ABSTRACT

Title of Document: CARBON STORAGE AND POTENTIAL CARBON SEQUESTRATION IN DEPRESSIONAL WETLANDS OF THE MID-ATLANTIC REGION.

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With recent concern over climate change, methods for decreasing atmospheric levels of greenhouse gasses such as CO_2 have been of particular interest, including carbon sequestration in soils that have depreciated levels of carbon from cultivated agricultural crop production. The Delmarva Peninsula contains many Delmarva Bay landforms, which commonly contain wetlands. Five pairs of Delmarva Bays were selected to examine change in carbon stocks following conversion to agriculture and to assess the potential for carbon sequestration if these soils were to be restored hydrologically and vegetatively. A loss of approximately 50 % of the stored soil carbon was observed following the conversion to agriculture. If these agricultural soils were to be restored, the wetland soils within the Delmarva Bay basin are predicted to sequester a total of approximately 11 kg C m^{-2} and the upland soils of the rim would be expected to sequester a total of approximately 4 kg C m^{-2}.

CARBON STORAGE AND POTENTIAL CARBON SEQUESTRATION IN DEPRESSIONAL WETLANDS OF THE MID-ATLANTIC REGION.

By

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Chapter 1 - Introduction

Wetlands are identified by the US Army Corps of Engineers by a three factor approach including wetland hydrology, hydrophytic vegetation, and hydric soils (USACE, 2010). The wetland hydrology could be considered as the master variable, because without wetland hydrology the wetland plants would not be present nor would hydric soils form. Wetlands are unique environments where processes occur that cannot elsewhere. It is the wetland hydrology that promotes the unique functions and ecosystem services of wetlands, such as carbon sequestration.

Since there has been an increasing concern of climate change, carbon sequestration has been of particular interest as a method to remove carbon dioxide (CO_2) from the atmosphere and store it as organic carbon in the soil. The quantity of carbon that most soils are able to retain is limited, but soils that are very poorly drained have the potential to accumulate more carbon. This is possible because of the presence of a shallow water table which helps to promote the formation of anaerobic conditions. It is the anaerobic conditions that retard microbial oxidation of carbon, thus allowing it to accumulate (Collins and Kuehl, 2001). Also, studies have found that input of small quantities of low carbon sediment into a carbon rich wetland can help to stimulate carbon sequestration.

Over the past 200 years, over half of the pre-colonial wetlands in the conterminous United States have been lost due to agriculture and development. More specifically, in the state of Maryland approximately 73 % of the pre-colonial wetlands have been lost (Mitsch and Gosselink, 2007), with a considerable amount lost on the Delmarva Peninsula (DNR, 2000). The dominant land use on the Delmarva Peninsula is agriculture (Norton and Fisher, 2000). Therefore, most of the wetlands probably were lost from drainage and the conversion to agriculture. When a wetland is drained for agriculture it loses the wetland hydrology. The change in hydrology diminishes the occurrence of anaerobic conditions, and thus the soil's ability to retain carbon is lowered. The carbon that had accumulated at elevated levels becomes vulnerable to microbial oxidation, and thus these converted wetlands are expected to lose carbon as they reestablish a new soil carbon steady state (Collins and Kuehl, 2001).

One way to reverse the effects caused by drainage and conversion to agriculture would be through ecosystem restoration. Restoration is the return of an ecosystem to its conditions prior to disturbance including physical, chemical and biological characteristics (NRC, 1992). If the wetland hydrology is returned to a prior converted cropland, then other soil and vegetative conditions should follow. Therefore, wetlands that have lost carbon following drainage and cultivation should be able to sequester carbon, eventually returning to levels near to those it had prior to disturbance.

Delmarva Bays are a type of depressional landform, which commonly contain wetlands, and that can be found on the Delmarva Peninsula. They are similar to Carolina Bays and are believed to have formed from similar processes. The Carolina Bays have been the focus of many studies (Ross, 1987), however surprisingly few studies have focused on the Delmarva Bays, particularly in regards to geomorphology. Delmarva Bays differ from Carolina Bays by being much smaller and having been found to contain a silty basin fill material which is absent from all Carolina Bays (Stolt and Rabenhorst, 1987a).

Objectives

1.) To determine “typical” morphological characteristics of Delmarva Bay landforms.

2.) To assess the impact of cultivation and agricultural drainage on the carbon stocks of depressional wetlands located on the Mid-Atlantic Coastal Plain, including Delmarva Bays.

3.) To assess the potential for carbon sequestration in the agricultural Delmarva Bay landscapes through ecosystem restoration.

4.) To assess the effectiveness of wetland restoration programs in regards to the ecosystem services of carbon sequestration and sediment removal.

Hypotheses

Because wetlands have been found to be carbon sinks due to the presence of wetland hydrological conditions, it is hypothesized that:

1.) the soils of wetlands that have been subject to artificial drainage and have historically been cultivated for agriculture will contain less organic carbon than natural wetland soils of similar origin, and

2.) the restoration of wetland hydrology in previously drained and cultivated wetlands will result in an increase in soil organic carbon.

Chapter 2 - Background

Delmarva and Carolina Bays

Carolina Bays are geographically isolated wetlands which can be found on the Atlantic Coastal Plain from Florida to New Jersey (Bruland et al., 2003; Caldwell et al., 2007; Prouty, 1952; Sharitz, 2003; Stolt and Rabenhorst, 1987a), although the text book Carolina Bays can be found primarily in southeastern North Carolina and mid-coastal South Carolina (Prouty, 1952; Tiner, 2003). They are characterized geomorphologically by their overall elliptical shape that is often oriented northwest to southeast along the major axis (Bruland et al., 2003; Sharitz and Gibbons, 1982; Stolt and Rabenhorst, 1987a). The major axis tends to have an orientation that systematically changes with geographic location, ranging from 55° to 15º East of South from the northern to southern parts of North Carolina (Prouty, 1952). Carolina Bays commonly have a sandy rim, particularly in the southeast end of each Bay (Prouty, 1952; Stolt and Rabenhorst, 1987b; Thom, 1970; Tiner, 2003). The Carolina Bays studied in North and South Carolina, were found to have an approximate area of 46 ha (Bennett and Nelson, 1991; Prouty, 1952), relief of 1.81 m (Prouty, 1952; Thom, 1970), and major to minor axis ratio of 1.51 (Melton and Scriever, 1933).

The “Carolina Bays” located on the Delmarva Peninsula are typically smaller than Carolina Bays, and therefore are generally known as Delmarva Bays and are referred to locally as “whale wallows” or “potholes.” They can be found primarily near the state border between Maryland and Delaware between the Nanticoke and Sassafras rivers (Stolt and Rabenhorst, 1987a; Tiner, 2003). In these areas where the Carolina and Delmarva Bays are readily found, they can cover as much as 50 % of the land area (Prouty, 1952) and can sometimes be superimposed upon each other (Prouty, 1952; Sharitz and Gibbons, 1982). Earlier work by

Prouty (1952) estimated that nearly half a million Bays exist, along the coastal shore of the eastern US, but more recent estimates by Richardson and Gibbons (1993) suggested that only 10,000 to 20,000 currently exist. More specifically on the Delmarva Peninsula, Stolt and Rabenhorst (1987a) estimated that there are approximately 1,500 to 2,500 Bays.

The Carolina and Delmarva Bays are believed to have formed from similar processes. There are many different theories on their origins, most of which are erroneous, including 1.) the formation from artesian springs, 2.) solution, 3.) coastal wind and water action forming a sand bar across the mouth of a Bay , 4.) submarine formation of eddies, 5.) segmentation of lagoons by a south easterly wind, 6.) shoals of fish or whales (giving rise to the term “whale wallow”), and 7.) meteor impacts (Prouty, 1952; Savage, 1982). Theories 1 and 2 have been proven incorrect because coarse fragments are found to be level in the landscape; if they had been associated with a sinkhole, from a spring or from solution, the coarse fragments would be sloping toward a center point. Theories 3, 4, 5, and 6 have been discarded due to fact that many of the features are generally located at elevations that have not been influenced by marine processes since Miocene times. Also, there were freshwater fauna present and certain types of diatoms, indicative of fresh, rather than marine fauna, even in buried horizons. Theory 7 (meteoric impact) is inconsistent with what are often multiple lithologic discontinuities present in the sand rims. A meteoric impact would have deposited the rim in a single event, but the discontinuities indicate that the rims were created over time through a series of events. The most accepted theory is that they are the product of blowouts, which are depressions created from strong winds removing sandy soil material. The blowouts became locations where the water table was above the surface. It is postulated that the blowouts became elongated due to wind driven currents in the ponded water, moving sands to form the characteristic elliptical shape and sandy rim (Prouty, 1952; Savage, 1982; Stolt and Rabenhorst, 1987a).

The Carolina Bays have been the focus of many studies (Ross, 1987), however, the Delmarva Bays have not been studied as thoroughly, and little has been reported on their geomorphology. The typical Carolina Bays have a major axis length that ranges from 0.5 to 8 km (Prouty, 1952; Sharitz and Gibbons, 1982) and can be as great as 11 km (Prouty, 1952). Delmarva Bays, on the other hand, tend to be much smaller and may range in length between 100 to 1000 m (Stolt and Rabenhorst, 1987a). In addition, over half (29 of 53) of the Delmarva Bays studied by Stolt and Rabenhorst (1987a; 1987b) contained a silty basin fill, which is absent from most southern Carolina Bays. They postulated that the basin fill had most likely originated from loess that was blown from the Chesapeake and Delaware Bays during the last glacial period and was relocated to the center of the Bay by erosion (Stolt and Rabenhorst, 1987a). Hydrologically, undisturbed Delmarva Bays function as a type of geographically isolated wetland (Tiner, 2003). These formations interact with the regional surficial groundwater table and can act as both a recharge wetland during the late summer months and as a discharge wetland during the winter and spring months (Phillips and Shedlock, 1993).

Climate Change

Recently there has been much discussion over climate change. It has been found that the concentration of atmospheric carbon dioxide (CO_2), which can contribute to climate change, has been increasing rapidly over the last decades and is expected to continue to rise at increasing rates over the next several decades (Raupach et al., 2007). A carbon pool is a reservoir of carbon that can either act as a sink by having more carbon enter than exit or as a source by having more carbon exit than enter. Five of the major global carbon pools are the ocean, geologic deposits (fossil fuels; excluding inorganic geologic forms), soils (excluding inorganic forms), the atmosphere, and vegetation containing approximately 38,000 Pg, 5,000 Pg, 1,550 Pg, 760 Pg, and 560 Pg, respectively (Batjes, 1996; Eswaran et al., 1995; Lal, 2003). The soil carbon comprises a significant pool of carbon. The ability of a soil to retain carbon can be affected by disturbance. In a natural setting a soil can be a sink, particularly in wetlands, but if that soil is disturbed by clearing and cultivation for agriculture, then that soil could be turned into a carbon source (Houghton et al., 1983). A lot of land has been converted to agriculture and thus has inevitably released carbon to the atmosphere. Therefore, these carbon depreciated agricultural soils have been the focus of various studies in order to remove CO_2 from the atmosphere and store it as soil carbon in order to revert the changes that have occurred and as an attempt to mitigate climate change.

Wetlands

The US Army Corps of Engineers (2010) recognizes wetlands through the use of a three-factor approach that includes hydrophytic vegetation, hydric soils, and hydrology. This combination of wetland vegetation, soils, and hydrology creates an environment which promotes ecosystem services that are unique to these ecosystems. One of the ecosystem services that wetlands provide is the sequestration of carbon from the atmosphere which helps to reduce the levels of the greenhouse gas carbon dioxide (CO_2) in the atmosphere. Although the sequestration of carbon, and the resulting lowered levels of atmospheric CO_2, can help to mitigate climate change, wetlands are also known to produce other greenhouse gasses such as methane (CH_4) and nitrous oxide (N_2O) which have warming potentials that are 23 and 296 times that of CO_2, respectively (Schimel and Holland, 2005). The production of CH_4 is of particular concern in freshwater wetlands where the levels of sulfate (SO_4^{2-}) are insufficient to inhibit methanogenisis. When SO_4^{2-} is present in excess, it inhibits the reduction of carbon, from CO_2 to CH_4, because it is a more efficient terminal electron acceptor. Therefore, the redox potential tends to be poised by the presence of SO_4^{2-}, preventing the production of methane (Vepraskas and Faulkner, 2001).

Another ecosystem service that wetlands can provide is the removal of nutrients from ground and surface water. This occurs primarily through the reduction of nitrate and the settling of sediment which can remove phosphorus sorbed to the sediment (Vepraskas and Faulkner, 2001). This ecosystem service is one of potentially great importance in Delmarva Bays since they are located in a region which is dominated by agriculture (Norton and Fisher, 2000) and in watersheds that feed the impaired waters of the Chesapeake Bay (EPA, 2011).

Another ecosystem service of wetlands is providing habitat for a broad array of plants and animals. Geographically isolated wetlands, like Delmarva Bays, contain many rare and endangered species, particularly amphibians. These species are able to thrive in these environments because they have adapted to a habitat that is ponded during breeding season but dries up in late summer. The seasonal drying of Delmarva Bays creates an environment that precludes predators, such as fish, which cannot survive through the period when the wetland has no ponded water, and contains no surface connection to facilitate escape or repopulation (Sharitz, 2003; Sharitz and Gibbons, 1982).

Natural Soil Drainage Classes divide soils into groups based upon morphological characteristics intended to reflect the depth to the seasonally high water table. They are distinguished by the depth at which depletions are present, and in the wetter situations the

Table 2-1. Natural Soil Drainage Classes for the Mid-Atlantic Region and the associated diagnostic soil morphological features.

Drainage Class	Diagnostic Soil Morphological Features
Very Poorly	Thick dark surface horizons (Histic, Mollic, or Umbric Epipedon) Depleted matrix under O/A horizons
Poorly	Ochric Epipedon Depleted matrix occurs immediately under O/A-horizons
Somewhat Poorly	Shallowest redox depletions occur within 50 cm
Moderately Well	Shallowest redox depletions occur 50-100 cm from soil surface
Well	Shallowest redox depletions occur >100 cm from soil surface

thickness and darkness of the A and O horizons (Table 2-1). Soils found in wetlands typically are either very poorly, or poorly drained. Because Natural Soil Drainage Classes are based on soil morphology developed under natural (undrained) conditions, they are only useful in describing hydrological conditions for undrained soils. Soil morphology is very slow to change following hydrological changes. Therefore, if a soil has been drained then the morphological characteristics used to determine the Drainage Class would not accurately indicate the current hydrological conditions (Soil Survey Staff, 1993).

