153	0.093	2.46	21.90
Forest	Fa30	30.73	0.00		0.000	0.025	0.115	0.081	0.006	1.83	32.79
Forest	Fb29	19.68	0.21		0.097	0.000	0.428	0.062	0.032	0.80	21.30
Forest	Fb47	23.66	0.00		1.322	0.000	0.738	0.047	0.009	1.86	27.64
Forest	Fb65	19.67	0.19		0.339	0.000	0.385	0.132	0.048	1.74	22.50
Transition	Ta1	0.19	0.04		0.193	0.000	0.002	0.000	1.089	0.29	1.80
Transition	Ta4	0.31	0.03		0.013	0.102	0.000	0.000	1.207	0.45	2.10
Transition	Ta13	0.22	0.20	0.06	0.053	0.000	0.022	0.002	0.898	0.35	1.79
Transition	Tb29	0.00	0.22		0.000	0.000	0.000	0.000	1.558	0.15	1.92
Transition	Tc2	0.28	0.05		0.018	0.000	0.014	0.000	0.975	0.33	1.66
Transition	Tc8	5.26	0.97	0.01	0.185	0.050	0.264	0.002	0.609	0.69	8.04
Transition	Tc18	2.65	0.80		0.168	0.010	0.104	0.000	1.135	0.22	5.08
Transition	Tc31	0.63	0.04		0.410	0.024	0.156	0.000	0.541	0.25	2.04
Transition	Td2	3.68	0.54		0.315	0.214	0.323	0.012	0.804	0.51	6.40
Transition	Td9	3.05	0.54		1.048	0.084	0.041	0.000	1.155	0.24	6.15
Transition	Td15	4.97	0.05		0.064	0.190	0.013	0.000	0.975	0.16	6.43
Transition	Td33	0.76	0.00		0.054	0.000	0.020	0.000	1.019	0.29	2.14
Transition	Td39	4.60	0.13		0.401	0.189	0.213	0.001	0.797	0.57	6.90
Transition	Td50	0.45	0.13		0.042	0.000	0.041	0.000	1.611	1.16	3.43
High Marsh	Ha5						0.018		1.260	0.27	1.55
High Marsh	Ha14								1.235	0.30	1.53
High Marsh	Ha19								0.714	0.65	1.36
High Marsh	Ha21								0.486	0.34	0.83
High Marsh	Ha36						0.001		1.032	0.41	1.44
High Marsh	Ha41								0.923	0.22	1.14
High Marsh	Ha52								0.448	0.03	0.48
High Marsh	Hb1								0.846	0.57	1.41
High Marsh	Hb4								1.056	0.37	1.43

High Marsh	Hc1	1.432	0.25	1.68

Zone	Site	Herb.Veg.	Herb. Litter	Total
High Marsh	Hc30	2.556	0.53	3.09
High Marsh	Hc37	0.051	0.03	0.00
High Marsh	Hc41	0.458	0.50	0.00
High Marsh	Hc42	2.743	0.51	0.00
High Marsh	Hc48	1.540	0.29	0.00
High Marsh	Hc72	1.052	0.24	0.00
High Marsh	Hc75	1.828	0.38	0.00
High Marsh	Hc84	0.693	0.47	0.00
High Marsh	Hc92	0.656	0.32	0.00
High Marsh	Ma1	2.712	0.30	0.00
High Marsh	Ma15	1.530	0.30	0.00
High Marsh	Mc2	0.468	0.17	0.00
High Marsh	Tb4	0.953	0.14	0.00
High Marsh	Tb14	0.814	0.34	0.00
High Marsh	Tb23	1.300	0.27	0.00
LMSS	LSa8	0.365	0.10	0.00
LMSS	LSa12	0.730	0.12	0.00
LMSS	LSb2	0.567	0.08	0.00
LMSS	LSb16	0.778	0.02	0.00
LMSS	LSb17	0.873	0.41	0.00
LMSS	LSb46	0.604	0.40	0.00
LMSS	LSb53	0.585	0.12	0.00
LMSS	LSb55	0.702	0.19	0.00
LMSS	Mb4	0.420	0.32	0.00
LMTS	LTS6	0.821	0.00	0.00
LMTS	LTS9	1.057	0.41	0.00
LMTS	LT6	1.664	0.21	0.00
LMTS	LT12	1.484	0.00	0.00
LMTS	LT25	1.119	0.00	0.00
LMTS	LT29	0.583	0.09	0.00
LMTS	LT33	1.231	0.15	0.00

APPENDIX B. SUMMATION OF BIOMASS, ASH-FREE DRY WEIGHT, AND CARBON MASS OF TREES PER FOREST AND TRANSITION SITE.

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Forest	Fa18	*Pinus taeda*	509.13	1.621	98	1.589	0.795
Forest	Fa18	*P. taeda*	843.76	2.687	98	2.633	1.317
Forest	Fa18	*P. taeda*	1293.87	4.121	98	4.038	2.019
Forest	Fa18	*P. taeda*	940.11	2.994	98	2.934	1.467
Forest	Fa18	*P. taeda*	1141.59	3.636	98	3.563	1.781
Forest	Fa18	*P. taeda*	858.57	2.734	98	2.680	1.340
Forest	Fa18	*Prunus virginiana*	2.59	0.008	98	0.008	0.004
Forest	Fa18	*P. virginiana*	9.01	0.029	98	0.028	0.014
Forest	Fa18	*P. virginiana*	3.56	0.011	98	0.011	0.006
Forest	Fa18	*P. virginiana*	5.98	0.019	98	0.019	0.009
Forest	Fa18	*P. virginiana*	2.56	0.008	98	0.008	0.004
Forest	Fa18	*P. virginiana*	1.85	0.006	98	0.006	0.003
Forest	Fa18	*P. virginiana*	1.71	0.005	98	0.005	0.003
Forest	Fa18	*P. virginiana*	4.71	0.015	98	0.015	0.007
Forest	Fa18	*P. virginiana*	1.28	0.004	98	0.004	0.002
Forest	Fa18	*P. virginiana*	10.76	0.034	98	0.034	0.017
Forest	Fa18	*P. virginiana*	20.72	0.066	98	0.065	0.032
Forest	Fa18	*P. virginiana*	1.28	0.004	98	0.004	0.002
Forest	Fa18	*P. virginiana*	2.16	0.007	98	0.007	0.003
Forest	Fa18	*P. virginiana*	9.21	0.029	98	0.029	0.014
Forest	Fa18	*P. virginiana*	3.56	0.011	98	0.011	0.006
Forest	Fa18	*Ilex opaca*	11.28	0.036	98	0.035	0.018
Forest	Fa18	*Ilex opaca*	10.25	0.033	98	0.032	0.016
Forest	Fa18	*Liriodendron styraciflua*	58.76	0.187	98	0.183	0.092
Forest	Fa18	*L. styraciflua*	39.38	0.125	98	0.123	0.061
Forest	Fa18	*Quercus phellos*	3.25	0.010	98	0.010	0.005
Forest	Fa18	*Aralia spinosa*	1.01	0.003	98	0.003	0.002
Forest	Fa18	*Aralia spinosa*	1.46	0.005	98	0.005	0.002
Forest	Fa18	*Celtis spp.*	1.01	0.003	98	0.003	0.002
Total			5794.38	18.45		18.08	9.04
Forest	Fa30	*P. taeda*	896.30	2.854	98	2.797	1.399
Forest	Fa30	*P. taeda*	1604.41	5.110	98	5.007	2.504
Forest	Fa30	*P. taeda*	991.28	3.157	98	3.094	1.547
Forest	Fa30	*P. taeda*	1020.31	3.249	98	3.184	1.592
Forest	Fa30	*P. taeda*	289.47	0.922	98	0.903	0.452
Forest	Fa30	*P. taeda*	1065.37	3.393	98	3.325	1.663
Forest	Fa30	*P. taeda*	685.39	2.183	98	2.139	1.070
Forest	Fa30	*P. taeda*	1021.10	3.252	98	3.187	1.593
Forest	Fa30	*P. taeda*	1043.30	3.323	98	3.256	1.628
Forest	Fa30	*Q. phellos*	1.01	0.003	98	0.003	0.002

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Forest	Fa30	*Q. phellos*	4.03	0.013	98	0.013	0.006
Forest	Fa30	*Juniperus virginiana*	140.62	0.448	98	0.439	0.219
Forest	Fa30	*J. virginiana*	104.78	0.334	98	0.327	0.164
Forest	Fa30	*J. virginiana*	287.13	0.914	98	0.896	0.448
Forest	Fa30	*J. virginiana*	494.42	1.575	98	1.543	0.772
Total			9648.92	30.73		30.11	15.06
Forest	Fb29	*P. taeda*	333.10	1.061	98	1.040	0.520
Forest	Fb29	*P. taeda*	727.68	2.317	98	2.271	1.136
Forest	Fb29	*P. taeda*	216.58	0.690	98	0.676	0.338
Forest	Fb29	*P. taeda*	369.80	1.178	98	1.154	0.577
Forest	Fb29	*P. taeda*	509.28	1.622	98	1.589	0.795
Forest	Fb29	*P. taeda*	705.42	2.247	98	2.202	1.101
Forest	Fb29	*Nyssa sylvatica*	773.12	2.462	98	2.413	1.206
Forest	Fb29	*N. sylvatica*	420.63	1.340	98	1.313	0.656
Forest	Fb29	*N. sylvatica*	1108.25	3.529	98	3.459	1.729
Forest	Fb29	*N. sylvatica*	2.13	0.007	98	0.007	0.003
Forest	Fb29	*N. sylvatica*	4.09	0.013	98	0.013	0.006
Forest	Fb29	*N. sylvatica*	4.16	0.013	98	0.013	0.006
Forest	Fb29	*N. sylvatica*	20.24	0.064	98	0.063	0.032
Forest	Fb29	*N. sylvatica*	25.34	0.081	98	0.079	0.040
Forest	Fb29	*N. sylvatica*	5.83	0.019	98	0.018	0.009
Forest	Fb29	*N. sylvatica*	7.76	0.025	98	0.024	0.012
Forest	Fb29	*N. sylvatica*	43.32	0.138	98	0.135	0.068
Forest	Fb29	*N. sylvatica*	100.73	0.321	98	0.314	0.157
Forest	Fb29	*N. sylvatica*	104.70	0.333	98	0.327	0.163
Forest	Fb29	*N. sylvatica*	58.38	0.186	98	0.182	0.091
Forest	Fb29	*N. sylvatica*	49.81	0.159	98	0.155	0.078
Forest	Fb29	*N. sylvatica*	10.33	0.033	98	0.032	0.016
Forest	Fb29	*N. sylvatica*	5.51	0.018	98	0.017	0.009
Forest	Fb29	*N. sylvatica*	0.61	0.002	98	0.002	0.001
Forest	Fb29	*N. sylvatica*	0.80	0.003	98	0.002	0.001
Forest	Fb29	*N. sylvatica*	0.62	0.002	98	0.002	0.001
Forest	Fb29	*N. sylvatica*	67.70	0.216	98	0.211	0.106
Forest	Fb29	*I. opaca*	4.87	0.016	98	0.015	0.008
Forest	Fb29	*I. opaca*	7.95	0.025	98	0.025	0.012
Forest	Fb29	*I. opaca*	2.63	0.008	98	0.008	0.004
Forest	Fb29	*I. opaca*	2.63	0.008	98	0.008	0.004
Forest	Fb29	*I. opaca*	0.75	0.002	98	0.002	0.001
Forest	Fb29	*I. opaca*	3.37	0.011	98	0.011	0.005
Forest	Fb29	*I. opaca*	10.32	0.033	98	0.032	0.016
Forest	Fb29	*P. virginiana*	19.77	0.063	98	0.062	0.031
Forest	Fb29	*P. virginiana*	34.30	0.109	98	0.107	0.054

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Forest	Fb29	*P. virginiana*	28.95	0.092	98	0.090	0.045
Forest	Fb29	*Acer rubrum*	171.70	0.547	98	0.536	0.268
Forest	Fb29	*J. virginiana*	9.10	0.029	98	0.028	0.014
Forest	Fb29	*J. virginiana*	15.16	0.048	98	0.047	0.024
Forest	Fb29	*J. virginiana*	27.29	0.087	98	0.085	0.043
Forest	Fb29	*J. virginiana*	15.16	0.048	98	0.047	0.024
Forest	Fb29	*J. virginiana*	74.38	0.237	98	0.232	0.116
Forest	Fb29	*J. virginiana*	74.38	0.237	98	0.232	0.116
Total			6178.6	19.68		19.28	9.64
Forest	Fb47	*P. taeda*	561.86	1.789	98	1.754	0.877
Forest	Fb47	*P. taeda*	223.76	0.713	98	0.698	0.349
Forest	Fb47	*P. taeda*	344.84	1.098	98	1.076	0.538
Forest	Fb47	*P. taeda*	607.70	1.935	98	1.897	0.948
Forest	Fb47	*P. taeda*	373.46	1.189	98	1.166	0.583
Forest	Fb47	*P. taeda*	801.98	2.554	98	2.503	1.251
Forest	Fb47	*P. taeda*	404.98	1.290	98	1.264	0.632
Forest	Fb47	*P. taeda*	1223.66	3.897	98	3.819	1.910
Forest	Fb47	*P. taeda*	187.19	0.596	98	0.584	0.292
Forest	Fb47	*P. taeda*	396.29	1.262	98	1.237	0.618
Forest	Fb47	*P. taeda*	477.00	1.519	98	1.489	0.744
Forest	Fb47	*P. taeda*	641.58	2.043	98	2.002	1.001
Forest	Fb47	*P. taeda*	84.39	0.269	98	0.263	0.132
Forest	Fb47	*L. styraciflua*	47.06	0.150	98	0.147	0.073
Forest	Fb47	*L. styraciflua*	64.89	0.207	98	0.203	0.101
Forest	Fb47	*L. styraciflua*	151.52	0.483	98	0.473	0.236
Forest	Fb47	*L. styraciflua*	177.01	0.564	98	0.552	0.276
Forest	Fb47	*L. styraciflua*	36.90	0.118	98	0.115	0.058
Forest	Fb47	*L. styraciflua*	18.49	0.059	98	0.058	0.029
Forest	Fb47	*L. styraciflua*	16.00	0.051	98	0.050	0.025
Forest	Fb47	*L. styraciflua*	15.81	0.050	98	0.049	0.025
Forest	Fb47	*L. styraciflua*	11.94	0.038	98	0.037	0.019
Forest	Fb47	*L. styraciflua*	13.47	0.043	98	0.042	0.021
Forest	Fb47	*N. sylvatica*	189.43	0.603	98	0.591	0.296
Forest	Fb47	*N. sylvatica*	35.08	0.112	98	0.109	0.055
Forest	Fb47	*N. sylvatica*	17.28	0.055	98	0.054	0.027
Forest	Fb47	*N. sylvatica*	9.25	0.029	98	0.029	0.014
Forest	Fb47	*N. sylvatica*	46.42	0.148	98	0.145	0.072
Forest	Fb47	*N. sylvatica*	84.19	0.268	98	0.263	0.131
Forest	Fb47	*N. sylvatica*	26.66	0.085	98	0.083	0.042
Forest	Fb47	*I. opaca*	1.72	0.005	98	0.005	0.003
Forest	Fb47	*I. opaca*	4.36	0.014	98	0.014	0.007

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Forest	Fb47	*I. opaca*	34.31	0.109	98	0.107	0.054
Forest	Fb47	*I. opaca*	1.00	0.003	98	0.003	0.002
Forest	Fb47	*I. opaca*	1.68	0.005	98	0.005	0.003
Forest	Fb47	*I. opaca*	7.29	0.023	98	0.023	0.011
Forest	Fb47	*I. opaca*	5.24	0.017	98	0.016	0.008
Forest	Fb47	*I. opaca*	84.19	0.268	98	0.263	0.131
Total			7429.90	23.66		23.19	11.59
Forest	Fb65	*P. taeda*	436.44	1.390	98	1.362	0.681
Forest	Fb65	*P. taeda*	41.78	0.133	98	0.130	0.065
Forest	Fb65	*P. taeda*	633.16	2.016	98	1.976	0.988
Forest	Fb65	*P. taeda*	8.57	0.027	98	0.027	0.013
Forest	Fb65	*P. taeda*	67.88	0.216	98	0.212	0.106
Forest	Fb65	*P. taeda*	529.93	1.688	98	1.654	0.827
Forest	Fb65	*P. taeda*	593.46	1.890	98	1.852	0.926
Forest	Fb65	*P. taeda*	577.37	1.839	98	1.802	0.901
Forest	Fb65	*P. taeda*	560.49	1.785	98	1.749	0.875
Forest	Fb65	*P. taeda*	613.63	1.954	98	1.915	0.958
Forest	Fb65	*P. taeda*	625.02	1.990	98	1.951	0.975
Forest	Fb65	*P. taeda*	885.88	2.821	98	2.765	1.382
Forest	Fb65	*P. taeda*	4.27	0.014	98	0.013	0.007
Forest	Fb65	*P. taeda*	2.55	0.008	98	0.008	0.004
Forest	Fb65	*J. virginiana*	74.39	0.237	98	0.232	0.116
Forest	Fb65	*J. virginiana*	49.44	0.157	98	0.154	0.077
Forest	Fb65	*J. virginiana*	24.25	0.077	98	0.076	0.038
Forest	Fb65	*J. virginiana*	74.39	0.237	98	0.232	0.116
Forest	Fb65	*J. virginiana*	15.16	0.048	98	0.047	0.024
Forest	Fb65	*J. virginiana*	9.10	0.029	98	0.028	0.014
Forest	Fb65	*J. virginiana*	49.44	0.157	98	0.154	0.077
Forest	Fb65	*J. virginiana*	74.39	0.237	98	0.232	0.116
Forest	Fb65	*J. virginiana*	24.25	0.077	98	0.076	0.038
Forest	Fb65	*J. virginiana*	27.29	0.087	98	0.085	0.043
Forest	Fb65	*J. virginiana*	27.29	0.087	98	0.085	0.043
Forest	Fb65	*J. virginiana*	104.78	0.334	98	0.327	0.164
Forest	Fb65	*I. opaca*	41.76	0.133	98	0.130	0.065
Total			6176.38	19.67		19.28	9.64
Transition	Ta1	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Ta1	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Ta1	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Ta1	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Ta1	*J. virginiana*	9.10	0.029	98	0.028	0.014
Total			59.24	0.19		0.18	0.09

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Ta4	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Ta4	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Ta4	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Ta4	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Ta4	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Ta4	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Ta4	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Ta4	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Ta4	*J. virginiana*	0.30	0.001	98	0.001	0.000
Total			95.93	0.31		0.30	0.150
Transition	Ta13	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Ta13	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Ta13	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Ta13	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Ta13	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Ta13	*J. virginiana*	7.70	0.025	98	0.024	0.012
Total			68.58	0.22		0.21	0.107
Transition	Tb29	N/A	0.00	0.000		0.000	0.000
Transition	Tc2	*J. virginiana*	2.66	0.008	98	0.008	0.004
Transition	Tc2	*P. taeda*	4.19	0.013	98	0.013	0.007
Transition	Tc2	*P. taeda*	0.66	0.002	98	0.002	0.001
Transition	Tc2	*P. taeda*	1.53	0.005	98	0.005	0.002
Transition	Tc2	*P. taeda*	1.53	0.005	98	0.005	0.002
Transition	Tc2	*P. taeda*	1.73	0.006	98	0.005	0.003
Transition	Tc2	*P. taeda*	1.53	0.005	98	0.005	0.002
Transition	Tc2	*P. taeda*	2.35	0.007	98	0.007	0.004
Transition	Tc2	*P. taeda*	2.35	0.007	98	0.007	0.004
Transition	Tc2	*P. taeda*	2.35	0.007	98	0.007	0.004
Transition	Tc2	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc2	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc2	*J. virginiana*	21.22	0.068	98	0.066	0.033
Total			87.59	0.28		0.27	0.14
Transition	Tc8	*P. taeda*	0.20	0.001	98	0.001	0.000
Transition	Tc8	*P. taeda*	3.55	0.011	98	0.011	0.006
Transition	Tc8	*P. taeda*	120.98	0.385	98	0.378	0.189
Transition	Tc8	*P. taeda*	49.86	0.159	98	0.156	0.078
Transition	Tc8	*P. taeda*	9.11	0.029	98	0.028	0.014
Transition	Tc8	*P. taeda*	13.41	0.043	98	0.042	0.021

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Tc8	*P. taeda*	87.28	0.278	98	0.272	0.136
Transition	Tc8	*P. taeda*	115.62	0.368	98	0.361	0.180
Transition	Tc8	*P. taeda*	0.40	0.001	98	0.001	0.001
Transition	Tc8	*P. taeda*	0.66	0.002	98	0.002	0.001
Transition	Tc8	*P. taeda*	5.03	0.016	98	0.016	0.008
Transition	Tc8	*P. taeda*	8.74	0.028	98	0.027	0.014
Transition	Tc8	*P. taeda*	113.92	0.363	98	0.356	0.178
Transition	Tc8	*P. taeda*	10.96	0.035	98	0.034	0.017
Transition	Tc8	*P. taeda*	27.26	0.087	98	0.085	0.043
Transition	Tc8	*P. taeda*	8.74	0.028	98	0.027	0.014
Transition	Tc8	*P. taeda*	6.76	0.022	98	0.021	0.011
Transition	Tc8	*P. taeda*	6.76	0.022	98	0.021	0.011
Transition	Tc8	*P. taeda*	8.74	0.028	98	0.027	0.014
Transition	Tc8	*P. taeda*	13.39	0.043	98	0.042	0.021
Transition	Tc8	*P. taeda*	8.74	0.028	98	0.027	0.014
Transition	Tc8	*P. taeda*	156.30	0.498	98	0.488	0.244
Transition	Tc8	*P. taeda*	29.89	0.095	98	0.093	0.047
Transition	Tc8	*P. taeda*	4.19	0.013	98	0.013	0.007
Transition	Tc8	*P. taeda*	15.67	0.050	98	0.049	0.024
Transition	Tc8	*P. taeda*	8.74	0.028	98	0.027	0.014
Transition	Tc8	*P. taeda*	16.10	0.051	98	0.050	0.025
Transition	Tc8	*P. taeda*	61.11	0.195	98	0.191	0.095
Transition	Tc8	*P. taeda*	5.07	0.016	98	0.016	0.008
Transition	Tc8	*P. taeda*	48.24	0.154	98	0.151	0.075
Transition	Tc8	*P. taeda*	64.71	0.206	98	0.202	0.101
Transition	Tc8	*P. taeda*	61.11	0.195	98	0.191	0.095
Transition	Tc8	*P. taeda*	12.81	0.041	98	0.040	0.020
Transition	Tc8	*P. taeda*	12.81	0.041	98	0.040	0.020
Transition	Tc8	*P. taeda*	0.66	0.002	98	0.002	0.001
Transition	Tc8	*P. taeda*	1.15	0.004	98	0.004	0.002
Transition	Tc8	*P. taeda*	1.15	0.004	98	0.004	0.002
Transition	Tc8	*P. taeda*	3.34	0.011	98	0.010	0.005
Transition	Tc8	*P. taeda*	10.68	0.034	98	0.033	0.017
Transition	Tc8	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc8	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc8	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc8	*J. virginiana*	36.38	0.116	98	0.114	0.057
Transition	Tc8	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Tc8	*J. virginiana*	46.72	0.149	98	0.146	0.073
Transition	Tc8	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc8	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Tc8	*J. virginiana*	21.22	0.068	98	0.066	0.033

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Tc8	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc8	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc8	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc8	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc8	*J. virginiana*	51.88	0.165	98	0.162	0.081
Transition	Tc8	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Tc8	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc8	*J. virginiana*	74.39	0.237	98	0.232	0.116
Transition	Tc8	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc8	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Tc8	*J. virginiana*	15.16	0.048	98	0.047	0.024
Total			1652.44	5.26		5.16	2.58
Transition	Tc18	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Tc18	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc18	*J. virginiana*	109.00	0.347	98	0.340	0.170
Transition	Tc18	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc18	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Tc18	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc18	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc18	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc18	*J. virginiana*	109.00	0.347	98	0.340	0.170
Transition	Tc18	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc18	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc18	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Tc18	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Tc18	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Tc18	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc18	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Tc18	*J. virginiana*	7.70	0.025	98	0.024	0.012
Transition	Tc18	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc18	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Tc18	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc18	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc18	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc18	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Tc18	*J. virginiana*	33.35	0.106	98	0.104	0.052
Transition	Tc18	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Tc18	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Tc18	*J. virginiana*	30.32	0.097	98	0.095	0.047

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Tc18	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Tc18	*P. taeda*	9.60	0.031	98	0.030	0.015
Transition	Tc18	*P. taeda*	150.06	0.478	98	0.468	0.234
Total			831.28	2.65		2.59	1.30
Transition	Tc31	*J. virginiana*	49.44	0.157	98	0.1543	0.077
Transition	Tc31	*J. virginiana*	33.35	0.106	98	0.10409	0.052
Transition	Tc31	*J. virginiana*	36.38	0.116	98	0.11355	0.057
Transition	Tc31	*J. virginiana*	7.70	0.025	98	0.02403	0.012
Transition	Tc31	*J. virginiana*	24.25	0.077	98	0.0757	0.038
Transition	Tc31	*J. virginiana*	12.13	0.039	98	0.03785	0.019
Transition	Tc31	*J. virginiana*	33.35	0.106	98	0.10409	0.052
Total			196.60	0.63		0.61	0.31
Transition	Td2	*P. taeda*	1.76	0.006	98	0.005	0.003
Transition	Td2	*P. taeda*	4.19	0.013	98	0.013	0.007
Transition	Td2	*P. taeda*	1.76	0.006	98	0.005	0.003
Transition	Td2	*P. taeda*	1.76	0.006	98	0.005	0.003
Transition	Td2	*P. taeda*	2.06	0.007	98	0.006	0.003
Transition	Td2	*P. taeda*	1.15	0.004	98	0.004	0.002
Transition	Td2	*P. taeda*	62.42	0.199	98	0.195	0.097
Transition	Td2	*P. taeda*	86.99	0.277	98	0.272	0.136
Transition	Td2	*P. taeda*	169.74	0.541	98	0.530	0.265
Transition	Td2	*P. taeda*	140.49	0.447	98	0.438	0.219
Transition	Td2	*P. taeda*	102.52	0.327	98	0.320	0.160
Transition	Td2	*P. taeda*	158.78	0.506	98	0.496	0.248
Transition	Td2	*P. taeda*	33.04	0.105	98	0.103	0.052
Transition	Td2	*P. taeda*	3.34	0.011	98	0.010	0.005
Transition	Td2	*P. taeda*	22.18	0.071	98	0.069	0.035
Transition	Td2	*P. taeda*	2.35	0.007	98	0.007	0.004
Transition	Td2	*P. taeda*	3.34	0.011	98	0.010	0.005
Transition	Td2	*P. taeda*	1.34	0.004	98	0.004	0.002
Transition	Td2	*P. taeda*	1.34	0.004	98	0.004	0.002
Transition	Td2	*P. taeda*	1.34	0.004	98	0.004	0.002
Transition	Td2	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td2	*J. virginiana*	74.39	0.237	98	0.232	0.116
Transition	Td2	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Td2	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Td2	*J. virginiana*	21.22	0.068	98	0.066	0.033
Transition	Td2	*J. virginiana*	21.22	0.068	98	0.066	0.033
Transition	Td2	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Td2	*J. virginiana*	18.19	0.058	98	0.057	0.028