Soil Carbon

Several factors affect the quantity of carbon that a soil will contain. On a regional scale climate, including temperature and precipitation, can have an effect on the quantity of carbon soils can retain. However with in a particular region where those two factors are fairly consistent, the one factor that has the most influence is hydrology. When examining soil carbon content in soils across a catena, the values appear to be relatively similar for the well drained, moderately well drained and poorly drained soil classes. However, when one moves into the very poorly drained portion of the catena the quantity of carbon stored increases greatly (Fig. 2-1). This trend is present because the very poorly drained soils are saturated and anaerobic long enough and high enough in the profile to substantially inhibit the aerobic decomposition of soil organic matter. Although, the poorly drained soils also have wetland hydrology, the duration of

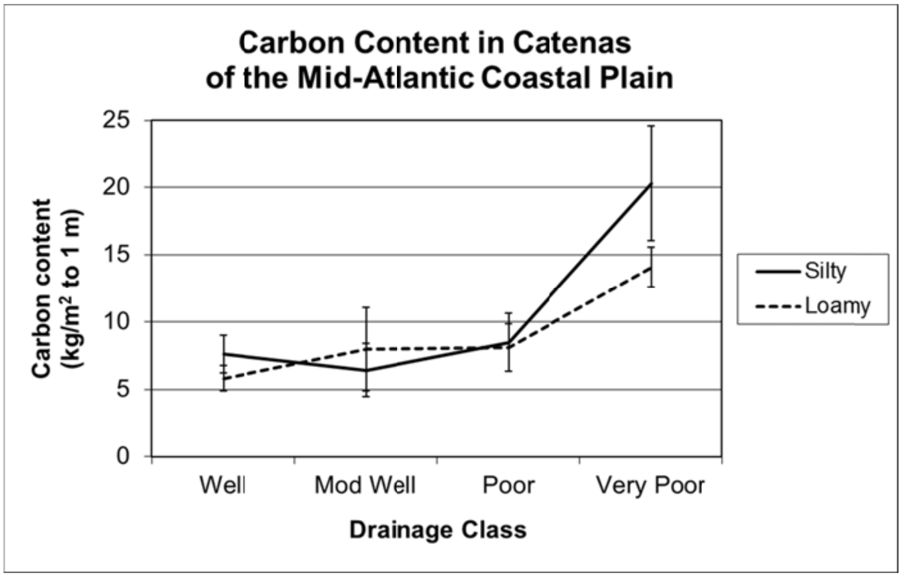

Figure 2-1. Carbon content in soils included in fine silty, and fine and coarse loamy particle size catenas from the Mid-Atlantic Coastal Plain in Maryland. Means for the fine silty catena were based on data from 11, 7, 7, and 4 pedons for the well, moderately well, poorly and very poor classes while means for the fine and coarse loamy catena were based on data from 5, 5, 3, and 3 pedons respectively. Data obtained from the National Cooperative Soil Survey Characterization Database (2011).

the anaerobic conditions near the surface is too short to promote the accumulation of carbon. Stolt and Rabenhorst (1987a) reported that the undrained basin soils of Delmarva Bays are generally poorly to very poorly drained and thus would be expected to promote the accumulation of organic matter. Delmarva Bays were observed to have O-horizons that ranged from 5 to 30 cm deep overlying an A horizon with either a Cg horizon, or Btg with a Cg horizon below that (Stolt and Rabenhorst, 1987b).

Soil carbon stocks, are often reported in kg C m^{-2} to a depth of one meter, but numerous studies commonly measure organic carbon to a much shallower depth. The soil bulk density can be used to calculate the amount of pore space of a soil (Blake and Hartage, 1986) and is also required when calculating the mass of carbon stored in a given volume of soil (carbon stocks) (Ellert et al., 2001). In Carolina Bays with histosols, undisturbed organic horizons typically have a bulk density of approximately 0.15 g cm^{-3} (Bruland et al., 2003; Caldwell et al., 2007; Ewing and Vepraskas, 2006). Histosols in natural Carolina Bay wetlands in North Carolina have been found to have carbon stocks of 84 and 130 kg C m^{-2} to a depth of a meter (Bruland et al., 2003). Other histosols, such as coastal marshes, have been found to contain 9-191 kg C m^{-2} with averages of 59 (Griffin and Rabenhorst, 1989) and 64 kg C m^{-2} (Rabenhorst, 1995). For comparison, natural prairie potholes, depressional wetlands in the Midwest, have been found to contain 9 kg C m^{-2} in the upper 30 cm (Gleason et al., 2008).

Conversion of Wetlands to Agricultural Land

It is estimated that over the last 200 years, approximately fifty percent of the pre-colonial wetlands in the conterminous US have been lost due to being drained or filled for agriculture or commercial and residential development (Mitsch and Gosselink, 2007). The rate of wetland loss in the conterminous US has decreased since implementation of the clean water act in the 1970s. Between 1998 and 2004 it was estimated that there was a net gain of wetlands of about 13,000 ha. Between 2004 and 2009, however, it was estimated that there was a net loss of 5,600 ha of wetlands (Fig. 2-2). More specifically, freshwater forested wetlands were estimated to have decreased by 256,320 ha between 2004 and 2009, which is more than any other wetland type during that period. This is most likely a result of silviculture in southeastern states (Dahl, 2011).

In the state of Maryland, over the past 200 years it is estimated that there has been a loss of approximately 73 % of the pre-colonial wetlands (Mitsch and Gosselink, 2007). Much of this loss has occurred on the Delmarva Peninsula (DNR, 2000) where there are a variety of wetland types, including Delmarva Bays. The Delmarva Peninsula is an area in which the dominant land use is agriculture (Norton and Fisher, 2000), which most likely is the leading cause of historic wetland loss in the area.

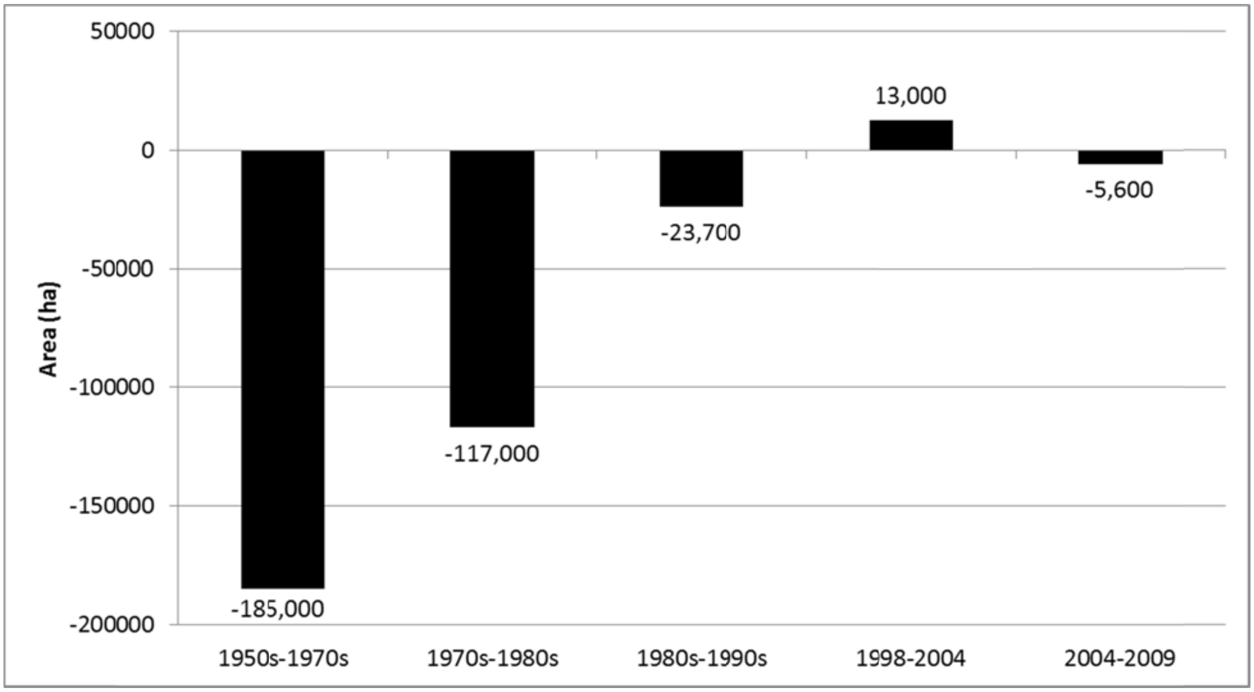

Figure 2-2. Estimate of average annual net loss and gain of wetlands in the conterminous United States, 1954-2009. Adapted from Dahl, 2011.

Wetland loss due to land conversion to agriculture occurred primarily through drainage structures which lower the water table to make the field workable (Sharitz and Gibbons, 1982). The removal of wetland hydrology by drainage also results in the change of the biogeochemical processes that occur in the soil. The presence of the wetland hydrology creates an anaerobic environment in the upper part of the soil which promotes the accumulation of carbon due to inefficient anaerobic microbial decomposition (Collins and Kuehl, 2001). When the water table is lowered for agriculture it also removes the saturated and anaerobic soil conditions that used to be present, and allows oxygen to readily diffuse into the soil. In an aerated environment, the microbial community would oxidize carbon transforming it into CO_2 through aerobic respiration (Wolf and Wagner, 2005). A newly drained wetland soil would therefore contain a higher quantity of carbon than could be supported under aerobic conditions, and therefore would be expected to lose carbon (Armentano and Menges, 1986).

Although there have been numerous studies that have examined the quantity of carbon present in various wetland types, there have been surprisingly few that have compared the quantity of carbon in natural wetlands to those that have been converted to agriculture in order to assess the amount of carbon that has been lost as a result of the conversion of wetlands to agriculture. One study conducted on prairie potholes observed a loss of approximately 26 % of the stored soil carbon in the wetland zones due to the conversion to agriculture (Gleason et al., 2008), while another study in prairie potholes did not observe a significant difference between carbon stocks in the reference (wetland) and cultivated sites. However, it was observed that the quantity of carbon in the upper 15cm of the cultivated sites was lower than the reference sites, suggesting that there had been an increase in oxidation of carbon due to the conversion to agriculture (Euliss Jr. et al., 2006).

Numerous studies have been conducted on the magnitude of soil carbon that has been lost following the conversion of forest land to agricultural land in areas that are not wetlands. In non-wetland soils, the conversion of forest to agriculture has been found to result in losses of 20 to 40 % of carbon stocks (Anderson, 1995; Davidson and Ackerman, 1993; Gleason et al., 2008; Mann, 1986; Murty et al., 2002). This change is primarily the result of the replacement of the native vegetative community with harvested crops and cultivation stimulating organic matter decomposition (Six et al., 2002). Cultivated non-hydric soils in the Maryland Delmarva Peninsula region have been found to contain approximately 5.7 kg C m^{-2} (Weil et al., 1988).

Ecosystem Restoration

Ecosystem restoration is the “return of an ecosystem to a close approximation to its condition prior to disturbance” which would include physical, chemical, and biological characteristics (NRC, 1992). If wetland hydrology is restored, then the soil biogeochemical processes as well as the hydrophytic vegetation would be expected to follow. Assuming that natural wetlands have a soil carbon content that is at some dynamic equilibrium, if a wetland that had been previously converted to agriculture were to be restored to its original wetland hydrology, then the quantity of carbon would be expected to return to its original level prior to drainage. Most cultivated Delmarva Bays use a ditch to facilitate artificial drainage. Since undisturbed Delmarva Bay landforms are depressional geographically isolated wetlands, they would be very easy to restore. Restoration of hydrology can be achieved simply by plugging the ditch where it dissects the rim, which would require little time and material.

The U.S. Department of Agriculture (USDA) promotes the restoration of ecosystems through conservation programs such as their Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP) where farmers receive incentives to restore farm land to original land uses when considered to be environmentally critical, such as prior converted croplands and agricultural land in close proximity to streams that could be used as riparian buffers (NRCS, 2011).

Recent Soil Erosion and Deposition

The conversion of a stable natural ecosystem to an agricultural one can result in an increased redistribution of sediments in the landscape. Vegetation communities such as forested ecosystems provide rainfall interception to help reduce the impact of rain fall on the soil surface, as well as roots to hold soil in place. The biomass also provides organic matter which helps to increase aggregate stability and improve infiltration. Overall, the forested ecosystem helps to protect the soil from erosional forces. Therefore the replacement of the forested vegetation with cultivated crops increases the vulnerability of soil to erosion. In a Delmarva Bay landscape, the eroded material would likely be deposited in the wetland basin area. A study conducted by McCarty and Ritchie (2002) sought to assess the influences that erosion and deposition have on carbon sequestration rates of wetlands. They observed that deposition of low carbon mineral soil (~1% OC) into wetlands with high soil carbon contents (~20 % OC) stimulates carbon sequestration in the wetland soils. This is believed to happen because the input of low carbon soil material lowers the concentration of carbon below the steady state level for the wetland soil, stimulating the sequestration of carbon to a point of re-equilibration.

One method to measure the input of recent soil deposition from erosion is to use chronological markers. One such marker, ^{137}Cs, is a radio isotope that does not exist naturally in soil (Ritchie and McHenry, 1990). Around 1952, ^{137}Cs was introduced into the environment as a result of atmospheric nuclear testing (Robbins et al., 1978) and was distributed globally because it was injected into the stratosphere. Measurable quantities began to accumulate in the soil around 1954 and the concentration peaked around 1963. Therefore, it is a useful marker in measuring the amounts of recent erosion and deposition that have occurred since the 1960s (Longmore, 1982).

^{137}Cs is useful in measuring erosion and deposition because it strongly adsorbs onto clay and organic matter and is essentially non-leachable. It behaves similarly to potassium (K^+) in the soil (Davis, 1963), thus it becomes fixed to the soil or sediment (Ritchie et al., 1970). Physical process such as tillage and erosion are capable of causing the redistribution of ^{137}Cs in soils. Erosion moves sediment and any sorbed ^{137}Cs down slope increasing the thickness of the ^{137}Cs enriched soil (Ritchie and McHenry, 1990). The general approach for using ^{137}Cs in natural systems is to take a 15 cm diameter core which is divided into multiple vertical sections of 2 to 5 cm so one can measure the change in concentration with depth. By examining the vertical distribution of ^{137}Cs with depth, one would be able to determine where the original soil surface was in the 1950's. However, that approach is ineffective in soils that have been cultivated because plowing causes an even distribution or homogenization within the plow zone eliminating the vertical trends with depth. Therefore, an alternative method would be to take cores to a specific depth and determine the total quantity of ^{137}Cs in the entire sample (Ritchie et al., 2007). Cores collected in locations where erosion and deposition may have occurred could be compared to reference samples collected at sites where it would be expected that no erosion and deposition, or other soil disturbance, would have occurred since the 1950s (McCarty et al., 2009; Ritchie and McCarty, 2003). Soils that have higher quantities of ^{137}Cs compared to the reference would be locations of deposition, and those that have lower quantities would be locations of erosion. In the case of cultivated Delmarva Bays, which are closed depressions, the ^{137}Cs sorbed to transported sediment would be expected to move from the surrounding rim and accumulate in the basin and not be lost from the system.

Chapter 3 - Morphometric Analysis of Delmarva Bay Landforms

Introduction

The improvement of water quality of Chesapeake Bay is imperative to the restoration of aquatic life and recreation. Most of the Delmarva Peninsula drains into Chesapeake Bay and more than 50 % of the land area is used for agriculture (Norton and Fisher, 2000). The region includes a great many depressional landforms called Delmarva Bays, which typically contain wetlands. They are primarily found between the Sassafras and Nanticoke Rivers near the state border between Maryland and Delaware (Stolt and Rabenhorst, 1987a; Tiner, 2003). Historically, a large percentage of these wetlands have been drained for agriculture. The state of Maryland has lost 73% of its wetlands over the past two centuries (Mitsch and Gosselink, 2007) and the Delmarva Peninsula has experienced the greatest wetland loss for the state (DNR, 2000). The quantification and characterization of Delmarva Bay land forms could be an aid in site location and selection in wetland conservation programs.