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td2	*J. virginiana*	49.44	0.157	98	0.154	0.077
Transition	Td2	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Td2	*J. virginiana*	36.38	0.116	98	0.114	0.057
Transition	Td2	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Td2	*J. virginiana*	33.35	0.106	98	0.104	0.052
Total			1156.11	3.68		3.61	1.80
Transition	Td9	*J. virginiana*	9.10	0.029	98	0.03	0.014
Transition	Td9	*J. virginiana*	9.10	0.029	98	0.03	0.014
Transition	Td9	*J. virginiana*	12.13	0.039	98	0.04	0.019
Transition	Td9	*J. virginiana*	12.13	0.039	98	0.04	0.019
Transition	Td9	*J. virginiana*	27.29	0.087	98	0.09	0.043
Transition	Td9	*J. virginiana*	33.35	0.106	98	0.10	0.052
Transition	Td9	*J. virginiana*	74.39	0.237	98	0.23	0.116
Transition	Td9	*J. virginiana*	18.19	0.058	98	0.06	0.028
Transition	Td9	*J. virginiana*	30.32	0.097	98	0.09	0.047
Transition	Td9	*J. virginiana*	30.32	0.097	98	0.09	0.047
Transition	Td9	*J. virginiana*	36.38	0.116	98	0.11	0.057
Transition	Td9	*J. virginiana*	18.19	0.058	98	0.06	0.028
Transition	Td9	*J. virginiana*	21.22	0.068	98	0.07	0.033
Transition	Td9	*J. virginiana*	74.39	0.237	98	0.23	0.116
Transition	Td9	*J. virginiana*	33.35	0.106	98	0.10	0.052
Transition	Td9	*J. virginiana*	74.39	0.237	98	0.23	0.116
Transition	Td9	*J. virginiana*	36.38	0.116	98	0.11	0.057
Transition	Td9	*J. virginiana*	18.19	0.058	98	0.06	0.028
Transition	Td9	*J. virginiana*	30.32	0.097	98	0.09	0.047
Transition	Td9	*J. virginiana*	104.78	0.334	98	0.33	0.164
Transition	Td9	*J. virginiana*	21.22	0.068	98	0.07	0.033
Transition	Td9	*J. virginiana*	18.19	0.058	98	0.06	0.028
Transition	Td9	*J. virginiana*	74.39	0.237	98	0.23	0.116
Transition	Td9	*J. virginiana*	21.22	0.068	98	0.07	0.033
Transition	Td9	*J. virginiana*	49.44	0.157	98	0.15	0.077
Transition	Td9	*J. virginiana*	24.25	0.077	98	0.08	0.038
Transition	Td9	*P. taeda*	1.53	0.005	98	0.00	0.002
Transition	Td9	*P. taeda*	2.35	0.007	98	0.01	0.004
Transition	Td9	*P. taeda*	17.94	0.057	98	0.06	0.028
Transition	Td9	*P. taeda*	0.48	0.002	98	0.00	0.001
Transition	Td9	*P. taeda*	1.53	0.005	98	0.00	0.002
Transition	Td9	*P. taeda*	5.63	0.018	98	0.02	0.009
Transition	Td9	*P. taeda*	0.88	0.003	98	0.00	0.001
Transition	Td9	*P. taeda*	8.74	0.028	98	0.03	0.014
Transition	Td9	*P. taeda*	5.63	0.018	98	0.02	0.009
Total			957.33	3.05		2.99	1.49

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td15	*J. virginiana*	21.22	0.068	98	0.066	0.033
Transition	Td15	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td15	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Td15	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td15	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td15	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Td15	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td15	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td15	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Td15	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Td15	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Td15	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td15	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Td15	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Td15	*J. virginiana*	33.35	0.106	98	0.104	0.052
Transition	Td15	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td15	*J. virginiana*	21.22	0.068	98	0.066	0.033
Transition	Td15	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Td15	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Td15	*J. virginiana*	33.35	0.106	98	0.104	0.052
Transition	Td15	*J. virginiana*	30.32	0.097	98	0.095	0.047
Transition	Td15	*J. virginiana*	9.10	0.029	98	0.028	0.014
Transition	Td15	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Td15	*J. virginiana*	12.13	0.039	98	0.038	0.019
Transition	Td15	*J. virginiana*	302.55	0.964	98	0.944	0.472
Transition	Td15	*J. virginiana*	162.39	0.517	98	0.507	0.253
Transition	Td15	*J. virginiana*	192.78	0.614	98	0.602	0.301
Transition	Td15	*J. virginiana*	302.55	0.964	98	0.944	0.472
Transition	Td15	*P. taeda*	70.89	0.226	98	0.221	0.111
Transition	Td15	*P. taeda*	72.40	0.231	98	0.226	0.113
Total			1561.35	4.97		4.87	2.44
Transition	Td33	*P. taeda*	12.28	0.039	98	0.038	0.019
Transition	Td33	*P. taeda*	10.03	0.032	98	0.031	0.016
Transition	Td33	*P. taeda*	2.50	0.008	98	0.008	0.004
Transition	Td33	*P. taeda*	11.15	0.036	98	0.035	0.017
Transition	Td33	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td33	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td33	*J. virginiana*	15.16	0.048	98	0.047	0.024
Transition	Td33	*J. virginiana*	18.19	0.058	98	0.057	0.028
Transition	Td33	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td33	*J. virginiana*	21.22	0.068	98	0.066	0.033

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td33	*J. virginiana*	36.38	0.116	98	0.114	0.057
Transition	Td33	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td33	*J. virginiana*	24.25	0.077	98	0.076	0.038
Total			239.09	0.76		0.75	0.37
Transition	Td39	*P. taeda*	44.71	0.142378	98	0.140	0.070
Transition	Td39	*P. taeda*	147.35	0.46928	98	0.460	0.230
Transition	Td39	*J. virginiana*	140.62	0.447819	98	0.439	0.219
Transition	Td39	*J. virginiana*	15.16	0.048277	98	0.047	0.024
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	18.19	0.057932	98	0.057	0.028
Transition	Td39	*J. virginiana*	51.58	0.164268	98	0.161	0.080
Transition	Td39	*J. virginiana*	66.16	0.210701	98	0.206	0.103
Transition	Td39	*J. virginiana*	24.25	0.077243	98	0.076	0.038
Transition	Td39	*J. virginiana*	27.29	0.086899	98	0.085	0.043
Transition	Td39	*J. virginiana*	30.32	0.096554	98	0.095	0.047
Transition	Td39	*J. virginiana*	9.10	0.028966	98	0.028	0.014
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	9.10	0.028966	98	0.028	0.014
Transition	Td39	*J. virginiana*	33.35	0.10621	98	0.104	0.052
Transition	Td39	*J. virginiana*	33.35	0.10621	98	0.104	0.052
Transition	Td39	*J. virginiana*	27.29	0.086899	98	0.085	0.043
Transition	Td39	*J. virginiana*	15.16	0.048277	98	0.047	0.024
Transition	Td39	*J. virginiana*	49.44	0.157452	98	0.154	0.077
Transition	Td39	*J. virginiana*	104.78	0.333694	98	0.327	0.164
Transition	Td39	*J. virginiana*	27.29	0.086899	98	0.085	0.043
Transition	Td39	*J. virginiana*	36.38	0.115865	98	0.114	0.057
Transition	Td39	*J. virginiana*	104.78	0.333694	98	0.327	0.164
Transition	Td39	*J. virginiana*	18.19	0.057932	98	0.057	0.028
Transition	Td39	*J. virginiana*	15.16	0.048277	98	0.047	0.024
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	9.10	0.028966	98	0.028	0.014
Transition	Td39	*J. virginiana*	41.87	0.133344	98	0.131	0.065
Transition	Td39	*J. virginiana*	27.29	0.086899	98	0.085	0.043
Transition	Td39	*J. virginiana*	15.16	0.048277	98	0.047	0.024
Transition	Td39	*J. virginiana*	12.13	0.038622	98	0.038	0.019
Transition	Td39	*J. virginiana*	30.32	0.096554	98	0.095	0.047
Transition	Td39	*J. virginiana*	27.29	0.086899	98	0.085	0.043
Transition	Td39	*J. virginiana*	30.32	0.096554	98	0.095	0.047
Transition	Td39	*J. virginiana*	140.62	0.447834	98	0.439	0.219
Total			1443.69	4.60		4.51	2.25

Zone	Site	Species	Dry wt. kg	Dry wt. kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td50	*J. virginiana*	24.25	0.077	98	0.076	0.038
Transition	Td50	*J. virginiana*	33.35	0.106	98	0.104	0.052
Transition	Td50	*J. virginiana*	33.35	0.106	98	0.104	0.052
Transition	Td50	*J. virginiana*	27.29	0.087	98	0.085	0.043
Transition	Td50	*P. taeda*	22.18	0.071	98	0.069	0.035
Total			140.42	0.45		0.44	0.22

APPENDIX C. SUMMATION OF BIOMASS, ASH-FREE DRY WEIGHT, AND CARBON MASS OF SHRUBS PER FOREST AND TRANSITON SITE

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Forest	Fa18	N/A	0.0	0.0		0.0	0.0
Forest	Fa30	N/A	0.0	0.0		0.0	0.0
Forest	Fb29	*Myrica cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb29	*M. cerifera*	2.78	0.04	98	0.03	0.017
Forest	Fb29	*M. cerifera*	1.88	0.02	98	0.02	0.012
Forest	Fb29	*M. cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb29	*M. cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb29	*M. cerifera*	0.56	0.01	98	0.01	0.003
Total			16.27	0.21		0.20	0.10
Forest	Fb47		0.0	0.0		0.0	0.0
Forest	Fb65	*M. cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb65	*M. cerifera*	2.78	0.04	98	0.03	0.017
Forest	Fb65	*M. cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb65	*M. cerifera*	3.68	0.05	98	0.05	0.023
Forest	Fb65	*M. cerifera*	0.97	0.01	98	0.01	0.006
Total			14.80	0.19		0.18	0.09
Transition	Ta1	*Baccharis halimifolia*	0.46	0.006	98	0.01	0.003
Transition	Ta1	*B. halimifolia*	1.02	0.013	98	0.01	0.006
Transition	Ta1	*B. halimifolia*	1.02	0.013	98	0.01	0.006
Transition	Ta1	*B. halimifolia*	0.37	0.005	98	0.00	0.002
Total			2.86	0.04		0.04	0.02
Transition	Ta4	*B. halimifolia*	0.46	0.006	98	0.006	0.003
Transition	Ta4	*B. halimifolia*	1.20	0.015	98	0.015	0.007
Transition	Ta4	*B. halimifolia*	0.37	0.005	98	0.005	0.002
Total			2.03	0.03	98	0.03	0.01
Transition	Ta13	*Iva frutescens*	0.24	0.003	98	0.003	0.002
Transition	Ta13	*I. frutescens*	0.17	0.002	98	0.002	0.001
Transition	Ta13	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Ta13	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Ta13	*I. frutescens*	0.52	0.007	98	0.007	0.003
Transition	Ta13	*I. frutescens*	0.24	0.003	98	0.003	0.002
Transition	Ta13	*I. frutescens*	0.35	0.004	98	0.004	0.002
Transition	Ta13	*I. frutescens*	0.24	0.003	98	0.003	0.002
Transition	Ta13	*I. frutescens*	0.90	0.012	98	0.011	0.006