Only a few studies have focused on the Delmarva Bays, and most do not address the geomorphology and spatial characteristics of these landforms (Stolt and Rabenhorst, 1987a). In contrast, more studies have focused on Carolina Bays farther to the south (Ross, 1987). Both Carolina Bays and Delmarva Bays are believed to have formed from similar processes related to "blowouts" (depressions created from strong winds removing sandy soil material) during the Pleistocene. It is postulated that the blowouts became elongated due to wind driven currents in the ponded water, moving sands to form the characteristic elliptical shape and a sandy rim (Prouty, 1952; Savage, 1982).

The objectives of this study were to determine the population and aerial density of Delmarva Bays, to determine their typical morphometric characteristics, to compare them with parameters of Carolina Bays and to examine the current land use associated with these landforms.

Materials and Methods

Light Detection and Ranging (LiDAR) data, and aerial photography were used to manually identify and locate, and then quantify Delmarva Bay landforms with the use ArcGIS (9.2). Delmarva Bay landforms identified on LiDAR as areas that had a somewhat circular area of low elevation (the basin) surrounded by an area of higher elevation (the rim). The rim may or may not be continuous if the landform is dissected by a ditch. Some Bays overlap each other, which causes the rim to appear like the outermost line of a Venn Diagram. The Basin of these overlapped features may or may not have a continuous basin. Those in which the basin was continuous were identified as a single feature. Those in which there was a zone of slightly higher elevation (although not as high as the rest of the rim) would divide the basin into two separate features. Those that lacked a zone of raised elevation between overlapping features (therefore making the basin continuous) were recognized as a single feature. Manmade depressions, such as ponds or reservoirs, which typically have a flat side for the dam, were not included in the study.

After all of the Bays were manually identified and located, a grid of 1.875-minute quadrants was created by dividing quarter-topo quad layers into quarters (sixteenth quads). Fifteen of these sixteenth quads were randomly selected for more detailed analysis using four strata based upon densities of Bays. The four density strata were 1 to 20, 21- 50, 51-100, and > 100 Bays per sixteenth quad, which corresponds to approximately >0 - 2.1, 2.2 - 5.3, 5.4 - 10.6, and >10.6 Bays per square km. Quads that contained no Bays were ignored during the landform analysis. The number of quads selected for each density level was based on the goal of having an approximately equal number of quads per density level (Table 3-1). Within each of the fifteen quads, Bays that touched the upper and right quad boundaries were included, while those that touched the left and lower boundaries were excluded. A total of 1090 Delmarva Bays were examined. Within each quadrant, each identified Delmarva Bay was manually outlined around the rim by drawing a polygon for each individual bay, following the highest elevation surrounding the basin, as one would do when delineating a watershed. The following morphometric parameters were collected using the *zonal geometry* tool in ArcGIS: raster area, raster perimeter, major axis, minor axis, and orientation. Vector data for area and perimeter were obtained using the *calculate geometry* tool in the attributes table of ArcGIS. An analysis of the data obtained from raster derived perimeters was found to be a severe overestimation, with an average divergence from the vector data of about 25 %. Therefore vector data were used in all calculations involving area and perimeter. To ensure that the elevation of ditches were not included in the calculation of the basin elevation, the relief for each Bay was determined manually by comparing the average elevations of three randomly selected points from the basin and the average of three randomly selected points on the rim. Land cover was documented using

Table 3-1. Number and proportion of quads in each density level found on the Delmarva Peninsula and the number of quads from each density level that were included in the morphometric analysis.

Density levels (Bays / quad)	Number of quads per density level	% of quads	Number of quads selected per density level	% of quads selected per density level
1-20	472	69.5	3	0.6
21-50	119	17.5	4	3.4
51-100	67	9.9	5	7.5
>100	21	3.1	3	14.3
Total	679	100	15	2.2

aerial photography by estimating percentages of each cover class in each bay. Statistical comparison of relief between natural and agricultural bays was conducted using a t-test.

Results and Discussion

Using the approach described above, a total of 14,930 Delmarva Bays were observed (Fig. 3-1). However, LiDAR data were missing for some parts of the study area, as shown in Figure 3-1. Densities of Delmarva Bay in the sixteenth quads surrounding the quads with missing LiDAR data were used approximate the spatial concentration of Bays where LiDAR data were missing. Quads that had similar topography with an adjacent quad of known density was estimated to contain an equal concentration of Bays. If a quad of unknown density had a river dissecting it, then the density of the adjacent quads were applied to the area of the quad in which Delmarva Bays would be expected to be present. Therefore, we estimated that there are roughly 17,000 Delmarva Bays are present in Maryland and Delaware. This population estimate is an order of magnitude greater than that previously reported by Stolt and Rabenhorst (1987) who suggested there were 1,500-2,500 Bays on the Delmarva Peninsula. Their estimate relied upon aerial photography rather than LiDAR, which is less effective in observing these landforms, especially in forested environments. For example, in one test area, Delmarva Bays were first identified by using only aerial photographs and then again with the use of LiDAR. Using only aerial photographs, 47 bays were identified (Fig. 3-2). When the LiDAR was used, 169 bays were identified (Fig. 3-3).Therefore, the high vertical resolution of available LiDAR data has greatly improved our ability to identify and quantify these landforms.

The mean values for the morphometric data for each of the 15 quads is presented in Table 3-2. The 15 quads selected for morphometric analysis (Fig. 3-4) had an average density of 7.7

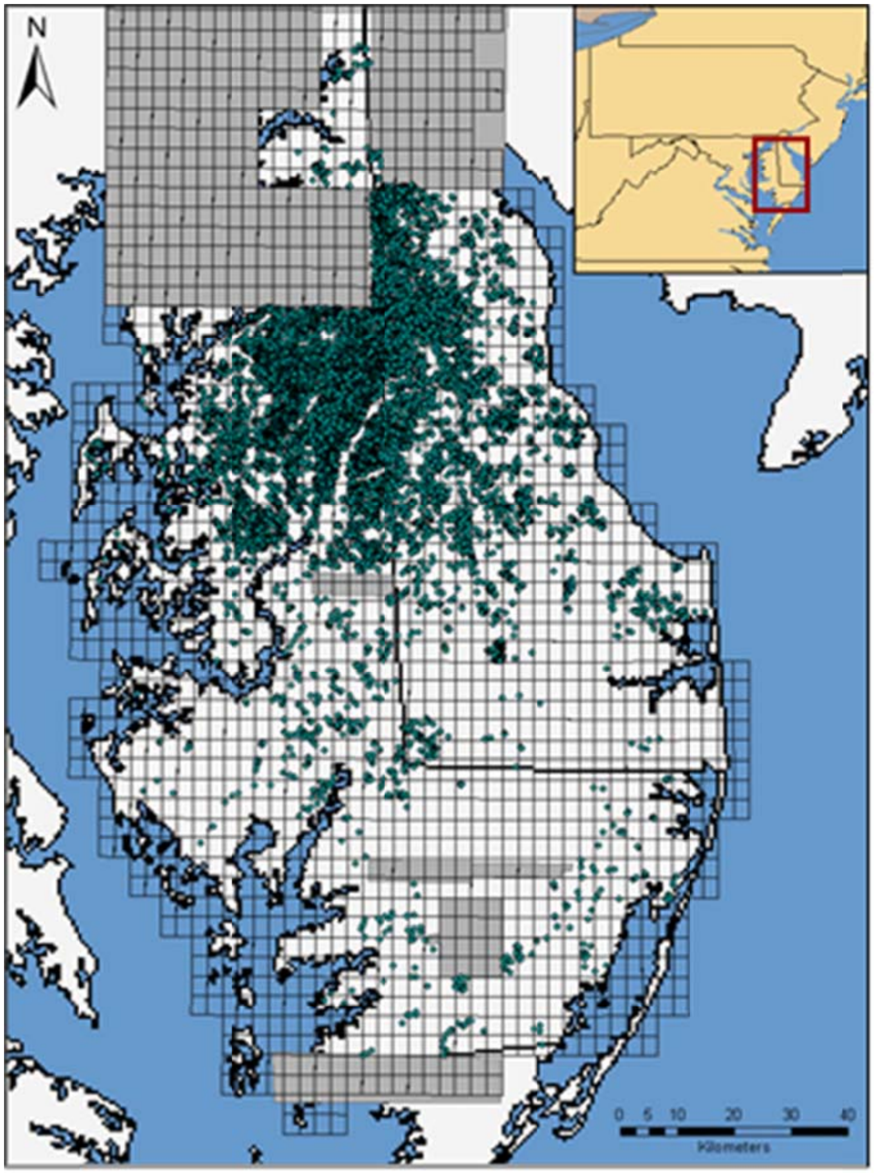

Figure 3-1. Map showing Delmarva Bays that were identified using LiDAR imagery, n=14,930. Gray areas represent zones where LiDAR data was lacking.

bays km^{-2} (median 5.84). Two of the quads had much higher densities compared to the rest, with densities of 21.7 and 27.5 bays km^{-2} as compared to the next closest of 14.7 bays km^{-2}. In the two quads with the highest densities, the land area covered in each quad by Delmarva Bay landforms was found to be 52 and 54 %, which is comparable to land coverage of Carolina Bays reported by Prouty (1952). There were some regions that contained no Delmarva Bays; these were excluded from the morphometric analysis.

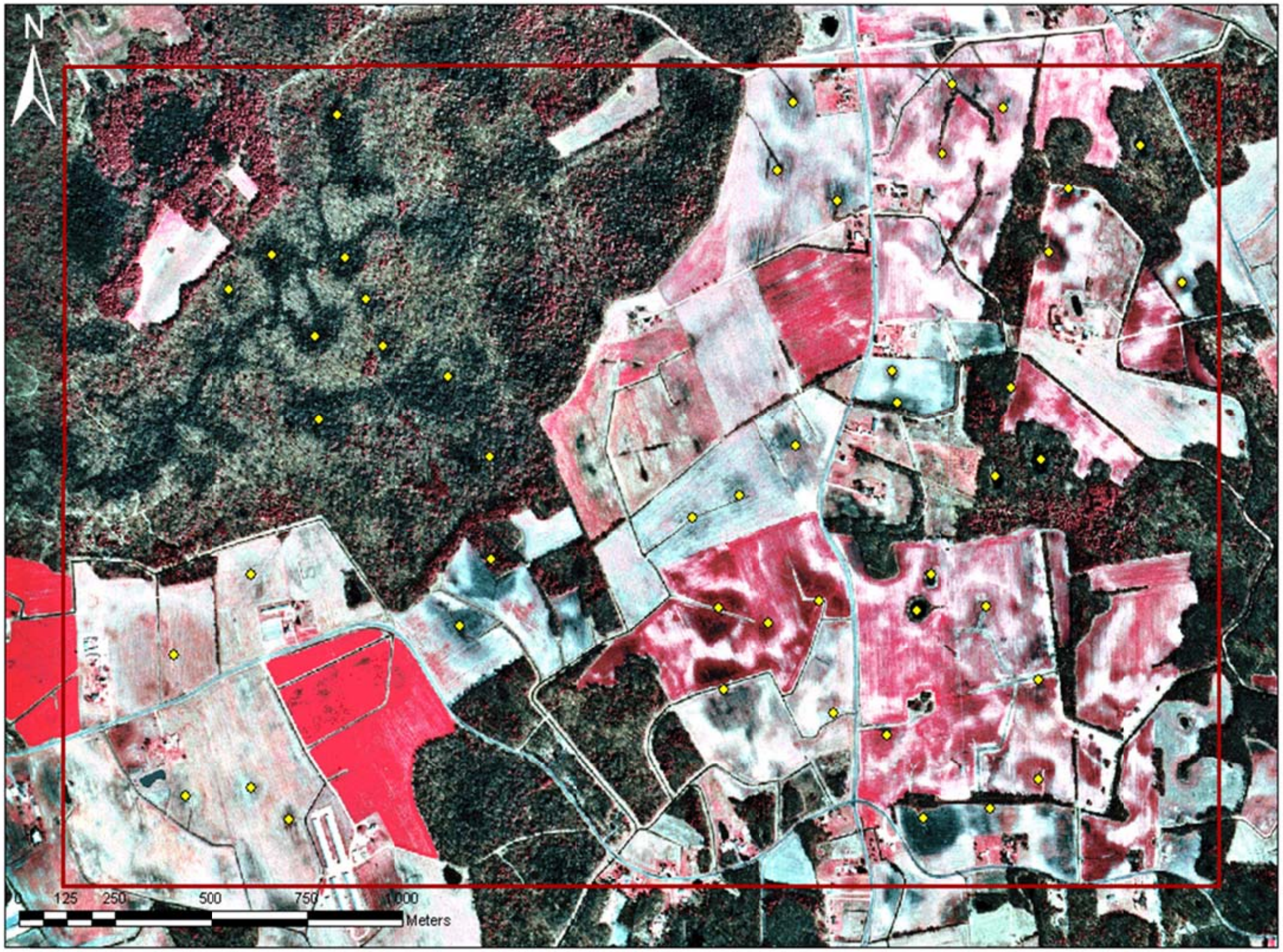

Figure 3-2. Identification of Delmarva Bays in a test area using only aerial photography. The total number of features that could be identified was 47.

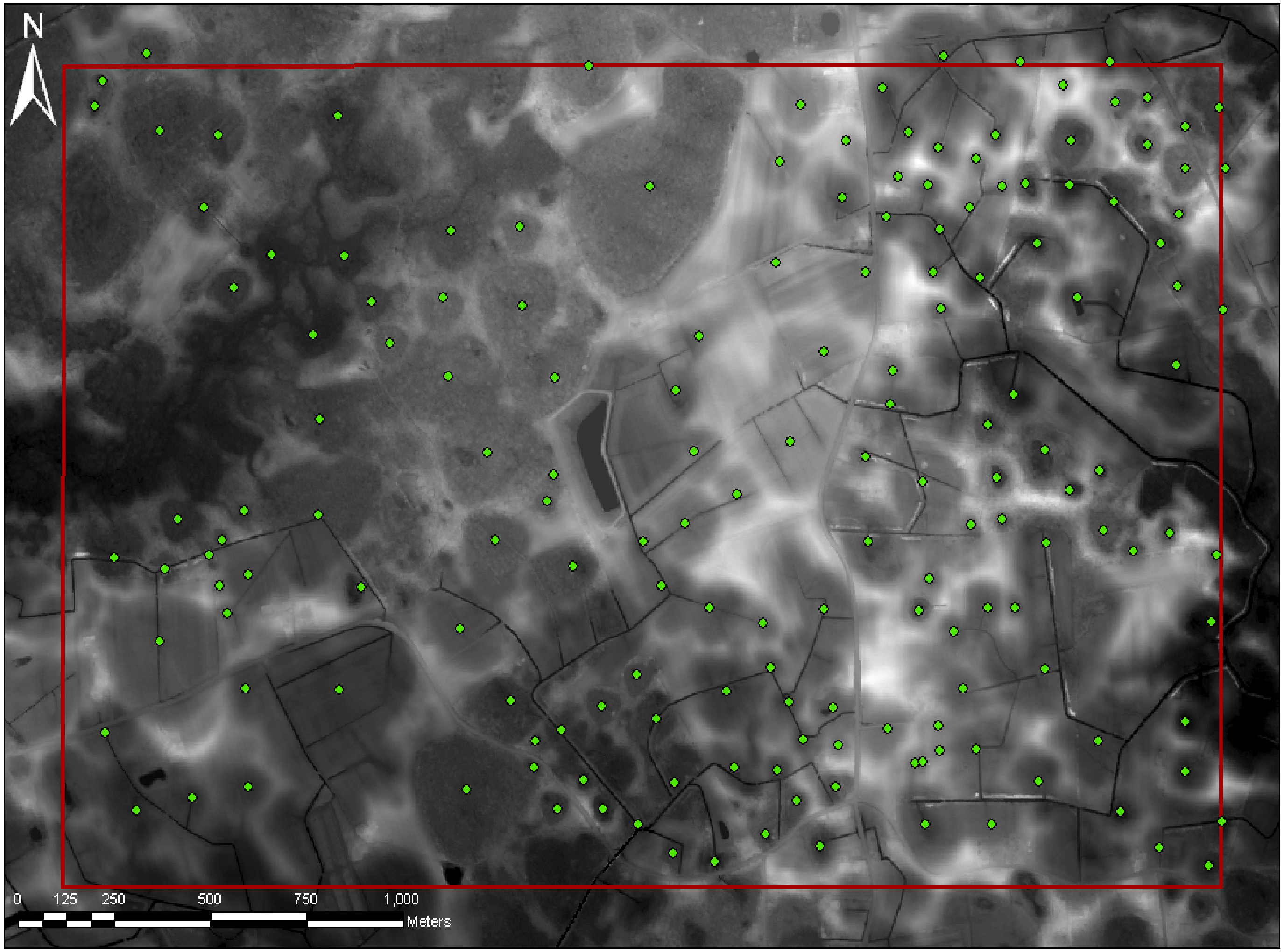

Figure 3-3. Identification of Delmarva Bays for the same test area used in Fig. 3-2, but using LiDAR elevation data. Total number of features that could be identified was 169.

Table 3-2. Mean values for Delmarva Bay morphometrics, with standard errors, for the 15 quadrats selected for the detailed analysis.

Quad ID	# of Bays	Density (Bays km^{-2})	Area (ha)	Major:Minor Axis Ratio	Orientation (circle deg.)	Relief (m)	Basin Elevation (m)
1141	259	27.50	1.91 ± 0.15	1.32 ± 0.02	102 ± 3	1.37 ± 0.03	18.3 ± 0.05
649	204	21.66	2.51 ± 0.19	1.35 ± 0.02	108 ± 3	1.54 ± 0.04	17.0 ± 0.06
1959	138	14.65	3.15 ± 0.41	1.36 ± 0.03	108 ± 4	1.02 ± 0.03	20.3 ± 0.06
489	78	8.28	0.72 ± 0.07	1.34 ± 0.03	107 ± 6	0.62 ± 0.03	9.9 ± 0.09
1847	77	8.18	1.89 ± 0.22	1.32 ± 0.03	112 ± 5	0.80 ± 0.05	14.9 ± 0.12
1190	60	6.37	2.73 ± 0.37	1.28 ± 0.02	121 ± 6	1.62 ± 0.10	16.1 ± 0.37
719	55	5.84	2.01 ± 0.26	1.32 ± 0.04	98 ± 7	0.95 ± 0.05	15.6 ± 0.13
50	56	5.95	3.69 ± 0.56	1.38 ± 0.03	98 ± 5	1.82 ± 0.08	13.7 ± 0.16
1260	44	4.67	2.14 ± 0.16	1.40 ± 0.03	110 ± 7	1.53 ± 0.09	16.2 ± 0.22
1505	30	3.19	2.97 ± 0.72	1.26 ± 0.03	85 ± 9	0.88 ± 0.08	17.4 ± 0.13
615	28	2.97	1.40 ±0.26	1.40 ± 0.04	122 ± 8	0.88 ±0.06	12.7 ± 0.12
955	23	2.44	2.36 ± 1.11	1.26 ± 0.03	91 ± 13	0.81 ± 0.07	13.5 ± 0.09
1925	18	1.91	2.17 ± 0.42	1.26 ± 0.04	88 ± 13	1.03 ± 0.11	21.3 ± 0.20
961	17	1.81	1.85 ± 0.66	1.26 ± 0.04	118 ± 12	0.91 ± 0.08	12.6 ± 0.08
1621	3	0.32	5.48 ± 0.72	1.83 ± 0.30	160 ± 7	2.25 ± 0.15	5.8 ± 0.26
Over All	1090	7.72	2.28 ± 0.09	1.33 ± 0.01	106 ± 1	1.24 ± 0.09	16.6 ± 0.09

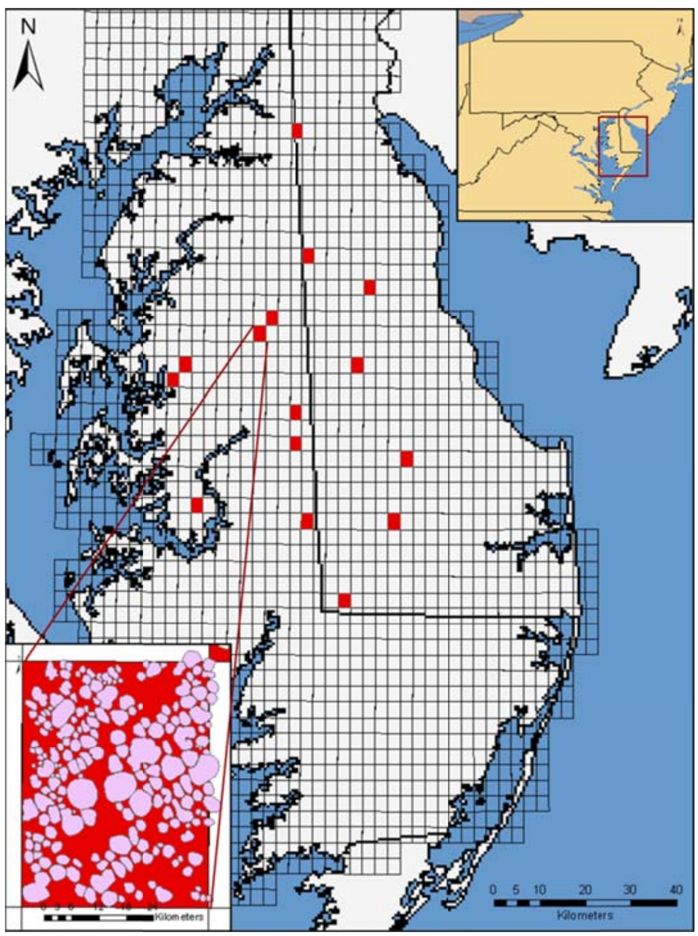

Figure 3-4. Map showing 15 randomly selected quads; Inset map shows individual Bays that were measured within the sampled quad.

The four rivers that flow from the core of the Delmarva Peninsula to the Chesapeake Bay are the Sassafras, Chester, Choptank, and Nanticoke Rivers. Along these rivers and tributaries there is a zone, of approximately 0.5 to 2 km in width, in which Delmarva Bays generally appear to be absent, although, there are a few bays that have persisted close to the rivers. Towards the mouths of the rivers the zone where bays are absent extends to about 3 to 5 km on either side. The absence of bays within this zone could be the result of erosional processes effectively removing the landforms. Of the fifteen quads studied, seven contained portions of second order, or greater, streams bisecting the quads, so it could be postulated that these regions might previously have had higher densities of Delmarva Bays before erosion associated with the streams removed the features. The two quads with the highest densities are located in regions that contain primarily first order streams which lack the erosional energy to remove the features from the landscape. It had been observed by Stolt and Rabenhorst (1987a) that these formations typically occur at elevations of 14-20 meters which is similar to this study with a mean basin elevation of 16.6 m (Fig. 3-5).

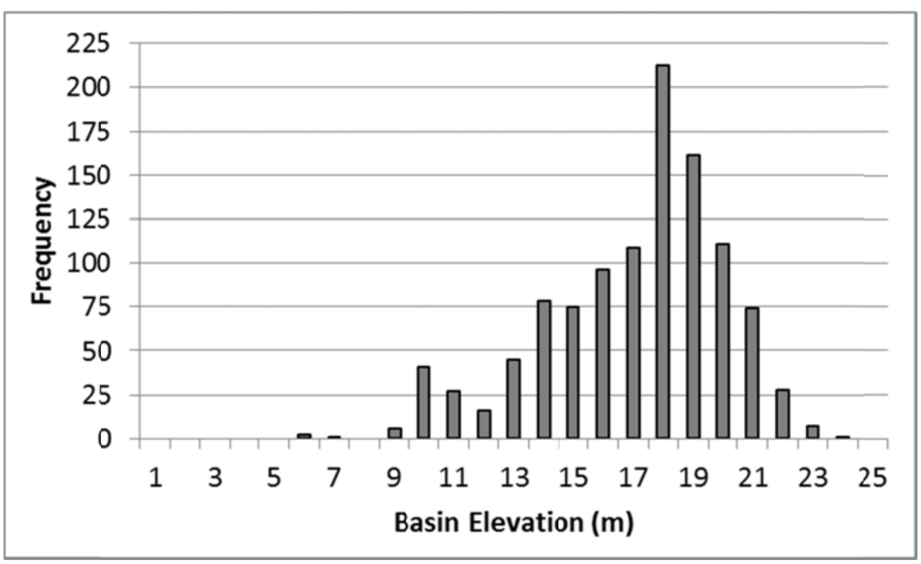

Figure 3-5. Histogram showing the elevation of the basin of the Delmarva Bays examined (n=1090).

The orientation of Carolina Bays was fairly consistent and characteristic of the landforms in North and South Carolina. They have been found to be oriented within the ranges of 55° east of south in the northern part of North Carolina to 15º East of South in the southern part of North Carolina (Prouty, 1952). Based on our analysis, Delmarva Bays appear to be less clearly oriented, but some orientation was evident among the population (Fig. 3-6). Some Delmarva Bays that were found to be oriented west of south were pairs of overlapping bays resulting in the major axis providing a false direction of orientation (Fig. 3-7). Since many of the Delmarva Bays were observed to be nearly circular features, those Bays with a major to minor axis ratio of less than 1.5 were ignored during subsequent analysis of orientation to remove instances where orientation was simply an artifact within a nearly equidimensional feature (Fig. 3-8). This resulted in the middle fifty percent having an orientation between 15 and 55° east of south, providing evidence that the orientation most likely is genuine and not an artifact. This orientation is similar to that of Carolina Bays (Prouty, 1952) offering evidence that these two landforms were formed by similar processes. It was also noticed that in the southeastern part of

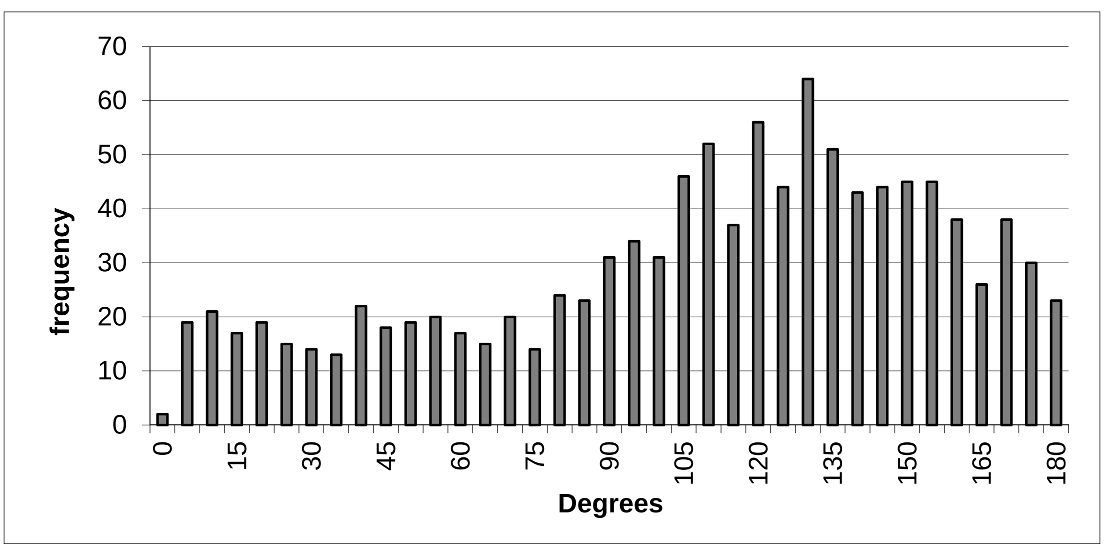

Figure 3-6. Histogram showing the orientation of the 1090 Delmarva Bays examined in detail (0° represents east and 90° represents north).

the Delmarva Peninsula, where population densities are very low, Delmarva Bays often occur in strings of 3 or more lined up along a similar NW to SE orientation. This provides further support for the hypothesis that they have formed from wind.

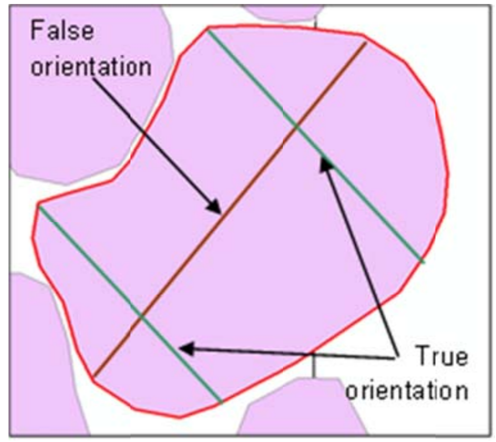

Figure 3-7. Example of Delmarva Bays that overlap causing the major axis to go against true orientation.