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Ta13	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Ta13	*I. frutescens*	0.35	0.004	98	0.004	0.002
Transition	Ta13	*I. frutescens*	0.17	0.002	98	0.002	0.001
Transition	Ta13	*I. frutescens*	0.52	0.007	98	0.007	0.003
Transition	Ta13	*I. frutescens*	1.04	0.013	98	0.013	0.007
Transition	Ta13	*I. frutescens*	0.90	0.012	98	0.011	0.006
Transition	Ta13	*I. frutescens*	0.83	0.011	98	0.010	0.005
Transition	Ta13	*I. frutescens*	0.83	0.011	98	0.010	0.005
Transition	Ta13	*I. frutescens*	1.22	0.015	98	0.015	0.008
Transition	Ta13	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Ta13	*I. frutescens*	0.17	0.002	98	0.002	0.001
Transition	Ta13	*I. frutescens*	0.52	0.007	98	0.007	0.003
Transition	Ta13	*B. halimifolia*	1.02	0.013	98	0.013	0.006
Transition	Ta13	*B. halimifolia*	0.74	0.009	98	0.009	0.005
Transition	Ta13	*B. halimifolia*	1.58	0.020	98	0.020	0.010
Total			15.36	0.20		0.19	0.10
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Tb29	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Tb29	*I. frutescens*	0.69	0.009	98	0.009	0.004
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	1.19	0.015	98	0.015	0.007
Transition	Tb29	*I. frutescens*	1.10	0.014	98	0.014	0.007
Transition	Tb29	*I. frutescens*	0.92	0.012	98	0.011	0.006
Transition	Tb29	*I. frutescens*	0.46	0.006	98	0.006	0.003
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Transition	Tb29	*I. frutescens*	0.23	0.003	98	0.003	0.001
Total			16.99	0.22		0.21	0.11
Transition	Tc2	*B. halimifolia*	0.37	0.005	98	0.005	0.002
Transition	Tc2	*B. halimifolia*	0.46	0.006	98	0.006	0.003
Transition	Tc2	*B. halimifolia*	0.12	0.002	98	0.001	0.001
Transition	Tc2	*B. halimifolia*	0.78	0.010	98	0.010	0.005
Transition	Tc2	*M. cerifera*	1.88	0.024	98	0.023	0.012
Total			3.61	0.05		0.05	0.02
Transition	Tc8	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc8	*M. cerifera*	0.56	0.007	98	0.007	0.003
Transition	Tc8	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc8	*M. cerifera*	6.39	0.081	98	0.080	0.040
Transition	Tc8	*M. cerifera*	7.30	0.093	98	0.091	0.046
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc8	*M. cerifera*	0.56	0.007	98	0.007	0.003
Transition	Tc8	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc8	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc8	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc8	*M. cerifera*	6.39	0.081	98	0.080	0.040
Transition	Tc8	*M. cerifera*	7.30	0.093	98	0.091	0.046
Transition	Tc8	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc8	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Tc8	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc8	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc8	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc8	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Tc8	*M. cerifera*	0.56	0.007	98	0.007	0.003
Transition	Tc8	*M. cerifera*	5.49	0.070	98	0.069	0.034
Transition	Tc8	*M. cerifera*	7.30	0.093	98	0.091	0.046
Total			76.39	0.97		0.95	0.48
Transition	Tc18	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc18	*M. cerifera*	6.39	0.081	98	0.080	0.040
Transition	Tc18	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc18	*M. cerifera*	4.59	0.058	98	0.057	0.029
Transition	Tc18	*M. cerifera*	6.39	0.081	98	0.080	0.040
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	4.59	0.058	98	0.057	0.029
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Tc18	*M. cerifera*	0.56	0.007	98	0.007	0.003
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Tc18	*M. cerifera*	1.88	0.024	98	0.023	0.012
Total			62.77	0.80		0.78	0.39
Transition	Tc31	*I. frutescens*	1.61	0.020	98	0.020	0.010
Transition	Tc31	*B. halimifolia*	0.46	0.006	98	0.006	0.003
Transition	Tc31	*B. halimifolia*	0.78	0.010	98	0.010	0.005
Total			2.85	0.04		0.04	0.02
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td2	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td2	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td2	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td2	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td2	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td2	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td2	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td2	*M. cerifera*	7.30	0.093	98	0.091	0.046
Transition	Td2	*B. halimifolia*	1.93	0.025	98	0.024	0.012
Total			42.17	0.54		0.53	0.26
Transition	Td9	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Td9	*M. cerifera*	4.14	0.053	98	0.052	0.026
Transition	Td9	*M. cerifera*	5.49	0.070	98	0.069	0.034
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	3.68	0.047	98	0.046	0.023
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td9	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td9	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td9	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td9	*M. cerifera*	2.88	0.037	98	0.036	0.018
Total			42.54	0.54		0.53	0.27

Zone	Site	Species	Biomass kg	Biomass kg/m^2	% Organic Matter	AFDW kg/m^2	Organic carbon kg/m^2
Transition	Td15	*M. cerifera*	4.14	0.05	98	0.05	0.03
Transition	Td33	N/A	0.00	0.000		0.00	0.000
Transition	Td39	*M. cerifera*	2.88	0.037	98	0.036	0.018
Transition	Td39	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td39	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td39	*M. cerifera*	2.78	0.035	98	0.035	0.017
Transition	Td39	*M. cerifera*	0.97	0.012	98	0.012	0.006
Total			10.39	0.13		0.12	0.06
Transition	Td50	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td50	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td50	*M. cerifera*	0.97	0.012	98	0.012	0.006
Transition	Td50	*M. cerifera*	2.62	0.033	98	0.033	0.016
Transition	Td50	*M. cerifera*	1.88	0.024	98	0.023	0.012
Transition	Td50	*M. cerifera*	1.88	0.024	98	0.023	0.012
Total			10.19	0.13		0.13	0.06

APPENDIX D. HERBACEOUS VEGETATION: SUMMARY OF BIOMASS, ASH-FREE DRY WEIGHT, AND ORGANIC CARBON (KG/M^2) PER SITE.

Zone	Site	Biomass	AFDW	Organic C
Forest	Fa18	0.09	0.09	0.05
Forest	Fa30	0.01	0.01	0.00
Forest	Fb29	0.03	0.03	0.02
Forest	Fb47	0.01	0.01	0.00
Forest	Fb65	0.05	0.05	0.02
Transition	Ta1	1.09	1.00	0.50
Transition	Ta4	1.21	1.11	0.56
Transition	Ta13	0.90	0.83	0.41
Transition	Tb29	1.56	1.43	0.72
Transition	Tc2	0.97	0.90	0.45
Transition	Tc8	0.61	0.56	0.28
Transition	Tc18	1.14	1.04	0.52
Transition	Tc31	0.54	0.50	0.25
Transition	Td2	0.80	0.74	0.37
Transition	Td9	1.16	1.06	0.53
Transition	Td15	0.97	0.90	0.45
Transition	Td33	1.02	0.94	0.47
Transition	Td39	0.80	0.73	0.37
Transition	Td50	1.61	1.48	0.74
High Marsh	Ha5	1.26	1.16	0.58
High Marsh	Ha14	1.24	1.14	0.57
High Marsh	Ha19	0.71	0.66	0.33
High Marsh	Ha21	0.49	0.45	0.22
High Marsh	Ha36	1.03	0.95	0.47
High Marsh	Ha41	0.92	0.85	0.42
High Marsh	Ha52	0.45	0.41	0.21
High Marsh	Hb1	0.85	0.78	0.39
High Marsh	Hb4	1.06	0.97	0.49
High Marsh	Hc1	1.43	1.32	0.66
High Marsh	Hc30	2.56	2.35	1.18
High Marsh	Hc37	0.05	0.04	0.02
High Marsh	Hc41	0.46	0.42	0.21
High Marsh	Hc42	2.74	2.52	1.26
High Marsh	Hc48	1.54	1.38	0.69
High Marsh	Hc72	1.05	0.97	0.48
High Marsh	Hc75	1.83	1.64	0.82
High Marsh	Hc84	0.69	0.64	0.32
High Marsh	Hc92	0.66	0.60	0.30
High Marsh	Ma1	2.71	2.49	1.25
High Marsh	Ma15	1.53	1.41	0.70

Zone	Site	Biomass	AFDW	Organic C
High Marsh	Mc2	0.47	0.43	0.22
High Marsh	Tb4	0.95	0.88	0.44
High Marsh	Tb14	0.81	0.75	0.37
High Marsh	Tb23	1.30	1.20	0.60
LMSS	LSa8	0.36	0.30	0.15
LMSS	LSa12	0.73	0.58	0.29
LMSS	LSb2	0.57	0.45	0.22
LMSS	LSb16	0.78	0.68	0.34
LMSS	LSb17	0.87	0.69	0.34
LMSS	LSb46	0.60	0.50	0.25
LMSS	LSb53	0.58	0.45	0.23
LMSS	LSb55	0.70	0.54	0.27
LMSS	Mb4	0.42	0.34	0.17
LMTS	LTS6	0.82	0.67	0.33
LMTS	LTS9	1.06	0.85	0.43
LMTS	LT6	1.66	1.33	0.67
LMTS	LT12	1.48	1.22	0.61
LMTS	LT25	1.12	0.92	0.46
LMTS	LT29	0.58	0.44	0.22
LMTS	LT33	1.23	0.96	0.48

APPENDIX E. QUALITATIVE CHARACTERISTICS - DAUBENMIRE'S PERCENT GROUNDCOVER, DOMINANT HERBACEOUS SPECIES, DEPTH OF SOIL ORGANIC MATTER, AND WOODY VINES.

Zone	Site	Quadrat	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm	Woody vines Species	Woody vines # / ha
Forest	Fa18	1	0	none	5	*R. radicans*	2737
Forest	Fa18	2	15	*Smilax* spp.	4	*Campsis radicans*	64
Forest	Fa18	3	15	*Smilax* spp.	3		
Forest	Fa18	4	15	*Smilax* spp.	3		
Forest	Fa18	5	37.5	*Smilax* spp.	6		
Forest	Fa30	1	2.5	*Rhus radicans*	6	*R. radicans*	2642
Forest	Fa30	2	2.5	*R. radicans*	5	*C. radicans*	382
Forest	Fa30	3	2.5	*R. radicans*	4		
Forest	Fa30	4	2.5	*R. radicans*	3		
Forest	Fa30	5	2.5	*R. radicans*	5		
Forest	Fb29	1	15	*R. radicans*/ *Smilax* spp.	8	*R. radicans*	891
Forest	Fb29	2	2.5	*R. radicans*	5	*C. radicans*	32
Forest	Fb29	3	2.5	*R. radicans*	5		
Forest	Fb29	4	2.5	*R. radicans*	4		
Forest	Fb29	5	0	none	3		
Forest	Fb47	1	2.5	*Mitchella repens*	7	*R. radicans*	318
Forest	Fb47	2	15	*Smilax* spp.	6	*C. radicans*	95
Forest	Fb47	3	2.5	*Mitchella repens*	8		
Forest	Fb47	4	15	*M. repens/ Smilax spp.*	6		
Forest	Fb47	5	0	none	7		

Zone	Site	Quadrat	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm	Woody vines Species	# / ha
Forest	Fb65	1	15	*Panicum virgatum*	5	*R. radicans*	318
Forest	Fb65	2	15	*Smilax* spp.	7	*C. radicans*	64
Forest	Fb65	3	15	*Smilax* spp.	7		
Forest	Fb65	4	0	none	4		
Forest	Fb65	5	15	*Smilax* spp.	6		
Transition	Ta1	1	67.5	*S. patens/ D. spicata*	30	*R. radicans*	64
Transition	Ta1	2	67.5	*D. spicata*	30		
Transition	Ta1	3	85	*S. patens*	20		
Transition	Ta1	4	100	*S. patens*	20		
Transition	Ta1	5	100	*S. patens*	unknown		
Transition	Ta13	1	97.5	*S. patens*	20	none	
Transition	Ta13	2	97.5	*D. spicata*	20		
Transition	Ta13	3	97.5	*S. patens*	20		
Transition	Ta13	4	97.5	*S. patens/ D. spicata*	20		
Transition	Ta13	5	100	*S. patens/ D. spicata*	15		
Transition	Ta4	1	67.5	*D. spicata*	20	*R. radicans*	32
Transition	Ta4	2	67.5	*D. spicata*	20		
Transition	Ta4	3	85	*D. spicata*	20		
Transition	Ta4	4	85	*D. spicata*	10		
Transition	Ta4	5	97.5	*S. patens*	10		
Transition	Tb29	1	97.5	*S. patens*	20	none	

Zone	Site	Quadrat	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm	Woody vines Species	# / ha
Transition	Tb29	2	97.5	*S. patens/ D. spicata*	15		
Transition	Tb29	3	97.5	*S. patens/ D. spicata*	7		
Transition	Tc2	1	67.5	*S. patens*	20	none	
Transition	Tc2	2	67.5	*Juncus roemerianus*	20		
Transition	Tc2	3	67.5	*D. spicata*	15		
Transition	Tc2	4	67.5	*D. spicata*	20		
Transition	Tc2	5	100	*S. patens*	20		
Transition	Tc8	1	97.5	*S. patens/ D. spicata/ P. virgatum*	20	*R. radicans*	286
Transition	Tc8	2	100	*S. patens*	20		
Transition	Tc8	3	100	*Juncus/ S. patens*	10		
Transition	Tc8	4	100	*Panicum/ S. patens*	20		
Transition	Tc8	5	85	*S. patens*	15		
Transition	Tc18	1	67.5	*Juncus*	15	none	
Transition	Tc18	2	37.5	*Juncus*	10		
Transition	Tc18	3	85	*S. patens*	10		
Transition	Tc18	4	67.5	*D. spicata*	8		
Transition	Tc18	5	85	*D. spicata*	15		
Transition	Tc31	1	97.5	*S. patens/ D. spicata*	20	*R. radicans*	32
Transition	Tc31	2	67.5	*D. spicata*	20		
Transition	Tc31	3	85	*D. spicata/ Scirpus spp.*	15		

Zone	Site	Quadrat	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm	Woody vines Species	# / ha
Transition	Tc31	4	97.5	*S. patens/ D. spicata*	20		
Transition	Tc31	5	85	*S. patens*	15		
Transition	Td15	1	97.5	*D. spicata*	18	*R. radicans*	64
Transition	Td15	2	97.5	*S. patens/ D. spicata*	10		
Transition	Td15	3	97.5	*S. patens/ D. spicata*	10		
Transition	Td15	4	85	*D. spicata*	10		
Transition	Td15	5	97.5	*D. spicata*	20		
Transition	Td2	1	100	*D. spicata*	15	*R. radicans*	668
Transition	Td2	2	97.5	*D. spicata*	19		
Transition	Td2	3	97.5	*S. patens*	17		
Transition	Td2	4	100	*Juncus*	10		
Transition	Td2	5	100	*S. patens*	15		
Transition	Td33	1	67.5	*D. spicata*	30	*R. radicans*	32
Transition	Td33	2	67.5	*D. spicata*	25		
Transition	Td33	3	85	*D. spicata*	25		
Transition	Td33	4	85	*D. spicata*	20		
Transition	Td33	5	100	*S. patens*	15		
Transition	Td39	1	85	*D. spicata*	25	*R. radicans*	95
Transition	Td39	2	100	*S. patens*	20		
Transition	Td39	3	100	*S. patens/ D. spicata*	10		

Zone	Site	Quadrat	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm	Woody vines Species	# / ha
Transition	Td39	4	97.5	*P. virgatum*	10		
Transition	Td39	5	97.5	*S. patens*	10		
Transition	Td50	1	67.5	*D. spicata*	25	*R. radicans*	95
Transition	Td50	2	85	*D. spicata*	25		
Transition	Td50	3	67.5	*D. spicata*	28		
Transition	Td50	4	85	*Juncus*	20		
Transition	Td50	5	85	*Juncus*	20		
Transition	Td9	1	85	*S. patens*	20		
Transition	Td9	2	85	*Juncus*	15		
Transition	Td9	3	85	*S. patens/ D. spicata*	15	*R. radicans*	191
Transition	Td9	4	85	*Juncus*	10		
Transition	Td9	5	67.5	*D. spicata*	20		
High marsh	Tb23	3	97.5	*S. patens*	9		
High marsh	Tb4	2	85	*Juncus*	7		
High marsh	Tb14	2	85	*D. spicata*	0		
High marsh	Ha5	N/A	100.0	*S .patens / D. spicata*	5		
High marsh	Ha14	N/A	100.0	*S. patens / D. spicata*	12		
High marsh	Ha19	N/A	85.0	*D. spicata*	15		
High marsh	Ha21	N/A	85.0	*D. spicata*	13		
High marsh	Ha36	N/A	97.5	*S. patens / D. spicata*	12		

Zone	Site	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm
High marsh	Ha41	97.5	*S. patens/ D. spicata*	5
High marsh	Ha52	85.0	*D. spicata*	7
High marsh	Hb1	100.0	*S. patens/ D. spicata*	8
High marsh	Hb4	100.0	*S. patens/ D. spicata*	16
High marsh	Hc1	100.0	*Juncus/ D. spicata*	33
High marsh	Hc30	100.0	*Juncus*	33
High marsh	Hc37	37.5	*D. spicata*	35
High marsh	Hc41	37.5	*D. spicata*	26
High marsh	Hc42	100.0	*Juncus*	28
High marsh	Hc68	100.0	*S. patens / D. spicata*	30
High marsh	Hc72	67.5	*S. alterniflora*	38
High marsh	Hc75	97.5	*D. spicata / S. patens*	20
High marsh	Hc84	100.0	*S. patens*	14
High marsh	Hc92	100.0	*S. patens / D. spicata*	57
High marsh	Ma1	100.0	*Juncus*	22
High marsh	Ma15	67.5	*S. patens / D. spicata*	8
High marsh	Mc2	85.0	*S. alterniflora*	70
LMSS	Mb4	67.5	*S. alterniflora*	0
LMSS	LSa8	37.5	*S. alterniflora*	0

Zone	Site	Daub. % ground cover	Dominant Herb. species	Soil organic depth cm
LMSS	LSa12	37.5	*S. alterniflora*	0
LMSS	LSb2	67.5	*S. alterniflora*	0
LMSS	LSb16	37.5	*D. spicata*	0
LMSS	LSb17	67.5	*S. alterniflora*	0
LMSS	LSb46	67.5	*S. alterniflora*	0
LMSS	LSb53	67.5	*S. alterniflora*	0
LMSS	LSb54	67.5	*S. alterniflora*	0
LMTS	LT6	37.5	*S. alterniflora*	0
LMTS	LT12	15.0	*S. alterniflora*	0
LMTS	LT25	15.0	*S. alterniflora*	0
LMTS	LT29	37.5	*S. alterniflora*	0
LMTS	LT33	37.5	*S. alterniflora*	0
LMTS	LTS6	15.0	*S. alterniflora*	0
LMTS	LTS9	15.0	*S. alterniflora*	0

APPENDIX F. MACROORGANIC MATTER OVEN-DRY MASS AND ORGANIC CARBON MASS (KG/M^2) PER SITE.

		0 to 10 cm		10 to 20 cm		20 to 30 cm		Total 0 to 30 cm		30 to 50 cm		Total 0 to 50	
Zone	Site	Dry	OC	Dry	OC	Dry	OC	Dry	OC	Dry	OC	Dry	OC
Forest	Fa18	1.79	0.77	0.52	0.24	0.29	0.13	2.60	1.13	0.29	0.13	2.89	1.26
Forest	Fa30	-	-	-	-	-	-	2.01	0.91	0.32	0.14	2.33	1.04
Forest	Fb29	3.17	1.43	0.68	0.25	0.27	0.12	4.12	1.80	1.10	0.47	5.22	2.27
Forest	Fb47	2.07	0.92	0.73	0.32	0.32	0.14	3.12	1.38	0.25	0.10	3.36	1.48
Forest	Fb65	3.70	1.72	0.64	0.29	0.33	0.14	4.67	2.16	0.33	0.14	5.00	2.30
Transition	Ta1	3.01	1.38	0.64	0.23	0.22	0.08	3.87	1.69				
Transition	Ta4	3.60	1.59	0.47	0.19	0.28	0.10	4.35	1.87				
Transition	Ta13	3.01	1.37	0.65	0.27	0.37	0.15	4.02	1.79				
Transition	Tb29	2.31	0.99	1.26	0.48	0.31	0.11	3.88	1.58				
Transition	Tc2	3.70	1.66	0.51	0.22	0.21	0.09	4.42	1.97				
Transition	Tc8	2.26	0.97	0.60	0.22	0.31	0.13	3.17	1.32				
Transition	Tc18	2.01	0.91	0.35	0.15	0.12	0.05	2.48	1.12				
Transition	Tc31	2.20	1.00	0.74	0.30	0.32	0.10	3.26	1.40				
Transition	Td2	3.30	1.51	0.39	0.18	0.14	0.06	3.84	1.74				
Transition	Td9	5.19	2.26	1.19	0.53	0.22	0.10	6.60	2.89				
Transition	Td15	3.32	1.55	1.01	0.46	0.28	0.11	4.61	2.12				
Transition	Td33	3.59	1.60	1.76	0.78	1.20	0.49	6.55	2.87				
Transition	Td39	2.96	1.34	0.96	0.44	0.33	0.15	4.25	1.93				
Transition	Td50	4.10	1.90	1.42	0.62	0.58	0.25	6.10	2.77				
High Marsh	Ha5	7.01	3.02	1.09	0.36	0.27	0.23	8.38	3.61				
High Marsh	Ha14	7.41	3.28	1.74	0.76	0.27	0.23	9.43	4.27				
High Marsh	Ha19	2.64	1.26	1.57	0.68	0.44	0.18	4.64	2.12				
High Marsh	Ha21	3.85	1.79	3.55	1.61	0.31	0.13	7.71	3.54				
High Marsh	Ha36	6.53	3.00	2.48	1.12	0.27	0.11	9.28	4.23				
High Marsh	Ha41	4.55	2.06	0.71	0.31	0.23	0.09	5.49	2.46				
High Marsh	Ha52	5.87	2.76	0.85	0.39	0.12	0.05	6.84	3.20				
High Marsh	Hc1	5.38	2.44	2.90	1.21	1.27	0.58	9.55	4.23				
High Marsh	Hc30	3.36	1.51	2.72	1.23	1.18	0.55	7.27	3.29				

		0 to 10 cm		10 to 20 cm		20 to 30 cm		Total 0 to 30 cm	
Zone	Site	Dry	OC	Dry	OC	Dry	OC	Dry	OC
High Marsh	Hc37	3.78	1.58	2.61	1.15	1.28	0.54	7.66	3.27
High Marsh	Hc41	3.24	1.54	3.64	1.58	1.85	0.85	8.72	3.96
High Marsh	Hc42	5.83	2.70	4.09	1.88	1.31	0.57	11.23	5.15
High Marsh	Hc68	5.86	2.70	5.00	2.33	1.19	0.56	12.06	5.58
High Marsh	Hc72	4.64	2.10	3.01	1.37	0.74	0.28	8.40	3.75
High Marsh	Hc75	5.71	2.58	3.40	1.54	4.39	1.20	13.49	5.32
High Marsh	Hc84	5.42	2.52	2.36	1.05	2.31	0.81	10.08	4.38
High Marsh	Hc92	7.50	3.14	5.53	2.51	3.53	1.66	16.56	7.32
High Marsh	Ma1	4.71	2.16	2.84	1.30	1.60	0.67	9.15	4.13
High Marsh	Ma15	4.06	1.91	3.67	1.60	1.18	0.55	8.91	4.06
High Marsh	Mc2	5.14	2.32	4.01	1.76	4.12	1.77	13.27	5.85
High Marsh	Tb4	5.52	2.33	0.25	0.10	0.14	0.05	5.92	2.48
High Marsh	Tb14	2.01	0.88	0.18	0.07	0.12	0.03	2.31	0.98
High Marsh	Tb23	2.95	1.40	1.17	0.49	0.35	0.14	4.47	2.04
LMSS	LSa8	4.49	1.86	1.79	0.84	1.09	0.44	7.37	3.13
LMSS	LSa12	2.48	1.07	1.55	0.55	0.33	0.08	4.37	1.69
LMSS	LSb2	5.17	2.25	4.37	1.91	2.05	0.84	11.60	4.99
LMSS	LSb16	3.77	1.58	0.89	0.30	0.23	0.08	4.89	1.96
LMSS	LSb17	4.66	2.11	2.89	1.04	0.52	0.16	8.07	3.31
LMSS	LSb46	7.19	3.20	3.54	1.64	1.74	0.80	12.47	5.64
LMSS	LSb53	3.36	1.43	2.72	1.14	1.18	0.43	7.27	3.00
LMSS	LSb54	4.53	1.96	3.05	1.35	1.54	0.68	9.12	3.98
LMSS	Mb4	5.30	2.24	3.73	1.54	1.05	0.41	10.08	4.19
LMTS	LT6	1.75	0.68	1.66	0.65	1.28	0.45	4.69	1.78
LMTS	LT12	2.48	1.05	1.55	0.67	1.30	0.52	5.34	2.23
LMTS	LT25	2.92	1.19	2.69	1.16	2.37	1.05	7.98	3.40
LMTS	LT29	2.03	0.79	1.38	0.54	0.72	0.25	4.12	1.58
LMTS	LT33	1.23	0.56	1.20	0.52	1.09	0.44	3.52	1.52
LMTS	LTS6	3.49	1.43	3.76	1.52	0.82	0.31	8.06	3.25
LMTS	LTS9	4.12	1.81	2.67	1.13	1.30	0.52	8.10	3.46

APPENDIX G. BELOWGROUND TOTAL ORGANIC MATTER AND TOTAL ORGANIC CARBON IN 10 cm INCREMENTS FOR ALL SITES.

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	*Pinus taeda* root OC kg/m^2	Fine root OC kg/m^2 @ 30 to 50 cm
Forest	Fa18	1	0 to10	0.636	10.60	6.74	3.37				
Forest	Fa18	2	0 to10	0.304	20.26	6.15	3.08				
Forest	Fa18	3	0 to10	0.437	16.71	7.31	3.65				
Forest	Fa18	4	0 to10	0.491	23.93	11.75	5.88				
Forest	Fa18	5	0 to10	0.379	22.38	8.47	4.24	8.09	4.04		
Forest	Fa18	1	10 to 20	1.234	3.61	4.45	2.23				
Forest	Fa18	2	10 to 20	0.922	4.01	3.70	1.85				
Forest	Fa18	3	10 to 20	0.759	4.84	3.68	1.84				
Forest	Fa18	4	10 to 20	0.928	3.46	3.21	1.60				
Forest	Fa18	5	10 to 20	1.012	4.22	4.27	2.14	3.86	1.93		
Forest	Fa18	1	20 to 30	1.251	1.82	2.28	1.14				
Forest	Fa18	2	20 to 30	0.737	3.55	2.62	1.31				
Forest	Fa18	3	20 to 30	0.783	4.62	3.62	1.81				
Forest	Fa18	4	20 to 30	1.074	2.15	2.31	1.15				
Forest	Fa18	5	20 to 30	1.000	3.63	3.63	1.82	2.89	1.45	2.24	0.13
Total 0 to 30								14.84	7.42		
Site Total TOC											9.79
Forest	Fa30	1	0 to10	0.612	28.23	17.28	8.64				
Forest	Fa30	2	0 to10	0.416	26.10	10.86	5.43				
Forest	Fa30	3	0 to10	0.416	17.95	7.47	3.74				
Forest	Fa30	4	0 to10	0.710	19.76	14.04	7.02				
Forest	Fa30	5	0 to10	0.623	20.63	12.85	6.43	12.50	6.25		
Forest	Fa30	1	10 to 20	1.365	5.83	7.96	3.98				
Forest	Fa30	2	10 to 20	1.055	4.95	5.22	2.61				
Forest	Fa30	3	10 to 20	0.747	3.89	2.90	1.45				

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2	Fine root OC kg/m^2 @ 30 to 50 cm
Forest	Fa30	4	10 to 20	1.381	5.29	7.30	3.65				
Forest	Fa30	5	10 to 20	1.121	2.69	3.02	1.51	5.28	2.64		
Forest	Fa30	1	20 to 30	1.510	4.70	7.11	3.55				
Forest	Fa30	2	20 to 30	1.321	5.05	6.67	3.33				
Forest	Fa30	3	20 to 30	1.448	3.10	4.49	2.25				
Forest	Fa30	4	20 to 30	1.398	4.26	5.95	2.97				
Forest	Fa30	5	20 to 30	1.348	2.08	2.81	1.40	5.40	2.70	4.00	0.14
Total 0 to 30								23.19	11.59		
Site Total TOC											15.74
Forest	Fb29	1	0 to 10	0.384	39.58	15.20	7.60				
Forest	Fb29	2	0 to 10	0.348	23.67	8.24	4.12				
Forest	Fb29	3	0 to 10	0.085	66.18	5.62	2.81				
Forest	Fb29	4	0 to 10	0.524	15.40	8.07	4.04	9.29	4.64		
Forest	Fb29	1	10 to 20	0.736	5.35	3.93	1.97				
Forest	Fb29	2	10 to 20	0.712	3.99	2.84	1.42				
Forest	Fb29	3	10 to 20	0.266	14.44	3.83	1.92				
Forest	Fb29	4	10 to 20	0.692	5.31	3.67	1.84				
Forest	Fb29	5	10 to 20	1.148	2.49	2.86	1.43	3.43	1.71		
Forest	Fb29	1	20 to 30	1.456	2.79	4.06	2.03				
Forest	Fb29	2	20 to 30	1.036	4.73	4.90	2.45				
Forest	Fb29	4	20 to 30	1.094	5.28	5.78	2.89				
Forest	Fb29	5	20 to 30	1.029	2.39	2.46	1.23	4.30	2.15	1.13	0.47
Total 0 to 30 cm								17.01	8.51		
Site Total TOC											10.11