Using the morphometric analyses described, typical characteristics for the Delmarva Bay landforms were estimated by excluding the upper and lower 10 percentile for each metric. The remaining, central 80 % of Delmarva Bays represents the range of what will be referred to as the typical characteristics for the landforms. Typical Delmarva Bays were found to have an area of 0.41 to 4.94 ha (mean 2.28 ha, median 1.33 ha), a relief of 0.54 to 2.10 m (Fig. 3-9; mean, 1.24 m, median 1.14 m) and a major to minor axis ratio of 1.09 to 2.19 (mean 1.33, median 1.26). Carolina Bays have been found to have a mean area of 45.9 ha (calculated from mean major axis data from Bennet and Nelson, 1991 and mean major to

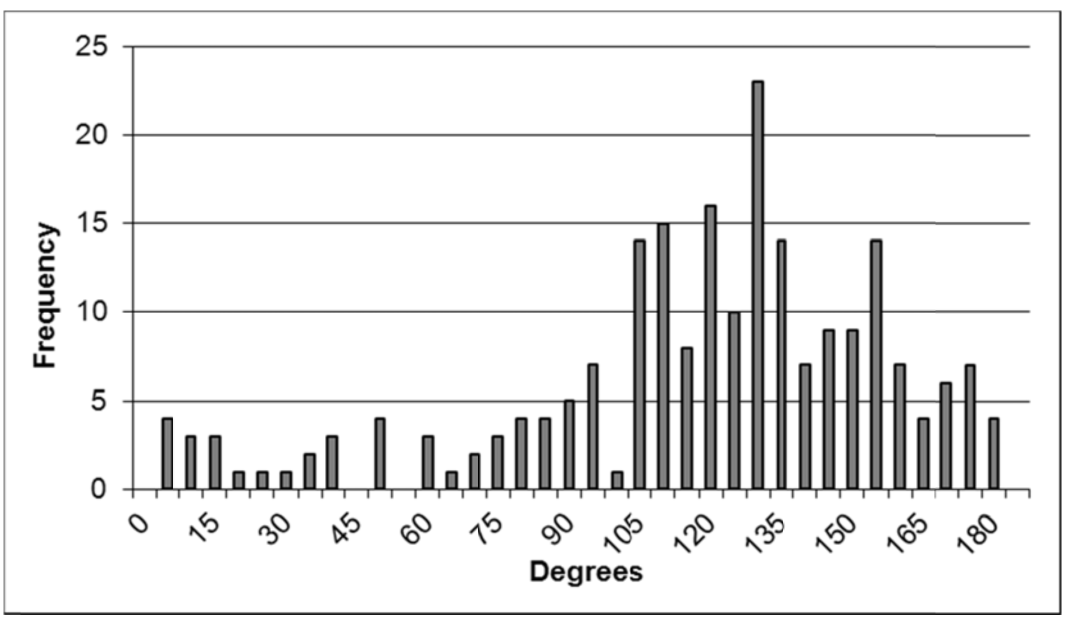

Figure 3-8. Histogram showing the orientation of only those Delmarva Bays having a major to minor axis ratio >1.5.

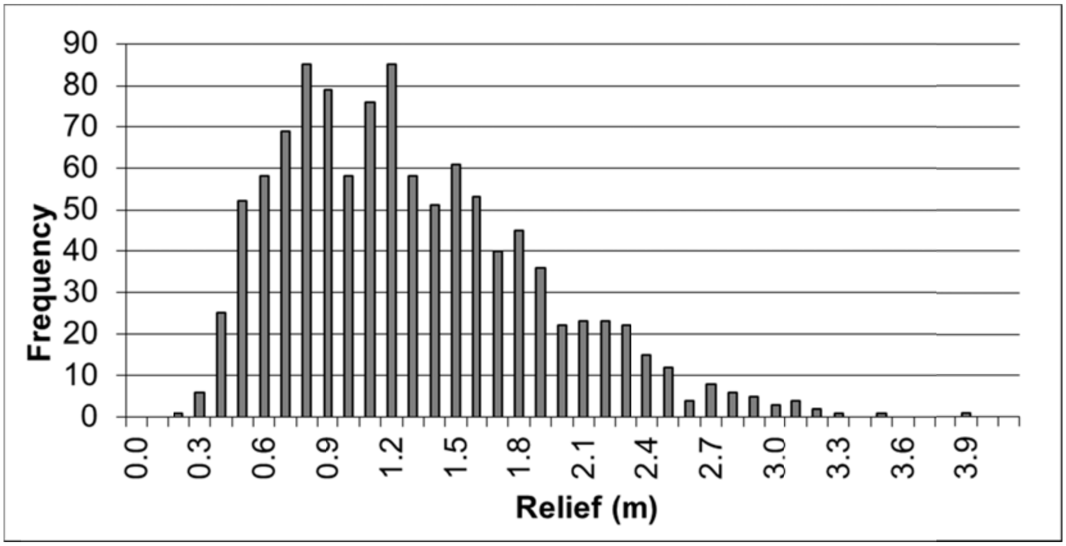

Figure 3-9. Histogram showing the relief for the Delmarva Bays examined in detail (n=1090).

minor axis ratio from Prouty, 1952), relief of 1.81 m (Prouty, 1952; Thom, 1970), and major to minor axis ratio of 1.51 (Melton and Scriever, 1933).

Since Delmarva and Carolina Bays are believed to have formed from similar processes, it might be anticipated that they would be more similar in size and shape. However, Delmarva Bays are clearly much smaller than the Carolina Bays in all three metrics. The best explanation for this difference is that the Delmarva Bays formed in a colder environment than the Carolina Bays. During the Pleistocene, when the features were formed, the Delmarva Peninsula was closer to the southern extent of the Laurentide Ice Sheet, being only 150-300 km south of the glacier as compared to the Carolinas which were more than 600 km away (Ives, 1978). Therefore the periglacial climate in the Delmarva region would have been much colder than in the Carolinas. Ponds formed by the blowouts, which played a crucial role in the development of these features, would have been frozen for longer periods which might have inhibited the further development of the Delmarva Bay landforms. Additional support for this theory can be observed in the morphological characteristics of the Delmarva Bays that are located on the southernmost part of Delmarva Peninsula in Virginia (Bliley and Pettry, 1979), just outside of our study area of

Maryland and Delaware. The majority of Bays in this region were found to have a mean area of 25.8 ha and a major to minor axis ratio of 1.28. Although these features have a similar elliptical shape as the Delmarva Bays in our study, they are much larger features, being an order of magnitude greater in area. They are located slightly farther south than the Delmarva Bays in this study, so when they formed they would have been in a slightly warmer environment, but not as warm as the Carolina Bays. These climatic conditions might have allowed for the features to increase in size more so than the rest of the Delmarva Bays but would have still limited their development as compared to the Carolina Bays.

Land cover of Delmarva Bays was found to be nearly evenly divided between natural, (mostly forested with some areas of emergent vegetation) and agricultural classes. The number of Bays that were dominated (>50 %) by natural land cover was slightly greater than those dominated by agriculture. However, when considering only those Bays that were composed entirely of a single land use, agricultural Bays were slightly more numerous (Fig. 3-10). Of the 1090 Bays examined in detail, 65 % had been clearly impacted by agriculture (having some portion of the Bay in agriculture), while only 35 % appeared to be unaffected. However, it is likely that many of those apparently unaffected bays in natural vegetation have in the past been affected by drainage structures in the area, even if there is currently no drainage present in the landform.

Delmarva Bays that were entirely in natural vegetation had a relief of 1.30 m. Bays that were entirely in agriculture had a relief of 1.10 m. The reliefs of these two land uses were found to be significantly different ($p<0.001$). One explanation for this lower relief in agricultural bays could be erosion and sedimentation following tillage. Alternatively, it is possible that the bays

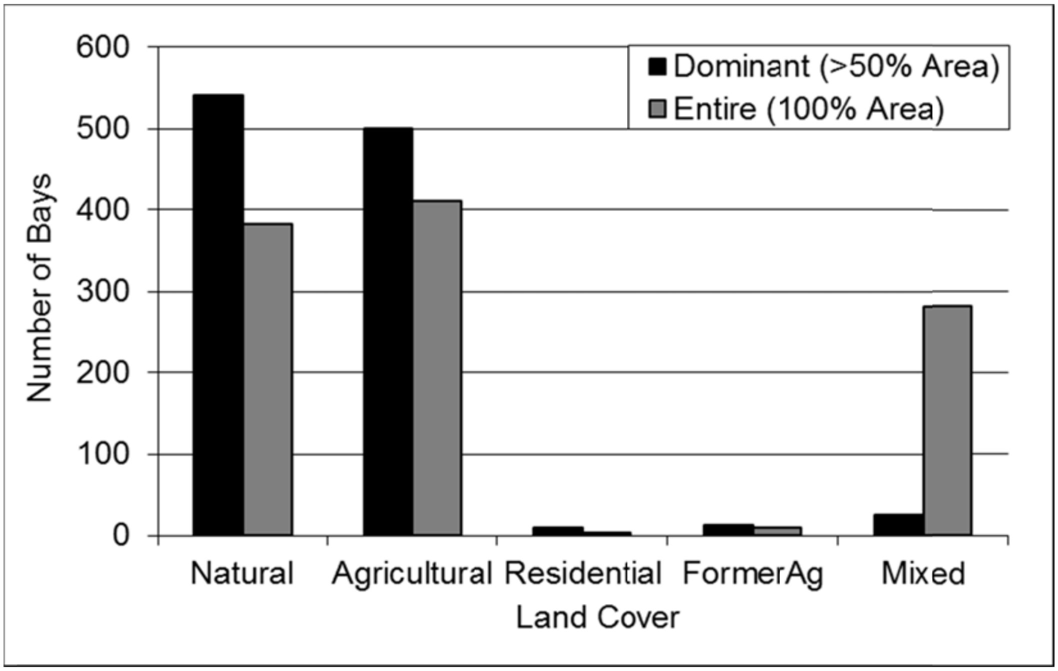

Figure 3-10. Land use of the 1090 Delmarva Bays examined in this study. The number of Bays that qualify for each class based upon dominant (>50%) land cover or entire (100%) land cover. Natural land cover is undisturbed (within the past 50-100 years) vegetation. Agricultural land use has been ditched and tilled for crop production. Residential areas includes homes and lawns. Former Ag areas were cultivated <50 years ago. Mixed areas include everything that does not fit into another category.

selected for agriculture may have originally had lower topographic relief and better natural drainage which would have led to greater ease or simplicity in installing drainage structures.

Conclusions

Delmarva Bays appear to be much more abundant than previously thought, with a population estimated to be approximately 17,000, which is an order of magnitude greater than previously estimated. The improvement of this estimate was mainly the result of the availability of LiDAR data which increases efficiency and accuracy of identifying landforms.

Typical Delmarva Bays were found to have an area of 0.41-4.94 ha, a relief of 0.54-2.10 m, and a major to minor axis ratio of 1.09-2.19. They are much smaller and less elliptical than Carolina Bays, however they both have similar orientations which supports the hypothesis that both landforms were formed from similar processes which would have occurred during the Pleistocene. The Delmarva Bays are smaller and less elliptical because they are believed to have formed in a colder periglacial climate than the Carolina Bays which that could have lessened the processes that lead to the larger and more elliptical features, which is supported by the medium sized Bays on the southern tip of the Delmarva Peninsula.

The identification and characterization of these landforms can aid in the identification of current wetlands and also wetlands that have been converted to cropland. Also, these data could be used to locate prior converted cropland sites that could have the greatest potential for restoration. They could also be coupled with data from other studies to develop models to predict the effects of climate change or what the potential might be for carbon sequestration through ecosystem restoration.

Chapter 4 - Carbon Storage in Delmarva Bay Wetlands

Introduction

It is estimated by Mitsch and Gosselink (2007) that over the last 200 years, approximately fifty percent of the wetlands in the conterminous US have been lost due to the draining of wetlands for agriculture, and commercial and residential development. More specifically, there has been a loss of approximately 73 % of the wetlands in the state of Maryland during the same period (Mitsch and Gosselink, 2007), most of which has occurred on the Delmarva Peninsula where there is an abundance of various types of wetlands that are in an area dominated by agriculture (DNR, 2000).

In soils, the quantity of organic carbon is at a dynamic equilibrium between the inputs from vegetation and the outputs from the oxidation of organic matter through microbial respiration. One factor that can affect the quantity of carbon that a soil can retain is the height

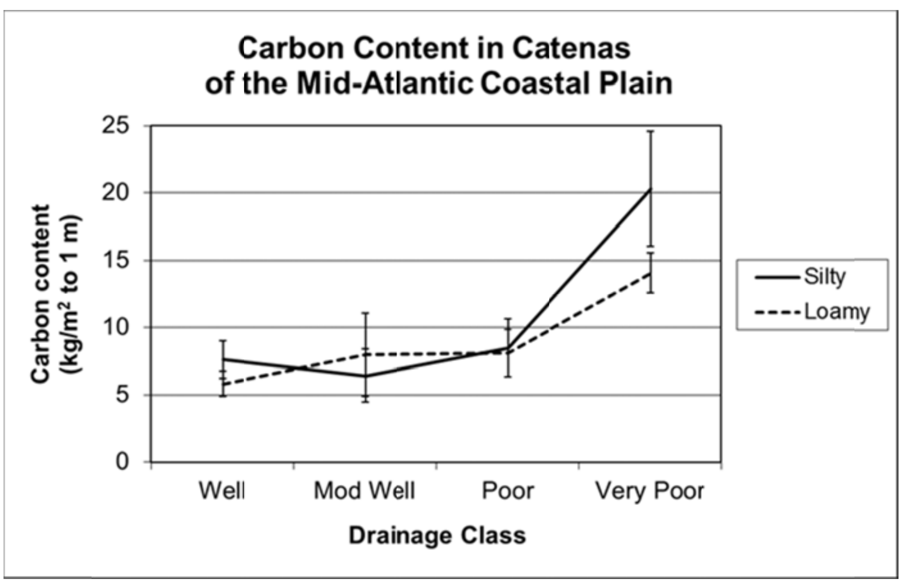

Figure 4-1. Carbon content in soils included in fine silty, and fine and coarse loamy particle size catenas from the Mid-Atlantic Coastal Plain in Maryland. Means for the fine silty catena were based on data from contained 11, 7, 7, and 4 pedons for the well, moderately well, poorly and very poor classes while means for the fine and coarse loamy catena contained were based on data from 5, 5, 3, and 3 pedons respectively. Data obtained from the National Cooperative Soil Survey Characterization Database (2011).

and duration of the water table. Soils that are well, moderately well, and poorly drained tend to contain similar quantities of organic carbon (Fig. 4-1). However, very poorly drained soils tend to store greater amounts of carbon than better drained soils, and therefore can act as carbon sink. The rate of oxygen diffusion through water is approximately 10^{-4} times the rate through air. If the soil is saturated, the slow diffusion of oxygen can result in an anaerobic environment where microbial oxidation of carbon is less efficient. Very poorly drained soils are saturated and anaerobic long enough and high enough in the profile to substantially inhibit the decomposition of soil organic matter and therefore enhances its accumulation (Collins and Kuehl, 2001). On the other hand, poorly drained soils are saturated high enough in the profile to create anaerobic conditions in the upper part, however the period during which the soils are aerobic is long enough to allow aerobic oxidation of the soil carbon. Therefore these soils do not readily accumulate such high levels of soil carbon as very poorly drained soils. When a wetland is drained for agriculture it causes a shift in the hydrology by lowering the water table. If a very poorly drained soil is drained, its hydrology shifts toward being somewhat poorly or moderately well drained, depending on the effectiveness of drainage. This shift in drainage class would decrease the duration of anaerobic conditions in the upper part, and increase the duration of aerobiosis. Therefore, the increased aerobic microbial oxidation of carbon, would cause a net loss of carbon from the wetland. Therefore when drained, very poorly drained soils become a carbon source instead of a carbon sink.