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2	Fine root OC kg/m^2 @ 30 to 50 cm
Forest	Fb47	1	0 to 10	0.567	15.57	8.82	4.41				
Forest	Fb47	2	0 to 10	0.395	20.92	8.27	4.13				
Forest	Fb47	3	0 to 10	0.301	43.38	13.06	6.53				
Forest	Fb47	4	0 to 10	0.421	24.43	10.29	5.14				
Forest	Fb47	5	0 to 10	0.652	12.99	8.48	4.24	9.78	4.89		
Forest	Fb47	1	10 to 20	0.692	9.07	6.28	3.14				
Forest	Fb47	2	10 to 20	0.715	5.96	4.26	2.13				
Forest	Fb47	3	10 to 20	0.812	6.68	5.42	2.71				
Forest	Fb47	4	10 to 20	0.688	7.69	5.29	2.64				
Forest	Fb47	5	10 to 20	0.760	6.91	5.25	2.63	5.30	2.65		
Forest	Fb47	1	20 to 30	1.103	6.15	6.78	3.39				
Forest	Fb47	2	20 to 30	0.842	3.95	3.33	1.66				
Forest	Fb47	3	20 to 30	0.870	4.56	3.96	1.98				
Forest	Fb47	4	20 to 30	0.772	6.19	4.78	2.39				
Forest	Fb47	5	20 to 30	0.801	4.27	3.42	1.71	4.46	2.23	2.33	0.10
Total 0 to 30 cm								19.54	9.77		
Site Total TOC											12.20
Forest	Fb65	1	0 to 10	0.325	45.29	14.70	7.35				
Forest	Fb65	2	0 to 10	0.241	69.13	16.68	8.34				
Forest	Fb65	3	0 to 10	0.186	49.94	9.27	4.63				
Forest	Fb65	4	0 to 10	0.384	26.45	10.15	5.08				
Forest	Fb65	5	0 to 10	0.487	15.86	7.73	3.86	11.70	5.85		
Forest	Fb65	1	10 to 20	0.673	4.98	3.35	1.68				
Forest	Fb65	2	10 to 20	1.119	4.08	4.56	2.28				
Forest	Fb65	4	10 to 20	0.705	5.27	3.72	1.86				
Forest	Fb65	5	10 to 20	0.798	4.08	3.25	1.63	3.72	1.86		

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2	Fine root OC kg/m^2 @ 30 to 50 cm
Forest	Fb65	1	20 to 30	0.801	3.84	3.08	1.54				
Forest	Fb65	2	20 to 30	1.084	2.45	2.65	1.33				
Forest	Fb65	4	20 to 30	0.851	4.42	3.77	1.88				
Forest	Fb65	5	20 to 30	1.157	2.81	3.25	1.63	3.19	1.59	2.61	0.14
Total 0 to 30 cm								18.61	9.31		
Site Total TOC											12.06
Transition	Ta1	1	0 to 10	0.160	66.54	10.66	5.33				
Transition	Ta1	2	0 to 10	0.130	73.54	9.52	4.76				
Transition	Ta1	4	0 to 10	0.176	60.79	10.69	5.35				
Transition	Ta1	5	0 to 10	0.327	23.08	7.55	3.78	9.61	4.80		
Transition	Ta1	1	10 to 20	0.425	25.90	11.00	5.50				
Transition	Ta1	2	10 to 20	0.536	19.60	10.51	5.26				
Transition	Ta1	4	10 to 20	0.508	17.68	8.97	4.49				
Transition	Ta1	5	10 to 20	1.157	4.13	4.78	2.39	8.82	4.41		
Transition	Ta1	1	20 to 30	0.907	6.92	6.27	3.14				
Transition	Ta1	2	20 to 30	0.891	8.48	7.55	3.78				
Transition	Ta1	3	20 to 30	0.938	4.60	4.32	2.16				
Transition	Ta1	4	20 to 30	1.013	4.88	4.94	2.47				
Transition	Ta1	5	20 to 30	1.356	1.53	2.08	1.04	5.03	2.52	0.00	N/A
Total 0 to 30 cm								23.46	11.73		
Site Total TOC										11.73	
Transition	Ta4	1	0 to 10	0.192	48.60	9.33	4.67				
Transition	Ta4	2	0 to 10	0.351	28.16	9.89	4.94				
Transition	Ta4	3	0 to 10	0.172	41.91	7.21	3.60				
Transition	Ta4	4	0 to 10	0.129	68.72	8.89	4.45				

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Ta4	5	0 to 10	0.089	65.94	5.85	2.93	8.23	4.12	
Transition	Ta4	1	10 to 20	0.447	16.40	7.33	3.67			
Transition	Ta4	2	10 to 20	0.860	9.35	8.04	4.02			
Transition	Ta4	3	10 to 20	1.130	6.33	7.16	3.58			
Transition	Ta4	4	10 to 20	1.021	7.56	7.72	3.86			
Transition	Ta4	5	10 to 20	0.277	22.17	6.14	3.07	7.28	3.64	
Transition	Ta4	1	20 to 30	0.811	6.30	5.11	2.56			
Transition	Ta4	3	20 to 30	1.594	2.38	3.80	1.90			
Transition	Ta4	4	20 to 30	1.243	3.07	3.81	1.91			
Transition	Ta4	5	20 to 30	0.833	11.53	9.61	4.80	5.58	2.79	0.002
Total 0 to 30 cm								21.09	10.55	
Site total TOC										10.55
Transition	Ta13	1	0 to 10	0.320	35.23	11.26	5.63			
Transition	Ta13	2	0 to 10	0.340	32.08	10.90	5.45			
Transition	Ta13	3	0 to 10	0.485	23.31	11.30	5.65			
Transition	Ta13	4	0 to 10	0.473	24.42	11.56	5.78			
Transition	Ta13	5	0 to 10	0.400	27.26	10.92	5.46	11.19	5.59	
Transition	Ta13	1	10 to 20	0.964	8.53	8.23	4.11			
Transition	Ta13	2	10 to 20	1.092	5.80	6.33	3.16			
Transition	Ta13	4	10 to 20	1.160	5.91	6.86	3.43			
Transition	Ta13	5	10 to 20	1.241	6.27	7.77	3.89	7.30	3.65	
Transition	Ta13	1	20 to 30	1.211	3.06	3.71	1.85			
Transition	Ta13	2	20 to 30	1.473	1.99	2.93	1.47			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Ta13	3	20 to 30	1.571	2.04	3.21	1.61			
Transition	Ta13	4	20 to 30	1.543	2.03	3.13	1.57			
Transition	Ta13	5	20 to 30	1.561	2.97	4.63	2.32	3.52	1.76	0.00
Total 0 to 30 cm								22.01	11.00	
Site Total TOC										11.00
Transition	Tb29	1	0 to 10	0.314	32.36	10.17	5.08			
Transition	Tb29	2	0 to 10	0.164	51.94	8.52	4.26			
Transition	Tb29	3	0 to 10	0.746	31.95	23.85	11.92	14.18	7.09	
Transition	Tb29	1	10 to 20	0.898	4.70	4.22	2.11			
Transition	Tb29	2	10 to 20	0.690	13.48	9.29	4.65	6.76	3.38	
Transition	Tb29	1	20 to 30	1.610	3.34	5.37	2.69			
Transition	Tb29	2	20 to 30	1.246	3.46	4.31	2.16			
Transition	Tb29	3	20 to 30	1.508	3.69	5.56	2.78	5.08	2.54	0.00
Total 0 to 30 cm								26.02	13.01	
Site Total TOC										13.01
Transition	Tc2	1	0 to 10	0.203	51.05	10.35	5.18			
Transition	Tc2	2	0 to 10	0.234	46.31	10.86	5.43			
Transition	Tc2	3	0 to 10	0.248	38.10	9.45	4.73			
Transition	Tc2	4	0 to 10	0.181	38.27	6.93	3.46			
Transition	Tc2	5	0 to 10	0.176	63.17	11.14	5.57	9.75	4.87	
Transition	Tc2	1	10 to 20	0.780	7.96	6.20	3.10			
Transition	Tc2	2	10 to 20	0.725	8.19	5.93	2.97			
Transition	Tc2	3	10 to 20	1.060	5.21	5.52	2.76			
Transition	Tc2	4	10 to 20	0.970	5.57	5.40	2.70			
Transition	Tc2	5	10 to 20	0.590	9.47	5.59	2.80	5.73	2.87	
Transition	Tc2	1	20 to 30	0.906	3.83	3.47	1.74			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Tc2	2	20 to 30	1.285	2.51	3.23	1.62			
Transition	Tc2	3	20 to 30	1.460	3.44	5.03	2.51			
Transition	Tc2	4	20 to 30	1.083	2.52	2.73	1.36			
Transition	Tc2	5	20 to 30	0.752	5.04	3.79	1.90	3.65	1.83	0.011
Total 0 to 30 cm								19.13	9.56	
Site Total TOC										9.57
Transition	Tc8	1	0 to 10	0.210	40.30	8.46	4.23			
Transition	Tc8	2	0 to 10	0.177	42.32	7.47	3.74			
Transition	Tc8	3	0 to 10	0.325	43.66	14.19	7.09			
Transition	Tc8	4	0 to 10	0.260	40.66	10.58	5.29			
Transition	Tc8	5	0 to 10	0.135	72.33	9.73	4.87	10.09	5.04	
Transition	Tc8	1	10 to 20	0.700	10.28	7.20	3.60			
Transition	Tc8	2	10 to 20	0.374	30.99	11.58	5.79			
Transition	Tc8	3	10 to 20	0.694	26.30	18.25	9.13			
Transition	Tc8	4	10 to 20	0.700	17.44	12.20	6.10			
Transition	Tc8	5	10 to 20	0.656	17.61	11.56	5.78	12.16	6.08	
Transition	Tc8	1	20 to 30	1.013	4.16	4.21	2.11			
Transition	Tc8	2	20 to 30	1.399	6.49	9.08	4.54			
Transition	Tc8	3	20 to 30	1.422	5.26	7.48	3.74			
Transition	Tc8	4	20 to 30	1.176	6.04	7.10	3.55			
Transition	Tc8	5	20 to 30	1.063	6.03	6.41	3.21	6.86	3.43	0.68
Total 0 to 30 cm								29.10	14.55	
Site Total TOC										15.23
Transition	Tc18	1	0 to 10	0.246	42.31	10.39	5.20			
Transition	Tc18	2	0 to 10	0.205	40.01	8.19	4.09			
Transition	Tc18	3	0 to 10	0.157	51.11	8.00	4.00			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Tc18	4	0 to 10	0.581	11.67	6.78	3.39			
Transition	Tc18	5	0 to 10	0.506	20.07	10.16	5.08	8.70	4.35	
Transition	Tc18	1	10 to 20	1.167	6.53	7.62	3.81			
Transition	Tc18	2	10 to 20	0.794	10.61	8.43	4.21			
Transition	Tc18	3	10 to 20	0.926	9.41	8.71	4.36			
Transition	Tc18	4	10 to 20	1.668	3.39	5.65	2.83			
Transition	Tc18	5	10 to 20	1.165	4.80	5.59	2.79	7.20	3.60	
Transition	Tc18	1	20 to 30	1.293	2.50	3.24	1.62			
Transition	Tc18	2	20 to 30	1.100	5.00	5.50	2.75			
Transition	Tc18	3	20 to 30	1.376	4.68	6.44	3.22			
Transition	Tc18	4	20 to 30	1.599	3.55	5.67	2.84			
Transition	Tc18	5	20 to 30	1.875	3.18	5.95	2.98	5.36	2.68	0.010
Total 0 to 30 cm								21.27	10.63	
Site Total TOC										10.64
Transition	Tc31	1	0 to 10	0.216	48.03	10.37	5.19			
Transition	Tc31	2	0 to 10	0.284	36.90	10.47	5.24			
Transition	Tc31	3	0 to 10	0.286	27.15	7.78	3.89			
Transition	Tc31	4	0 to 10	0.157	63.55	9.95	4.97			
Transition	Tc31	5	0 to 10	0.258	39.24	10.12	5.06	9.74	4.87	
Transition	Tc31	1	10 to 20	0.740	7.20	5.32	2.66			
Transition	Tc31	2	10 to 20	0.803	6.23	5.00	2.50			
Transition	Tc31	3	10 to 20	1.222	4.91	6.00	3.00			
Transition	Tc31	4	10 to 20	0.633	16.17	10.24	5.12			
Transition	Tc31	5	10 to 20	0.881	6.96	6.13	3.06	6.54	3.27	
Transition	Tc31	1	20 to 30	0.884	2.92	2.58	1.29			
Transition	Tc31	2	20 to 30	1.010	4.14	4.18	2.09			
Transition	Tc31	3	20 to 30	1.462	3.83	5.60	2.80			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Tc31	4	20 to 30	1.240	3.96	4.91	2.45			
Transition	Tc31	5	20 to 30	0.961	4.17	4.01	2.00	4.26	2.13	0.00
Total 0 to 30 cm								20.53	10.27	
Site Total TOC										10.27
Transition	Td2	1	0 to 10	0.220	50.75	11.16	5.58			
Transition	Td2	2	0 to 10	0.234	50.26	11.79	5.89			
Transition	Td2	3	0 to 10	0.248	74.85	18.57	9.29			
Transition	Td2	4	0 to 10	0.181	38.89	7.04	3.52			
Transition	Td2	5	0 to 10	0.176	40.52	7.14	3.57	11.14	5.57	
Transition	Td2	1	10 to 20	0.825	7.84	6.47	3.24			
Transition	Td2	2	10 to 20	0.777	9.40	7.30	3.65			
Transition	Td2	3	10 to 20	0.383	19.35	7.41	3.70			
Transition	Td2	4	10 to 20	0.932	6.04	5.63	2.81			
Transition	Td2	5	10 to 20	0.999	5.99	5.99	2.99	6.56	3.28	
Transition	Td2	1	20 to 30	1.598	3.55	5.67	2.83			
Transition	Td2	2	20 to 30	1.215	2.48	3.01	1.51			
Transition	Td2	3	20 to 30	1.133	3.84	4.35	2.18			
Transition	Td2	4	20 to 30	1.420	3.34	4.75	2.37			
Transition	Td2	5	20 to 30	1.047	3.29	3.45	1.72	4.24	2.12	0.456
Total 0 to 30 cm								21.94	10.97	
Site Total TOC										11.43
Transition	Td9	1	0 to 10	0.106	72.52	7.68	3.84			
Transition	Td9	2	0 to 10	0.144	54.84	7.89	3.95			
Transition	Td9	3	0 to 10	0.164	60.88	10.01	5.00			
Transition	Td9	4	0 to 10	0.222	54.31	12.05	6.03			
Transition	Td9	5	0 to 10	0.093	71.54	6.68	3.34	8.86	4.43	