Ecosystem restoration is the “return of an ecosystem to a close approximation of its condition prior to disturbance” which would include physical, chemical, and biological characteristics (NRC, 1992). If wetland hydrology is restored to a drained wetland, then generally the biological and chemical processes will follow (Kusler and Kentula, 1990). If an agricultural area that was formerly a wetland were to be hydrologically restored, then the quantity of carbon in the soil would likely be lower than that which the new hydrological conditions could support. Therefore, additional carbon sequestration would be expected to occur until the wetland achieved a new steady state similar to the original soil prior to drainage.

Carbon sequestration in wetlands has been found to be stimulated by small inputs of low carbon sediment (McCarty and Ritchie, 2002). The amount of recent soil erosion and deposition can be assessed through the use of ^{137}Cs, a radionucleotide that originated from nuclear testing. It was distributed globally because it was released into the stratosphere during bomb testing. Deposition of ^{137}Cs began to occur around 1952 (Robbins et al., 1978) with the peak of deposition occurring around 1963 (Longmore, 1982). In the soil, ^{137}Cs behaves similarly to potassium by adsorbing to soil particles, and thus it is essentially immobile in the soil except when the soil particles are physically moved as by erosion (Davis, 1963). Therefore it can be used to help evaluate the amount of erosion and deposition that has occurred since the 1960s.

Delmarva Bays are one type of wetland that occurs on the Delmarva Peninsula. They are similar to the well-studied Carolina Bays in that they are geographically isolated wetlands with sandy rims and are located on the coastal plain. There are numerous theories on the formation of these landforms, however the most accepted theory is that they have formed as blowouts that were elongated by wind acting on ponded water. This resulted in a higher sandy rim and the unique elliptical shape seen in Carolina Bays (Bruland et al., 2003; Prouty, 1952; Savage, 1982; Sharitz, 2003; Sharitz and Gibbons, 1982; Stolt and Rabenhorst, 1987a; Tiner, 2003). There may be some similarities between the two landforms, but, Delmarva Bays differ from Carolina Bays in a number of characteristics. The Delmarva Bays are much smaller in size, more circular, less clearly oriented (see chapter 3), and commonly contain a silty basin fill (Stolt and Rabenhorst, 1987a). In contrast, Carolina Bays are much larger, have a strong elliptical shape, being mostly oriented in the same direction and lack the silty basin fill (Bennett and Nelson, 1991; Prouty, 1952; Savage, 1982; Thom, 1970). Most natural Delmarva Bays contain wetlands in the basin which typically are forested, although some support emergent vegetation. The hydrology of Delmarva Bays alternates from being a discharge wetland in the spring to being a recharge wetland in the late summer and early fall without ponded water (Phillips and Shedlock, 1993).

Delmarva Bays, like other wetlands, can provide a wide array of ecosystem services. Nutrient removal occurs primarily through the reduction of nitrate and the entrapment of sediment to remove phosphorus (Vepraskas and Faulkner, 2001). They are located in a region that is dominated by agriculture (Norton and Fisher, 2000), so that during the spring when they function as discharge wetlands, they contribute to the reduction of nitrate to help improve water quality. Also, they provide habitat for many rare and endangered species, particularly amphibians, which are able to thrive in these environments. Predators like fish are excluded because they cannot survive when Delmarva Bays dry out as water tables drop below the surface in most years during late summer (Sharitz, 2003; Sharitz and Gibbons, 1982).

The objectives of this study were 1) to assess the impact of cultivation and agricultural drainage on the soil properties of Delmarva Bays with an emphasis on soil carbon and recent soil erosion and deposition, and 2) to assess the potential for carbon sequestration in previously drained and cultivated Delmarva Bay wetlands through wetland restoration.

Materials and Methods

Five pairs of Delmarva Bay wetlands were selected for study. Each pair included one that was natural and one that had been previously converted to agriculture. The pairs were selected on the basis of similar morphological characteristics of area and relief (Fig. 4-2) that were within the typical ranges of characteristics of the landforms (see chapter 3). The pairs were also selected based upon their geographical proximity to each other. For each pair of sites, three different positions in the landscape were selected for sampling (Fig. 4-3). The basin is the lowest position in the landscape and is found near the center of the depression which is generally level and contains hydric soils. The transition zone is a relatively narrow zone located at the hydric soil boundary. The rim is the highest position in the Delmarva Bay landscape. Within the basin, three representative sample locations were identified at each site, while at the transition zone and the rim, a single representative sample location was selected for each. At each sampling location, a soil morphological description was made from a shallow excavated pit, and a bucket auger was used for deeper observations. Bulk soil samples were collected by horizon to a depth of 2 m. Bulk density samples were collected in duplicate by horizon using the core method (Blake and Hartage, 1986) to the depth of 100 cm. In cases where shallow water tables impeded the use of

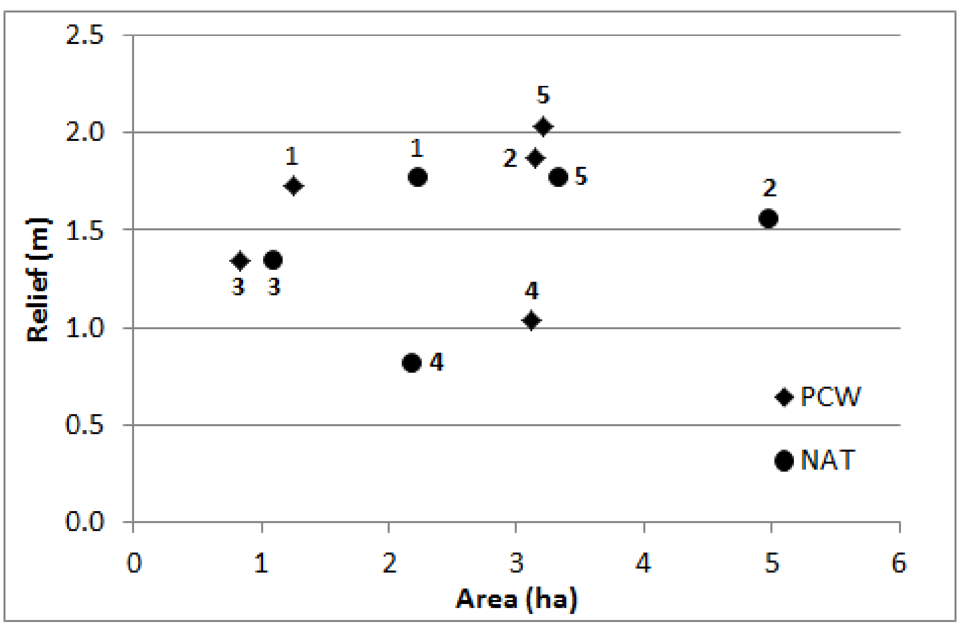

Figure 4-2. Area and relief of selected pairs of prior converted to agricultural wetland (PCC) and natural (NAT) Delmarva Bay sites. Numbers indicate sites that were paired.

the core method and where the soil material was soft enough, a McCauley sampler was used. This device permits collection of a 5 cm diameter half core that was then split into 10 cm lengths so that volume could be calculated. Bulk density samples were dried at 60°C until reaching a constant weight, which usually required 3 days. Bulk density samples and bulk soil samples for deeper horizons (from 1 to 2 m deep) were homogenized and subsampled for carbon analysis. Samples were placed into a glass vial containing two steel rods for fine grinding. These vials were then placed on a table with rollers that rotated the vials, tumbling the sample against the steel rods. Carbon analysis was performed in duplicate using the dry combustion method (Nelson and Sommers, 1996) on a LECO TruSpec CN Analyzer. When carbon values for replicate analyses had a standard deviation greater than 0.15 and a coefficient of variation greater than 7 %, the sample would be analyzed again until at least one of these two measures of variance was attained or until eight replicate analyses were done.

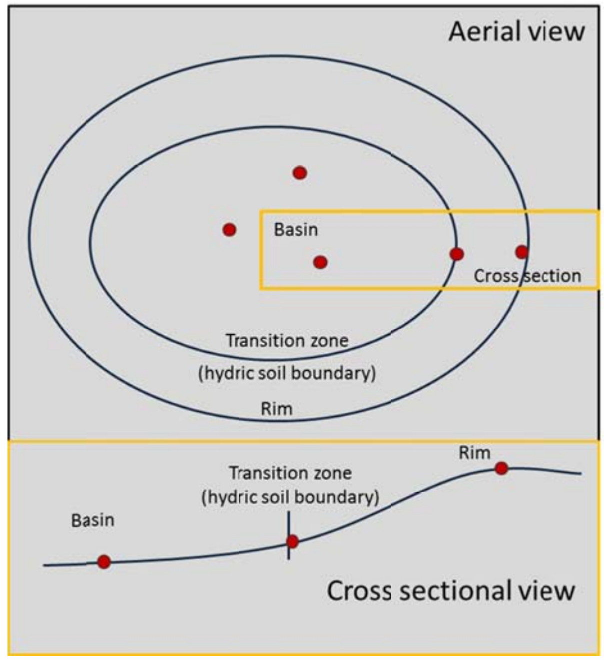

Figure 4-3. Schematic diagram of a Delmarva Bay (including cross section) showing 3 landscape positions sampled and an example of sampling locations.

Total carbon stocks for each horizon were calculated for each duplicate bulk density sample with its respective mean percent carbon. After calculating the quantity of carbon in each sample, the duplicate samples for each horizon were then averaged and multiplied by the thickness of the horizon and were reported on a 1 m^2 area. All of the horizons in the profile to a depth of 1 m were summed to get the total carbon stocks (kg C m^{-2}). When the coefficient of

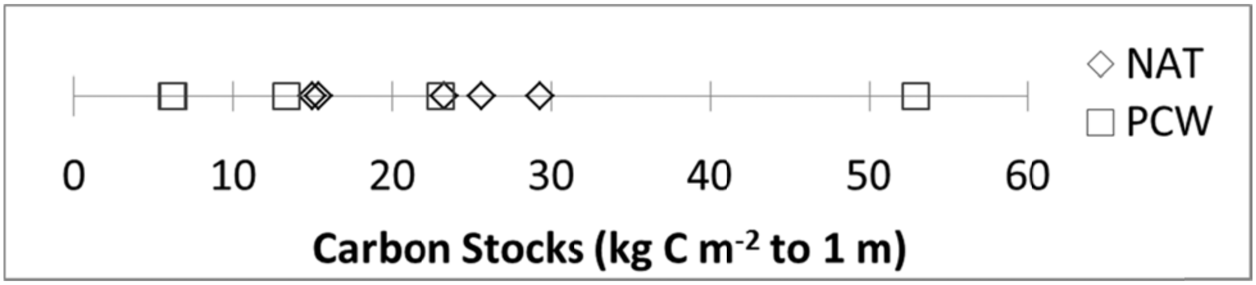

Figure 4-4. Carbon stocks for the basin position in each of the 10 sites (5 pairs). The mean for the nine sites is approximately 20 kg C m^{-2}. The site BT site (55 kg C m^{-2}) was determined to be a statistical outlier because it is greater than four standard deviations away from the mean for all of the other sites.

variation for the percent carbon of the duplicate samples was greater than 20 %, the bulk soil samples were also analyzed for percent carbon and carbon stocks for that horizon were calculated using the mean for the values of percent carbon and using the mean bulk density. Following this approach, the carbon stocks for each basin were determined in the three different locations (basin, transition zone, rim).

Based on basin carbon stocks, the BT (agricultural) site appeared to have an abnormally high quantity of carbon (Fig. 4-4), even exceeding all of the natural sites. Its carbon value was more than 4 standard deviations away from the mean of the other nine sites and was therefore determined to be a statistical outlier. The reason it is a statistical outlier is because closer examination of the soil morphology at this location revealed that this site represents a different type of Delmarva Bay wetland which is not very common, perhaps representing less than 5% of the population, and which has a much greater hydroperiod that is sustained even through dry years (Lang, personal communication 2011). This likely results in the soil accumulating a much greater amount of carbon. Therefore, the BT site as well as its natural pair (JL) were removed from all analyses leaving four pairs of sites. Statistical analysis by an ANOVA was used to compare the three landscape positions sampled along the topo-hydrologic gradient in each of the PCC and NAT classes independently. For the basin and transition zone positions, a paired t-test was used to compare the mean carbon stocks between the NAT and PCC sites. A paired test was used in order to maintain the significance of the pairing based upon morphometric parameters of area and relief. A standard t-test was used in the rim position to compare mean carbon stocks of the NAT and PCC sites, rather than a paired t-test, because the size or relief of the depression would not be expected to have any influence. The estimate of the quantity of carbon that could potentially be sequestered through ecosystem restoration was determined as the quantity of carbon that was lost following the conversion to agriculture.

In an attempt to estimate the amount of recent soil erosion and deposition, the total inventory of ^{137}Cs, activity on a soil volumetric basis, was measured at the rim and in the basin at each site. The standard method of sampling usually is by vertical increments in order to find the zone of peak deposition which would correspond to the 1963 surface (Longmore, 1982). However, this technique would be meaningless in agricultural systems where the surface soils have been homogenized by plowing. Therefore, samples were collected in an attempt to capture the total amount of ^{137}Cs that was present in the upper 30 cm, the plow zone. Soils that have been eroded would be expected to have lower total inventories of ^{137}Cs, while soils that have received sediment would be expected to have elevated inventories (Ritchie et al., 2007).

Two different sampling techniques were utilized due to overlapping projects (chapter 5). At three of the sites, as well as a reference site, samples were collected to a depth of 30 cm with the use of a 1.9 cm push probe at six random points within a square meter area which were then combined to create one composite sample for each position. Bulk density was calculated from the volume of six push probes and mass of the dry soil sample in order to calculate total inventories of ^{137}Cs (Ritchie et al., 2007). At the remaining five sites, bulk soil samples were used from each horizon to a depth of 30 cm and any A horizons that extended deeper. The mean bulk density for each horizon was used to calculate the inventory for each horizon. All of the analyzed horizons in each profile were summed to get the total inventory.

The reference site was a nearby cemetery that is fairly flat and has a well maintained lawn. All but one of its occupants arrived prior to 1925. Therefore, the soil at the reference site should have been undisturbed since the period of deposition of ^{137}Cs. Samples were collected at three locations at the reference site in order to obtain an average for the total inventory of an undisturbed soil in the area. Each sample was dried at 60ºC and homogenized before being analyzed by Viktor Polyakov, USDA-ARS Tucson, AZ using the method described by McCarty et al. (2009).

Results and Discussion

Impact of Agriculture

The comparison of natural Delmarva Bays soils with those that had been converted to agriculture and cultivated, was conducted to evaluate the impact of conversion to agriculture on the quantity of soil carbon. Carbon storage data are shown in Tables 4-1 and 4-2. Soils in the basin position of the PCC sites contained significantly less carbon than the NAT sites ($p=<0.05$). The decrease in soil carbon in the PCC basin soils, of about 11.1 ± 7.0 kg C m^{-2} (approximately 48 %) relative to that in the NAT basin soils, follows the loss of wetland hydrology, a change in vegetation, and regular tillage. The loss of carbon in the PCC basin could be facilitated by an increase in oxygen diffusion into the soil which would promote microbial oxidation of the carbon that had accumulated during the previous anaerobic conditions. Also, the change in vegetative community from a forested ecosystem to an agricultural field could result in a change of biomass composition and also the regular cultivation of the soil would stimulate microbial oxidation.