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Td9	1	10 to 20	0.300	27.06	8.13	4.06			
Transition	Td9	2	10 to 20	0.675	12.01	8.11	4.06			
Transition	Td9	3	10 to 20	0.708	7.24	5.13	2.56			
Transition	Td9	4	10 to 20	1.061	4.44	4.71	2.36			
Transition	Td9	5	10 to 20	0.441	15.84	6.99	3.49	6.61	3.31	
Transition	Td9	1	20 to 30	0.904	4.77	4.31	2.16			
Transition	Td9	2	20 to 30	1.196	2.17	2.59	1.30			
Transition	Td9	3	20 to 30	1.265	2.87	3.63	1.82			
Transition	Td9	4	20 to 30	1.171	2.85	3.34	1.67			
Transition	Td9	5	20 to 30	1.350	2.50	3.38	1.69	3.45	1.73	0.025
Total 0 to 30 cm								18.93	9.46	
Site Total TOC										9.49
Transition	Td15	1	0 to 10	0.087	71.44	6.21	3.11			
Transition	Td15	2	0 to 10	0.098	68.96	6.75	3.37			
Transition	Td15	3	0 to 10	0.137	51.69	7.08	3.54			
Transition	Td15	4	0 to 10	0.304	32.53	9.90	4.95			
Transition	Td15	5	0 to 10	0.102	71.57	7.34	3.67	7.45	3.73	
Transition	Td15	1	10 to 20	0.268	25.11	6.74	3.37			
Transition	Td15	2	10 to 20	0.534	12.78	6.82	3.41			
Transition	Td15	3	10 to 20	0.696	5.46	3.80	1.90			
Transition	Td15	4	10 to 20	0.755	6.37	4.81	2.40			
Transition	Td15	5	10 to 20	0.377	21.71	8.18	4.09	6.07	3.04	
Transition	Td15	1	20 to 30	0.725	4.81	3.48	1.74			
Transition	Td15	2	20 to 30	1.081	3.55	3.84	1.92			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Td15	3	20 to 30	0.946	3.47	3.28	1.64			
Transition	Td15	4	20 to 30	1.303	2.73	3.56	1.78			
Transition	Td15	5	20 to 30	1.181	2.97	3.51	1.75	3.53	1.77	0.110
Total 0 to 30 cm								17.06	8.53	
Site Total TOC										8.64
Transition	Td33	1	0 to 10	0.189	36.96	6.99	3.49			
Transition	Td33	2	0 to 10	0.067	81.69	5.47	2.73			
Transition	Td33	3	0 to 10	0.106	67.71	7.17	3.58			
Transition	Td33	4	0 to 10	0.056	75.77	4.25	2.12			
Transition	Td33	5	0 to 10	0.115	57.69	6.65	3.32	6.10	3.05	
Transition	Td33	1	10 to 20	0.257	19.90	5.11	2.56			
Transition	Td33	2	10 to 20	0.092	65.55	6.01	3.01			
Transition	Td33	3	10 to 20	0.351	15.03	5.28	2.64			
Transition	Td33	4	10 to 20	0.141	57.46	8.13	4.06			
Transition	Td33	5	10 to 20	1.029	6.61	6.80	3.40	6.27	3.13	
Transition	Td33	1	20 to 30	0.786	4.59	3.61	1.81			
Transition	Td33	2	20 to 30	0.795	8.12	6.45	3.22			
Transition	Td33	3	20 to 30	1.046	5.45	5.70	2.85			
Transition	Td33	4	20 to 30	1.273	5.95	7.58	3.79			
Transition	Td33	5	20 to 30	1.590	2.35	3.74	1.87	5.42	2.71	0.027
Total 0 to 30 cm								17.78	8.89	
Site Total TOC										8.92
Transition	Td39	1	0 to 10	0.066	78.70	5.23	2.61			
Transition	Td39	2	0 to 10	0.177	48.21	8.54	4.27			
Transition	Td39	3	0 to 10	0.228	32.87	7.51	3.75			
Transition	Td39	4	0 to 10	0.339	31.46	10.67	5.33			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Td39	5	0 to 10	0.478	19.08	9.13	4.56	8.22	4.11	
Transition	Td39	1	10 to 20	0.245	43.88	10.73	5.37			
Transition	Td39	2	10 to 20	0.530	15.07	7.98	3.99			
Transition	Td39	3	10 to 20	0.761	4.38	3.33	1.67			
Transition	Td39	4	10 to 20	0.797	3.99	3.18	1.59			
Transition	Td39	5	10 to 20	0.881	4.62	4.07	2.04	5.86	2.93	
Transition	Td39	1	20 to 30	0.476	16.62	7.91	3.96			
Transition	Td39	2	20 to 30	0.879	5.13	4.51	2.26			
Transition	Td39	3	20 to 30	1.111	2.31	2.56	1.28			
Transition	Td39	4	20 to 30	0.970	4.93	4.78	2.39			
Transition	Td39	5	20 to 30	1.271	3.38	4.29	2.14	4.81	2.41	0.107
Total 0 to 30 cm								18.89	9.44	
Site Total TOC										9.55
Transition	Td50	1	0 to 10	0.101	78.34	7.88	3.94			
Transition	Td50	2	0 to 10	0.107	89.83	9.62	4.81			
Transition	Td50	3	0 to 10	0.090	67.21	6.06	3.03			
Transition	Td50	4	0 to 10	0.079	72.84	5.74	2.87			
Transition	Td50	5	0 to 10	0.138	70.81	9.78	4.89	7.82	3.91	
Transition	Td50	1	10 to 20	0.254	33.69	8.57	4.28			
Transition	Td50	2	10 to 20	0.404	23.57	9.53	4.76			
Transition	Td50	3	10 to 20	0.438	18.83	8.24	4.12			
Transition	Td50	4	10 to 20	0.315	39.67	12.51	6.26			
Transition	Td50	5	10 to 20	0.646	15.42	9.96	4.98	9.76	4.88	

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2	Mean TOM kg/m^2	Mean TOC kg/m^2	P. *taeda* root OC kg/m^2
Transition	Td50	1	20 to30	1.093	7.22	7.89	3.95			
Transition	Td50	2	20 to 30	1.082	6.54	7.08	3.54			
Transition	Td50	3	20 to 30	1.336	4.24	5.67	2.84			
Transition	Td50	4	20 to 30	1.357	6.14	8.33	4.16			
Transition	Td50	5	20 to 30	1.513	3.03	4.59	2.29	6.71	3.36	0.017
Total 0 to 30 cm								24.29	12.15	
Site Total TOC										12.16
High Marsh	Ha5		0 to 10	0.350	44.16	15.47	7.73			
High Marsh	Ha5		10 to 20	1.483	7.33	10.87	5.44			
High Marsh	Ha5		20 to 30	1.519	2.22	3.38	1.69			
Total 0 to 30 cm						29.72	14.86			
High Marsh	Ha14		0 to 10	0.181	67.56	12.24	6.12			
High Marsh	Ha14		10 to 20	0.513	36.17	18.57	9.29			
High Marsh	Ha14		20 to 30	*	*	9.25	4.63			
Total 0 to 30 cm						40.06	20.03			
High Marsh	Ha19		0 to 10	0.048	71.71	3.41	1.71			
High Marsh	Ha19		10 to 20	0.200	34.04	6.80	3.40			
High Marsh	Ha19		20 to 30	1.485	4.56	6.77	3.38			
Total 0 to 30 cm						16.98	8.49			
High Marsh	Ha21		0 to 10	0.098	72.22	7.09	3.55			
High Marsh	Ha21		10 to 20	*	*	10.95	5.48			
High Marsh	Ha21		20 to 30	*	*	9.25	4.63			
Total 0 to 30 cm						27.29	13.65			

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
High Marsh	Ha36		0 to 10	0.153	65.34	9.98	4.99
High Marsh	Ha36		10 to 20	0.556	17.29	9.61	4.80
High Marsh	Ha36		20 to 30	*	*	9.25	4.63
Total 0 to 30 cm						28.84	14.42
High Marsh	Ha41		0 to 10	0.197	55.32	10.91	5.45
High Marsh	Ha41		10 to 20	1.579	5.63	8.89	4.45
High Marsh	Ha41		20 to 30	1.642	4.29	7.05	3.52
Total 0 to 30 cm						26.85	13.42
High Marsh	Ha52		0 to 10	0.139	70.52	9.77	4.88
High Marsh	Ha52		10 to 20	0.479	34.93	16.73	8.36
High Marsh	Ha52		20 to 30	0.960	15.51	14.88	7.44
Total 0 to 30 cm						41.38	20.69
High Marsh	Hb1		0 to 10	0.131	66.40	8.71	4.36
High Marsh	Hb1		10 to 20	0.517	37.58	19.41	9.71
High Marsh	Hb1		20 to 30	*	*	9.25	4.63
Total 0 to 30 cm						37.38	18.69
High Marsh	Hb4		0 to 10	0.140	66.31	9.25	4.63
High Marsh	Hb4		10 to 20	0.357	36.10	12.88	6.44
High Marsh	Hb4		20 to 30	1.405	10.08	14.16	7.08
Total 0 to 30 cm						36.30	18.15

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
High Marsh	Hc1		0 to 10	0.177	58.35	10.30	5.15
High Marsh	Hc1		10 to 20	0.165	58.55	9.63	4.82
High Marsh	Hc1		20 to 30	0.494	18.05	8.92	4.46
Total 0 to 30 cm						28.86	14.43
High Marsh	Hc30		0 to 10	0.133	50.54	6.70	3.35
High Marsh	Hc30		10 to 20	0.163	47.75	7.79	3.90
High Marsh	Hc30		20 to 30	0.168969	48.98	8.28	4.14
Total 0 to 30 cm						22.77	11.39
High Marsh	Hc37		0 to 10	0.115	58.03	6.70	3.35
High Marsh	Hc37		10 to 20	0.152	52.90	8.05	4.02
High Marsh	Hc37		20 to 30	0.208	45.82	9.54	4.77
Total 0 to 30 cm						24.29	12.14
High Marsh	Hc41		0 to 10	0.106	71.08	7.55	3.78
High Marsh	Hc41		10 to 20	0.154	58.91	9.06	4.53
High Marsh	Hc41		20 to 30	*	*	7.86	3.93
Total 0 to 30 cm						24.48	12.24
High Marsh	Hc42		0 to 10	0.101	80.37	8.13	4.06
High Marsh	Hc42		10 to 20	0.135	56.30	7.61	3.80
High Marsh	Hc42		20 to 30	0.183	59.62	10.88	5.44
Total 0 to 30 cm						26.62	13.31
High Marsh	Hc68		0 to 10	0.135	59.25	8.01	4.01
High Marsh	Hc68		10 to 20	0.149	60.97	9.08	4.54
High Marsh	Hc68		20 to 30	0.141	58.29	8.21	4.10
Total 0 to 30 cm						25.30	12.65