The pairing of sites was based primarily on the landform morphometrics of area and relief. It was anticipated that the basins with greater area and greater relief might contain more carbon because they would have the greater contributing area and that the greater relief might bring the groundwater nearer to the surface creating a longer hydroperiod. However, contrary to expectation, when the basin carbon stocks were plotted against relief (Fig. 4-5), an inverse relationship was observed in both the PCC and NAT sites. Our first thought was that the bays with less relief might be located at a lower part of the landscape, where the water table could be closer to the surface, creating a wetter hydroperiod and resulting in greater accumulation of carbon. However, when examining the carbon stocks as a function of basin elevation (Fig. 4-6), there appears to be a positive relationship between the basin elevation and the quantity of carbon in the basin soils. As elevation increases, one might anticipate that the depth to the groundwater table would also increase. Unfortunately no hydrologic data were collected, so an explanation for this phenomenon eludes us.

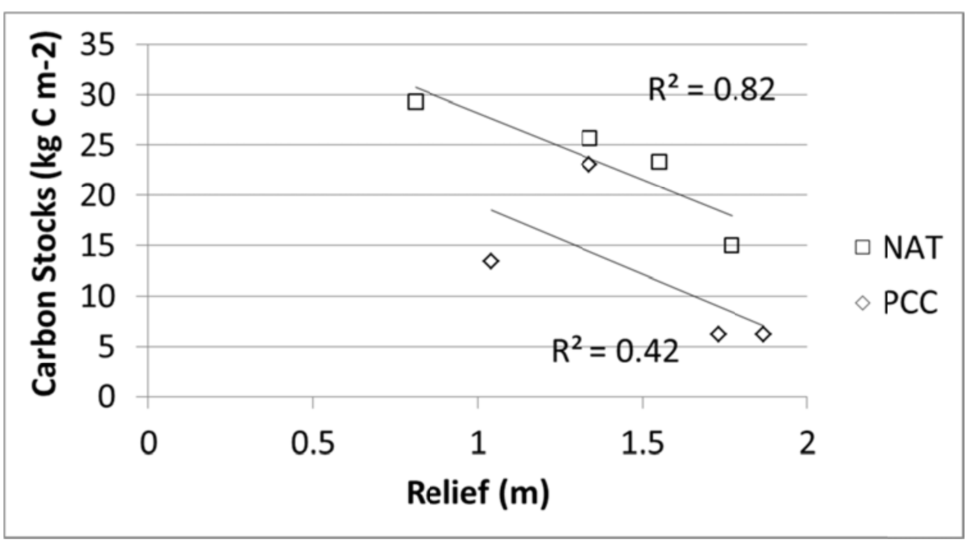

Figure 4-5. Plot of carbon stocks as a function of relief in the basin soils of Delmarva Bays under both natural and prior converted conditions. Carbon stocks are mean values of three sample points in each basin to a depth of a meter.

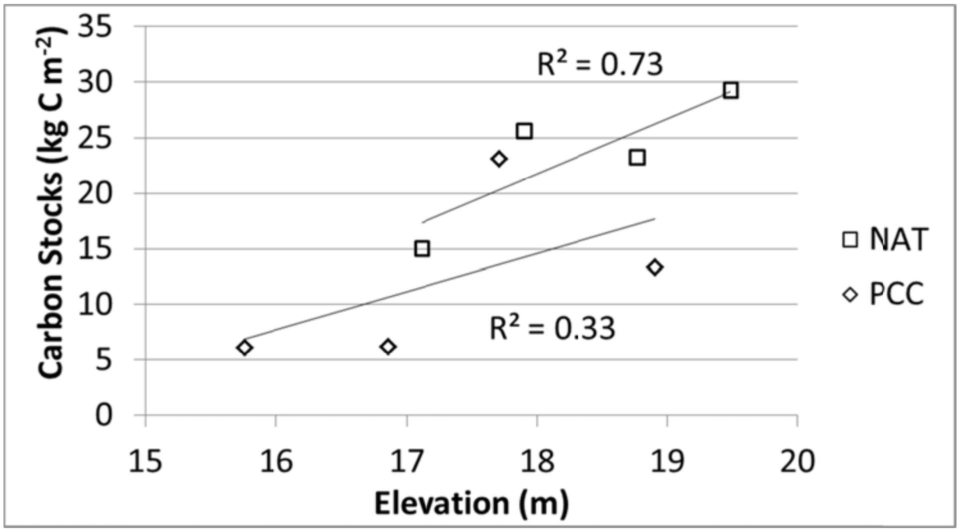

Figure 4-6. Plot of carbon stocks in the basin soils of Delmarva Bays under both natural and prior converted to cropland conditions as a function of basin elevation. Carbon stocks are mean values of three sample points in each basin to a depth of a meter. Basin elevations are a mean of three random points with in the basin derived from LiDAR data.

Although the soil carbon stocks of the transition zone were lower in the PCC sites than the NAT sites, showing a similar trend to that observed for the basin position these differences were not significant (p=0.10; Tables 4-1 & 4-2). This may be a result of the small sample size (n=4) with only one sample per site. If the sample size were larger, a significant difference might have been observed. The distance over which the soil transitions from being hydric to non-hydric is generally less than five meters, and in some cases where the transition was driven by sharp changes in elevation, it could occur in less than a meter. Therefore, the effort of teasing out the quantity of carbon in such a small area may not be justified.

The carbon stocks of the rim position followed the same trend as both the basin and transition positions with the PCC sites containing significantly less carbon (2.49 ± 0.30 kg C m^{-2}) than the NAT sites (6.88 ± 1.37 kg C m^{-2}; p=0.02; Tables 4-1 & 4-2). This would represent a loss of 4.39 ± 1.67 kg C m^{-2}, which equates to a loss of approximately 64 % of the soil carbon following the conversion to agriculture. Soils on the rim positions have deeper water tables

(Table 4-3) and support a forested vegetative community in the NAT sites. Therefore, the loss of carbon in the rim position most likely is the result of the change of the stable forested vegetative community to an agricultural condition. This could have caused a change in the carbon balance by changing litter composition as well as acceleration of microbial oxidation from tillage (Six et al., 2002). Artificial drainage would not have an effect on the soil carbon at this position in the landscape as it did in the basin because the depth to the seasonal water table is fairly deep to begin with. Our observed loss of approximately 64 % of the soil carbon in the rim soils from the

Table 4-1. Carbon stocks to a depth of 1m, for the three sampled landscape positions in the natural (NAT) Delmarva Bays.

Site (pair)	Mean Basin C Stocks (kg C m^{-2})	Transition Zone C Stocks (kg C m^{-2})	Rim C Stocks (kg C m^{-2})
EN(1)	15.1 ± 2.4	4.63	3.73
ST(2)	23.3 ± 3.6	10.8	6.42
AB(3)	25.7 ± 4.6	16.0	10.4
EV(4)	29.3 ± 2.7	15.4	6.98
MEAN ± SE	23.3 ± 5.7	11.7 ± 2.6	6.88 ± 1.37

Table 4-2. Carbon stocks to a depth of 1m, for the Delmarva Bays that were converted to agriculture and historically cultivated (PCC).

Site (pair)	Mean Basin C Stocks (kg C m^{-2})	Transition Zone C Stocks (kg C m^{-2})	Rim C Stocks (kg C m^{-2})
EA(1)	6.24 ± 0.34	3.85	3.28
CF(2)	6.17 ± 0.38	6.43	2.12
BF(3)	23.1 ± 1.7	2.84	1.96
ML(4)	13.4 ± 0.82	9.69	2.62
MEAN ± SE	12.2 ± 4.0	5.70 ± 1.53	2.49 ± 0.30

Table 4-3. Occurrence of drainage class, epipedon, and the presence of silty basin fill in soil profiles for each for the landscape positions (basin, transition zone [trans] and rim) in Delmarva Bays under natural (NAT) land cover and those prior converted to cropland (PCC).

Land Use	Position	# of Profiles	Drainage Class VPD	PD	SWPD	MWD	WD	Epipedon Histic	Umbric	Ochric	Basin Fill Present
NAT	Basin	13	11	2	0	0	0	3	7	3	7
PCC	Basin	12	9	3	0	0	0	0	8	4	8
NAT	Trans	4	0	0	3	1	0	0	1	3	0
PCC	Trans	4	0	0	3	1	0	0	2	2	0
NAT	Rim	4	0	0	0	2	2	0	1	3	0
PCC	Rim	4	0	0	1	0	3	0	0	4	0

conversion to agriculture is greater than the losses of 20 to 40 percent in carbon stocks of upland soils through the conversion to agriculture that have been observed in other studies (Anderson, 1995; Davidson and Ackerman, 1993; Gleason et al., 2008; Mann, 1986). One possible explanation for the greater carbon loss in the cultivated rim soils is that they have sandy loam and loamy sand surface textures with less than 8 % clay. Theses soils would have little surface area, decreased water holding capacity and might result in greater oxidation of carbon with fewer carbon inputs than other cultivated soils. Also, erosion could have removed some portion of the soil carbon from the rim position and thereby increasing the amount of carbon lost.

Effect of Topo-hydrologic Gradient on Carbon Stocks

Hydrology, especially proximity of the water table, is one of the factors that can regulate the quantity of carbon that a soil can retain (Fig. 4-1). The three landscape positions studied represent a topo-hydrologic gradient with the basins containing very poorly drained soils, the transition zone having somewhat poorly drained soils and the rim being better drained (Table 4-3). When examining the carbon stocks of the soils along this topo-hydrologic gradient in the NAT sites, the basin position was found to contain significantly more carbon than the both the transition zone ($p=0.02$) and rim ($p=<0.01$), with no significant difference between the transition zone and rim (Fig. 4-7). This trend is what was expected, since the basins were very poorly drained they should contain more carbon the other landscape positions.

When examining the carbon stocks for the PCC sites along the topo-hydrologic gradient (Fig.4- 8), the basin was found to be significantly higher than the rim ($p=0.05$), however neither the basin nor the rim were significantly different from the transition zone. Therefore, one could conclude that the artificial drainage has caused a shift in the hydrology. The shift in hydrology

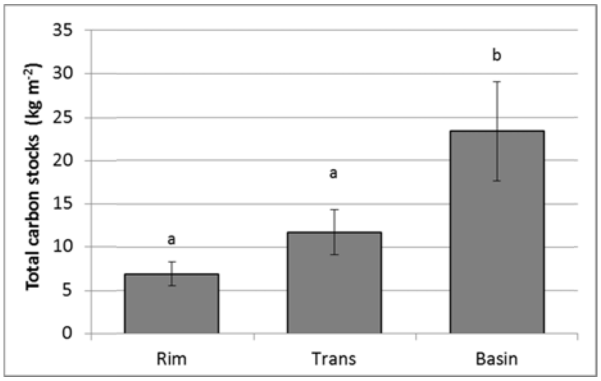

Figure 4-7. Soil carbon stocks, reported to a depth of 1 m, for Delmarva Bays with natural land cover along a topo-hydrologic sequence; sample points were at the rim, transition zone (Trans), and basin. The carbon stocks of the basin are significantly higher than both the rim (p=<0.01) and the Transition zone (p=0.02).

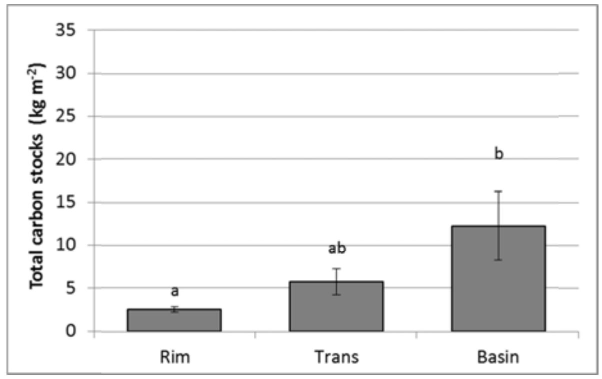

Figure 4-8. Soil carbon stocks, reported to a depth of 1 m, for the prior converted to cropland Delmarva Bays along a topo-hydrologic sequence; sample points were at the rim, transition zone (Trans), and basin. The basin is significantly higher than the rim (p=<0.05).

would have effectively changed the drainage class (hydroperiod) in the basin, although the soil morphology would be quite slow to change. Therefore, the basin soils have become more similar in carbon stocks to those of the transition zone, and through continued cultivation, they may also become more similar to the soils of the rim as well.

Deep Carbon Pools

When studies have been conducted on soil carbon and the effect of land use, they typically focus on the upper meter or less. Very few studies examine the effect of land use on the soil carbon located below one meter. Therefore, we decided to examine the deeper zone to see how much carbon is missed by sampling only to 1 m and also to see if the impact of the conversion to agriculture could be observed in soil properties deeper than 1 m. Since no bulk density samples were collected for the horizons below one meter, bulk density values measured at 1 m were used for the deeper horizons between 1 and 2 m of depth. The effort that is involved in collecting samples for bulk density and carbon analysis becomes exponentially more difficult with increasing depth, particularly in wetlands where one must combat shallow water tables. Therefore, there must be some justification in order to sample deeper.

Carbon data for the 1 to 2 m depth are presented in Figures 4-9, 4-10, and 4-11. At the 1-2 m depth, there were no significant differences observed between land uses (NAT vs. PCC) at any of the site positions. Therefore, the data for both NAT and PCC sites were combined for each landscape position when testing for effects along the topo-hydrological gradient. The mean soil carbon content in the basin at depths of 1 to 2 m was significantly higher than both the transition zone ($p=<0.01$) and the rim ($p=<0.001$), with no difference between the transition zone and the rim (Fig. 4-9). The quantity of carbon located deeper than one meter constitutes approximately 17, 9, and 11 % of the carbon to a depth of 2 m for soils in the basin, transition zone, and rim respectively (Fig 4-7, 4-8, and 4-9). These observations are similar to results from Jobbagy and Jackson (2000) who examined the distribution of soil carbon to a depth of 3 m. They observed that in temperate deciduous forests, the proportion of soil carbon in the 1 - 2 m section is approximately 16 % of that in the upper 2 m. Jobbagy and Jackson grouped soils based upon "biome" but did not take into account hydrology. Therefore their data likely included soils of varying soil drainage classes, favoring non-hydric soils. The quantity of carbon they reported at the 1-2 m (3.3 ± 3.7 kg C m^{-2}) is slightly lower than that observed in this study in the basin soils (4.5 kg C m^{-2}), but is much greater than that observed in the transition zone (0.74 kg C m^{-2}) and rim (0.48 kg C m^{-2}) (Fig. 4-9).