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
High Marsh	Hc72		0 to 10	0.112	64.11	7.18	3.59
High Marsh	Hc72		10 to 20	0.162	45.84	7.44	3.72
High Marsh	Hc72		20 to 30	0.239	33.18	7.92	3.96
Total 0 to 30 cm						22.53	11.27
High Marsh	Hc75		0 to 10	0.199	55.97	11.12	5.56
High Marsh	Hc75		10 to 20	0.414	25.34	10.48	5.24
High Marsh	Hc75		20 to 30	0.930	7.64	7.11	3.55
Total 0 to 30 cm						28.70	14.35
High Marsh	Hc84		0 to 10	0.141	66.51	9.36	4.68
High Marsh	Hc84		10 to 20	0.690	16.91	11.67	5.84
High Marsh	Hc84		20 to 30	1.565	2.75	4.30	2.15
Total 0 to 30 cm						25.33	12.67
High Marsh	Hc92		0 to 10	0.229	50.13	11.48	5.74
High Marsh	Hc92		10 to 20	0.190	52.27	9.94	4.97
High Marsh	Hc92		20 to 30	0.159	47.92	7.64	3.82
Total 0 to 30 cm						29.06	14.53
High Marsh	Ma1		0 to 10	0.094	70.88	6.66	3.33
High Marsh	Ma1		10 to 20	0.176	59.58	10.49	5.24
High Marsh	Ma1		20 to 30	*	*	9.25	4.63
Total 0 to 30 cm						26.40	13.20
High Marsh	Ma15		0 to 10	0.131	51.26	6.73	3.37
High Marsh	Ma15		10 to 20	0.232	30.57	7.09	3.55
High Marsh	Ma15		20 to 30	0.697	8.98	6.26	3.13
Total 0 to 30 cm						20.08	10.04

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
High Marsh	Mc2		0 to 10	0.222	48.885	10.84	5.42
High Marsh	Mc2		10 to 20	0.223	36.116	8.07	4.03
High Marsh	Mc2		20 to 30	0.192	38.850	7.46	3.73
Total 0 to 30 cm						26.37	13.19
High Marsh	Tb4		0 to 10	0.598	13.24	7.92	3.96
High Marsh	Tb4		10 to 20	1.525	3.16	4.82	2.41
High Marsh	Tb4		20 to 30	1.663	3.55	5.90	2.95
Total 0 to 30 cm						18.65	9.32
High Marsh	Tb14		0 to 10	0.869	8.99	7.82	3.91
High Marsh	Tb14		10 to 20	1.172	2.93	3.43	1.71
High Marsh	Tb14		20 to 30	1.473	2.63	3.87	1.94
Total 0 to 30 cm						15.12	7.56
High Marsh	Tb23		0 to 10	0.135	59.64	8.03	4.02
High Marsh	Tb23		10 to 20	0.722	13.86	10.00	5.00
High Marsh	Tb23		20 to 30	1.704	3.60	6.14	3.07
Total 0 to 30 cm						24.18	12.09
LMSS	LSa8		0 to 10	0.380	28.74	10.91	5.46
LMSS	LSa8		10 to 20	0.327	26.09	8.53	4.26
LMSS	LSa8		20 to 30	*	*	7.11	3.56
Total 0 to 30 cm						26.55	13.28
LMSS	LSa12		0 to 10	1.102	7.91	8.72	4.36
LMSS	LSa12		10 to 20	1.447	5.28	7.64	3.82
LMSS	LSa12		20 to 30	*	*	7.11	3.56
Total 0 to 30 cm						23.46	11.73

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
LMSS	LSb2		0 to 10	0.281	28.66	8.05	4.03
LMSS	LSb2		10 to 20	0.668	12.64	8.44	4.22
LMSS	LSb2		20 to 30	0.967	8.04	7.78	3.89
Total 0 to 30 cm						24.26	12.13
LMSS	LSb16		0 to 10	1.347	3.76	5.06	2.53
LMSS	LSb16		10 to 20	1.721	2.43	4.18	2.09
LMSS	LSb16		20 to 30	1.749	2.78	4.87	2.44
Total 0 to 30 cm						14.11	7.05
LMSS	LSb17		0 to 10	0.408	28.87	11.77	5.89
LMSS	LSb17		10 to 20	1.364	4.53	6.17	3.09
LMSS	LSb17		20 to 30	1.571	2.50	3.92	1.96
Total 0 to 30 cm						21.87	10.93
LMSS	LSb46		0 to 10	0.292	41.59	12.13	6.07
LMSS	LSb46		10 to 20	0.232	35.14	8.14	4.07
LMSS	LSb46		20 to 30	0.376	21.59	8.11	4.06
Total 0 to 30 cm						28.38	14.19
LMSS	LSb53		0 to 10	0.312	31.77	9.90	4.95
LMSS	LSb53		10 to 20	0.358	22.04	7.88	3.94
LMSS	LSb53		20 to 30	0.838	6.62	5.55	2.77
Total 0 to 30 cm						23.34	11.67
LMSS	LSb54		0 to 10	0.277	36.95	10.23	5.11
LMSS	LSb54		10 to 20	0.308	28.52	8.77	4.39
LMSS	LSb54		20 to 30	0.432	28.88	12.46	6.23
Total 0 to 30 cm						31.46	15.73

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
LMSS	Mb4		0 to 10	0.288	38.58	11.11	5.55
LMSS	Mb4		10 to 20	0.254	37.64	9.55	4.77
LMSS	Mb4		20 to 30	*	*	7.11	3.56
Total 0 to 30 cm						27.76	13.88
LMTS	LT6		0 to 10	0.368	22.85	8.40	4.20
LMTS	LT6		10 to 20	0.415	19.76	8.20	4.10
LMTS	LT6		20 to 30	0.364	21.87	7.97	3.98
Total 0 to 30 cm						24.56	12.28
LMTS	LT12		0 to 10	0.330	19.97	6.58	3.29
LMTS	LT12		10 to 20	*	*	7.41	3.71
LMTS	LT12		20 to 30	*	*	6.56	3.28
Total 0 to 30 cm						20.55	10.27
LMTS	LT25		0 to 10	0.365	20.24	7.39	3.69
LMTS	LT25		10 to 20	0.362	15.32	5.55	2.77
LMTS	LT25		20 to 30	0.376	18.43	6.93	3.46
Total 0 to 30 cm						19.86	9.93
LMTS	LT29		0 to 10	0.623	14.15	8.82	4.41
LMTS	LT29		10 to 20	0.963	9.12	8.79	4.39
LMTS	LT29		20 to 30	*	*	6.56	3.28
Total 0 to 30 cm						24.17	12.08
LMTS	LT33		0 to 10	0.301	15.41	4.64	2.32
LMTS	LT33		10 to 20	0.851	6.92	5.89	2.94
LMTS	LT33		20 to 30	0.888	3.81	3.39	1.69
Total 0 to 30 cm						13.92	6.96

Zone	Site	Quadrat	Depth cm	Bulk Density g/cm^3	% 0rganic Matter	TOM kg/m^2	TOC kg/m^2
LMTS	LTS6		0 to 10	0.331	28.35	9.37	4.69
LMTS	LTS6		10 to 20	0.356	22.60	8.05	4.02
LMTS	LTS6		20 to 30	*	*	6.56	3.28
Total 0 to 30 cm						23.98	11.99
LMTS	LTS9		0 to 10	0.389	20.72	8.05	4.03
LMTS	LTS9		10 to 20	0.438	18.21	7.98	3.99
LMTS	LTS9		20 to 30	0.532	14.92	7.94	3.97
Total 0 to 30 cm						23.98	11.99
Tidal Creek	C1		0 to 10	0.555	12.57	6.98	3.49
Tidal Creek	C1		10 to 20	0.439	12.35	5.42	2.71
Tidal Creek	C1		20 to 30	0.685	7.67	5.25	2.63
Total 0 to 30 cm						17.65	8.83
Tidal Creek	C2		0 to 10	0.598	8.87	5.30	2.65
Tidal Creek	C2		10 to 20	0.605	11.17	6.75	3.38
Tidal Creek	C2		20 to 30	0.684	9.24	6.32	3.16
Total 0 to 30 cm						18.38	9.19
Tidal Creek	C3		0 to 10	0.608	9.92	6.04	3.02
Tidal Creek	C3		10 to 20	0.839	5.42	4.55	2.27
Tidal Creek	C3		20 to 30	0.843	6.89	5.80	2.90
Total 0 to 30 cm						16.39	8.20

APPENDIX H. CHN ANALYSES OF SOIL CORES.

Sample ID	Depth (cm)	%C	%N
Fa18Q1	0-10	6.11	0.35
Fa18Q2	10-20	1.64	0.08
Fa18Q4	20-30	0.69	0.04
Fa30Q1	10-19	2.16	0.15
Fb47Q4	0-10	13.75	0.38
Fb47Q4	10-20	2.56	0.07
Fb65Q4	0-10	13.88	0.42
Ha5	10-20	2.94	0.12
Ha19	0-10	34.40	1.63
Ha36	10-14	7.36	0.35
Ha41	10-20	2.62	0.08
Ha52	10-20	14.42	0.94
Hc1	20-30	7.93	0.50
Hc37	0-10	18.82	1.17
Hc72	10-20	12.42	0.83
Hc84	10-20	6.72	0.34
LSa8	10-20	10.04	0.56
LSa12	0-10	3.08	0.15
LSb2	0-10	12.75	0.62
LSb16	0-10	1.09	0.06
LSb16	20-30	0.35	0.02
LSb53	20-30	2.43	0.13
LTS9	20-30	5.71	0.32
LT33	10-20	2.60	0.14
Tb4	0-10	5.98	0.28
Tb4	10-20	1.02	0.03
Tb4	20-30	0.72	0.03
Tb23Q2	10-20	8.60	0.47
Tb23Q3	10-20	6.96	0.28
Tb23Q4	0-10	7.61	0.42
Tb29Q1	10-20	2.14	0.07
Tb29Q1	20-30	0.75	0.03
Tb29Q3*	10-20	1.52	0.05
Tc2Q2	20-30	1.14	0.03
Tc2Q3	20-30	0.85	0.03
Tc2Q5	0-10	30.08	1.08
Tc2Q5	20-30	1.71	0.09
Tc8Q3	20-30	1.63	0.07
Tc8Q4	10-20	8.15	0.34
Tc8Q4	20-30	2.36	0.09

Sample ID	Depth (cm)	%C	%N
Tc31Q2	10-20	2.63	0.10
Ta1Q2	0-10	33.96	1.62
Ta4Q4	10-20	3.42	0.12
Ta13Q1	10-20	3.71	0.17
Ta13Q5	10-20	3.11	0.13
Td2Q5	10-20	2.70	0.12
Td15Q2	20-30	1.49	0.03
Td15Q4	20-30	0.95	0.03
Td15Q5	0-10	34.34	1.67
Td39Q4	10-20	1.46	0.04

*Soil sample was not used in cubic regression due to possible error in bulk density (g/cm^3).

APPENDIX I. GPS SURVEY OF SITE COORDINATES AND ELEVATION FOR ALL SITES EXCEPT TIDAL CREEK.

Site	Latitude	Longitude	Elevation(m)
Fa18	37.45827275	-75.83101698	2.540
Fa30	37.45800192	-75.8309846	1.844
Fb29	37.46429748	-75.83741756	2.960
Fb47	37.4647559	-75.83097758	2.210
Fb65	37.4629122	-75.83337509	1.201
Ta1	37.462267	-75.82931942	1.367
Ta4	37.46158267	-75.8358191	0.730
Ta13	37.4596393	-75.83129823	1.087
Tb29	37.46084767	-75.8340213	0.794
Tc2	37.4624025	-75.82980253	1.132
Tc8	37.46216677	-75.83096015	1.316
Tc18	37.4616915	-75.83180489	1.122
Tc31	37.46174132	-75.8324005	1.157
Td2	37.46269529	-75.83326499	1.195
Td9	37.46279632	-75.83386952	1.187
Td15	37.46287196	-75.83508715	1.225
Td33	37.46318967	-75.83431557	1.099
Td39	37.46317467	-75.83601544	1.245
Td50	37.4634608	-75.83402833	0.995
Ha5	37.4595168	-75.83155473	1.229
Ha14	37.4601146	-75.83092076	1.063
Ha19	37.46020715	-75.83205501	1.047
Ha21	37.46049289	-75.83221814	0.957
Ha36	37.46056984	-75.83084546	*
Ha41	37.46073699	-75.8311535	1.051
Ha52	37.46181218	-75.83039906	1.030
Hb1	37.46146852	-75.83229173	1.104
Hb4	37.4612343	-75.83287377	1.067
Hc1	37.46316958	-75.83769199	0.954
Hc30	37.46228915	-75.83692389	0.940
Hc37	37.46185523	-75.8350857	1.086
Hc41	37.46199484	-75.83426657	0.922
Hc42	37.4620176	-75.83396079	1.085
Hc68	37.46110735	-75.83547743	1.059
Hc72	37.46174742	-75.83674655	0.926
Hc75	37.46143113	-75.83676859	0.886
Hc84	37.46089095	-75.83450192	1.090
Hc92	37.4606908	-75.83561184	0.914
Ma1	37.46005265	-75.83216438	1.012
Ma15	37.45932557	-75.83262928	0.978
Mc2	37.46030785	-75.83657352	0.698
Tb4	37.46089833	-75.83243869	1.102

Site	Latitude	Longitude	Elevation(m)
Tb14	37.45977767	-75.83315822	1.005
Tb23	37.46125428	-75.8334436	1.023
LSa8	37.45863325	-75.83277866	0.784
LSa12	37.45880534	-75.83241855	0.852
LSb2	37.45902331	-75.8332824	0.767
LSb16	37.45944985	-75.83354545	0.850
LSb17	37.45921942	-75.83364574	0.801
LSb46	37.45910627	-75.83523896	0.722
LSb53	37.46024436	-75.83571531	0.674
LSb54	37.46047421	-75.8358191	0.730
Mb4	37.45981122	-75.83595583	0.738
LT6	37.45932196	-75.83627024	0.447
LT12	37.45905437	-75.83555928	0.416
LT25	37.45848405	-75.83441722	0.488
LT29	37.45827532	-75.83328139	0.268
LT33	37.45884185	-75.83298936	0.348
LTS6	37.46063246	-75.83695996	0.484
LTS9	37.46016193	-75.83702832	0.516

* Error in elevation reading