The deep carbon pools in the basin soils are much greater than those in the transition zone and rim positions and most likely is a function of hydrology. Soils in the basin positions sustain a water table that is often shallower than a meter. In the upland (rim) positions, which are generally 1-2 m above the basin (Fig. 4-5), the water table may be as shallow as a meter during

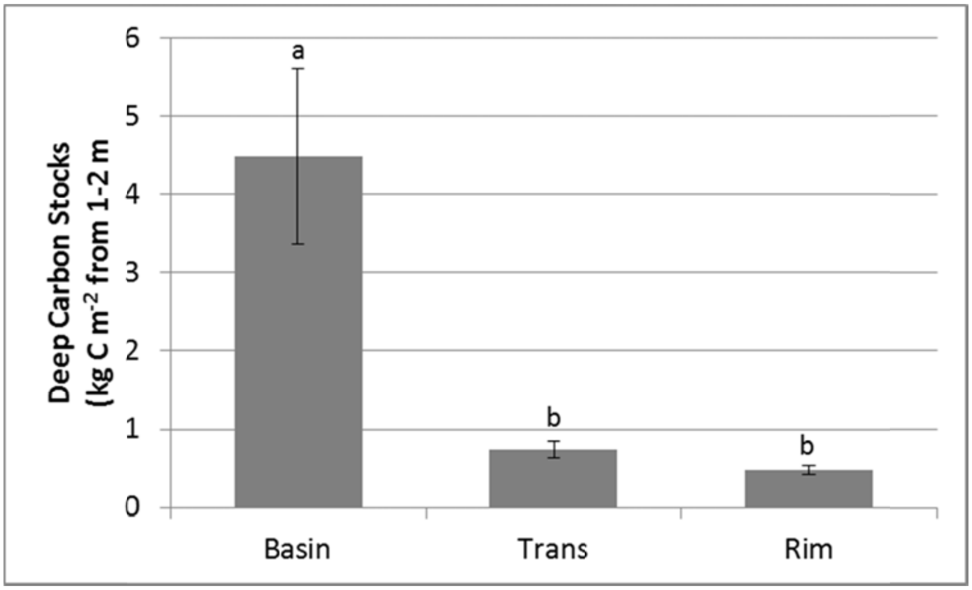

Figure 4-9. The estimate of the “deep” soil carbon stocks that occur from a depth of 1 to 2 m at Delmarva Bay landscape positions of basin, transition zone (trans), and rim. Both natural and agricultural sites were combined.

winter and spring, but will be much deeper throughout the summer and fall. The transition zone has a more complex hydrology but, by being on the wetland fringe, the period when the water table is deeper must be long enough to result in carbon quantities similar to that found in the rim soils.

When examining the mean carbon content depth functions for each landscape position (Fig. 4-10), something like an asymptote for carbon content is reached. In the basin, the asymptote is reached at a depth of approximately 100 cm while for the transition zone and rim soils, this occurs at approximately 60 cm. If the depth functions are shown separately for the different land uses (Fig. 4-11), the differences in the upper meter are evident, although the asymptotes still occur at approximately the same depths. It appears, therefore, that in the (rim) soils that are non-hydric, sampling to a depth of one meter is sufficient to reasonably quantify the soil carbon present. In fact, by sampling to only 70 cm, the soil carbon asymptote is reached enabling one to estimate the soil carbon to a depth of one or two meters based on the soil carbon

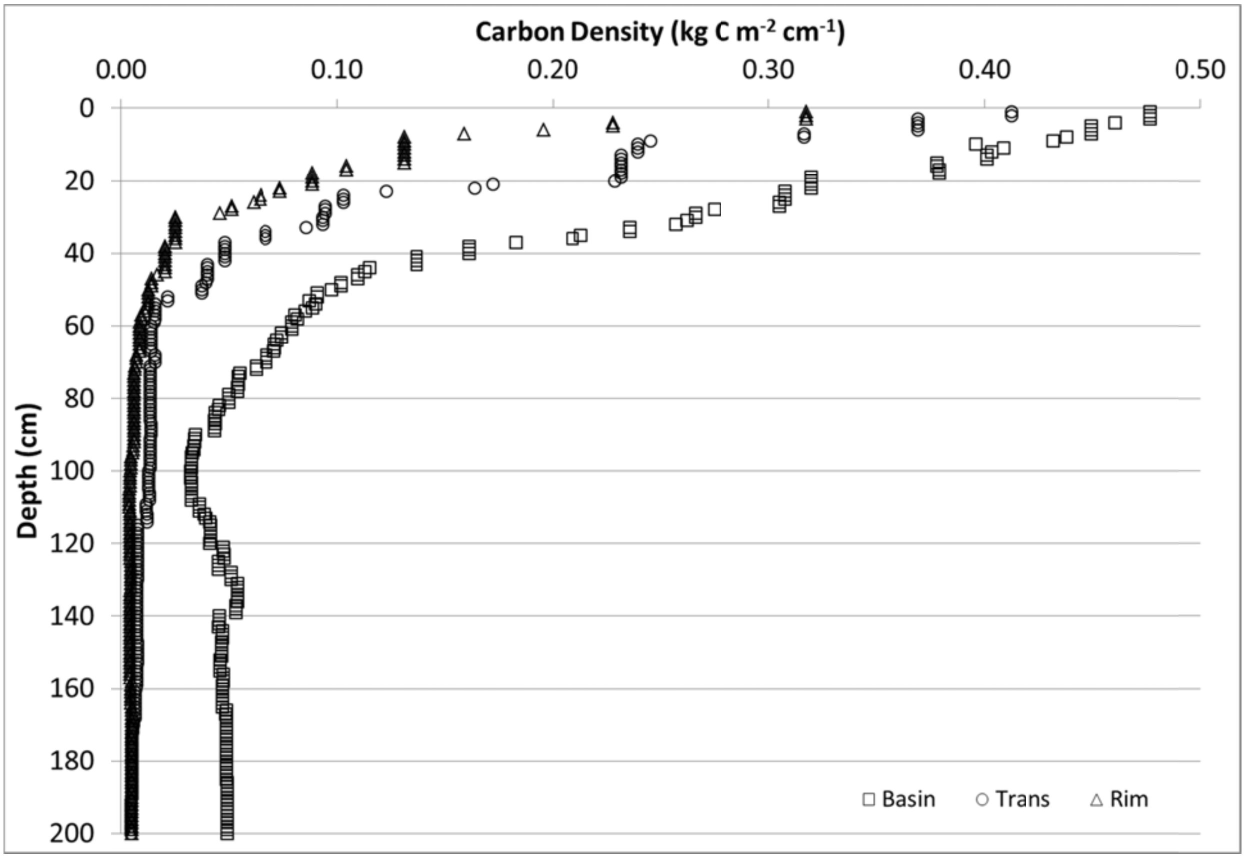

Figure 4-10. The mean mass of soil carbon per centimeter at each of the three landscape positions. include both natural and agricultural land uses, plotted with soil depth.

content at 70 cm. For some of the hydric (basin) soils, sampling to 100 cm reaches the carbon asymptote. However in the wettest soils, this may not be deep enough to reach the asymptote.

Because our approach used an estimated, rather than measured, bulk density, there may be some error associated with the analyses above. The bulk densities for the deepest horizon sampled in the basin profiles ranged from 0.63 to 1.85 g cm^{-3} with a mean of 1.55 ± 0.07 g cm^{-3}. There was, however, a much narrower range in bulk densities at 1 m in the rim position with a mean of 1.70 ± 0.03 g cm^{-3} (Table 4-4). The mean carbon content of the samples between depths of one to two meters in the basin was 0.20 ± 0.04 %, and was 0.03 ± 0.002 % in the rim (Table 4-5). Our calculations indicate that if a bulk density estimate was off by one standard deviation, it

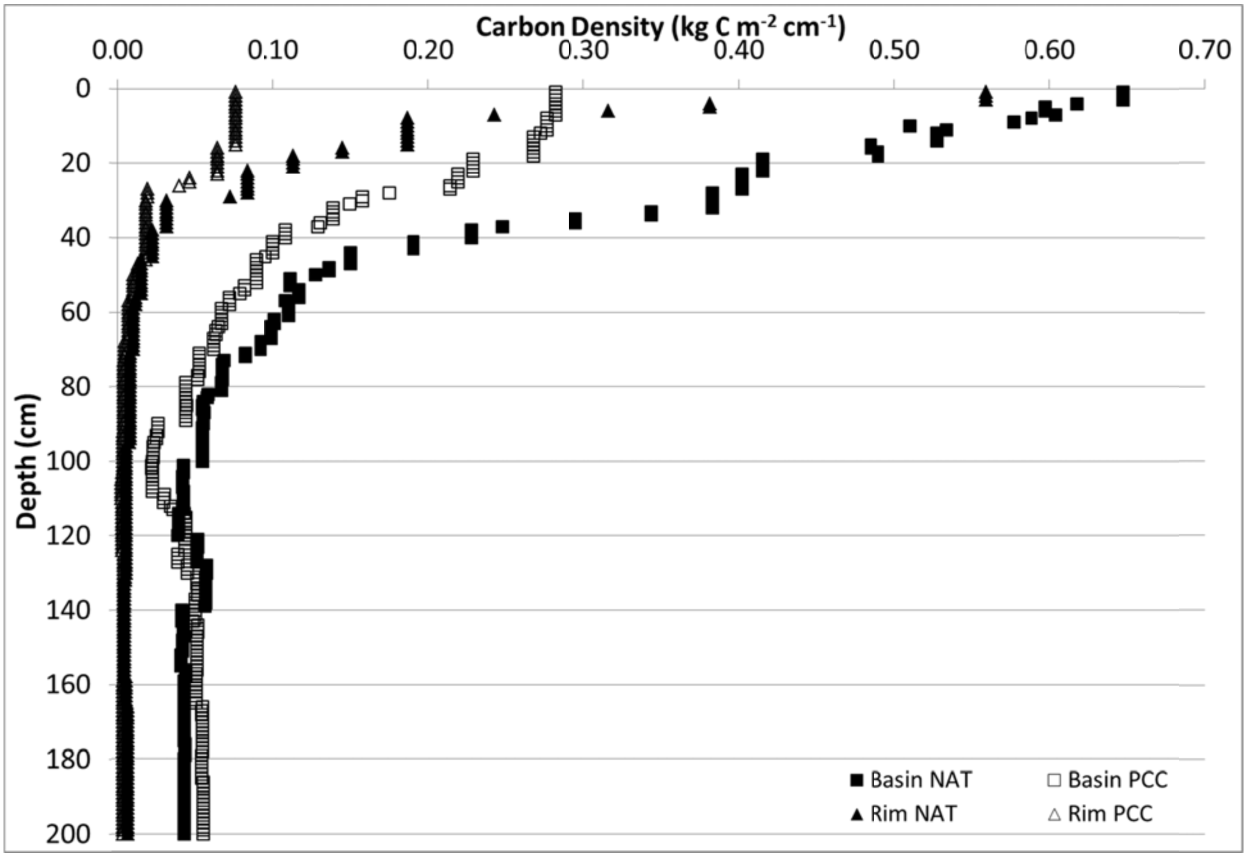

Figure 4-11. The mean mass of soil carbon per centimeter for the basin and rim landscape positions; natural and agricultural sites are plotted separately.

Table 4-4. Statistics for bulk density samples collected from the deepest horizon that was sampled for bulk density in the three landscape positions (basin, transition zone [trans], and rim).

	Basin	Trans	Rim
Mean (g cm^{-3})	1.55	1.71	1.70
Standard Error	0.07	0.06	0.03
Standard Deviation	0.34	0.16	0.10
Min (g cm^{-3})	0.63	1.34	1.57
Max (g cm^{-3})	1.85	1.83	1.82
Median (g cm^{-3})	1.71	1.76	1.70

Table 4-5. Statistics for percent carbon in the horizons located between the depths of one and two meters at the three landscape positions (basin, transition zone [trans], and rim).

	Basin	Trans	Rim
Mean (% C)	0.20	0.04	0.03
Standard Error	0.04	0.003	0.002
Standard Deviation	0.35	0.02	0.01
Min (%C)	0.02	0.01	0.01
Max (% C)	1.41	0.08	0.06
Median (%C)	0.05	0.03	0.02

would result in an error of approximately 0.68 kg C m^{-3} in the basin and 0.03 kg C m^{-3} at the rim. When considering the quantity of soil carbon stored in the 1-2 m zone, these correspond to approximately a 15 % error in the basin and a 6 % error in the rim.

Potential Carbon Sequestration

With growing concern regarding climate change, it is important to determine what methods might be useful to sequester carbon to help mitigate these changes. We have observed that carbon has been lost from the Delmarva Bays that were converted to agriculture both in the hydric soils of the basin and in the upland rim soils. Therefore these soils have potential for sequestering carbon if they were restored to their natural hydrological and vegetative conditions. The quantity of carbon that could be sequestered in these soils can be estimated by using the assumption that in a natural setting, the carbon stocks for these soils would be at a dynamic equilibrium. Therefore, if these agricultural soils were to be restored, it would be anticipated that they would eventually return to the levels occurring in the natural soil. Thus, the difference in measured carbon stocks between the PCC and NAT sites is an estimate of the amount of carbon that could potentially be sequestered. Therefore, it would be anticipated that through restoration 11.1 ± 7.0 kg C m^{-2} could be sequestered in the basin while the rim soils would be able to sequester 4.39 ± 1.67 kg C m^{-2}.

Estimated rates of wetland carbon sequestration are highly variable. A compilation of carbon sequestration rates reported by Chmura et al. (2003) for tidal marshes were found to range from 0.018 to 1.71 kg C m^{-2} yr^{-1} with a mean rate of 0.22 kg C m^{-2} yr^{-1}. Rates of 0.18 kg C m^{-2} yr^{-1} were reported in a Maryland tidal marsh (Wills et al., 2008). Studies conducted in freshwater wetlands were found to range from 0.14 to 0.18 kg C m^{-2} yr^{-1} in Maryland, Ohio, Pennsylvania, and West Virginia (Anderson and Mitsch, 2006; Wieder et al., 1994). If the freshwater wetlands in this study were to accumulate carbon at a similar rate (0.16 kg C m^{-2} yr^{-1}), it is anticipated that the basin soils would be able to achieve the levels of carbon in the natural soils in approximately 69 ± 44 years. The area of Delmarva Bay landforms that has been impacted by the conversion of agriculture is approximately 25,000 ha (see Chapter 3). Approximately half of the area of Delmarva Bays consists of the hydric soils associated with the basin (Fig 4-12), resulting in approximately 12,500 ha of basin soils that have been impacted by agriculture. Therefore, with the potential carbon sequestration of 11.1 ± 7.0 kg C m^{-2}, there is the potential of sequestering 1,390,000 ± 875,000 Mg of carbon, in the upper meter, if all of the basins that have been impacted by agriculture were to be restored.

Various studies have examined the restoration of cropland to forest and estimate that carbon sequestration rates are approximately 0.0338 kg C m^{-2} yr^{-1} (Post and Kwon, 2000). Therefore, in the Delmarva Bay rims, it is estimated that these soils would be able to sequester 4.39 ± 1.37 kg C m^{-2} to return to the steady state carbon levels of the natural sites of about 6.88 ± 1.37 kg C m^{-2} in approximately 130 ± 49 years. Approximately half of the area of Delmarva Bays consist of the soils associated with the rim (Fig 4-12), resulting in approximately 12,500 ha of rim soils that have been impacted by agriculture. Therefore, with the potential carbon

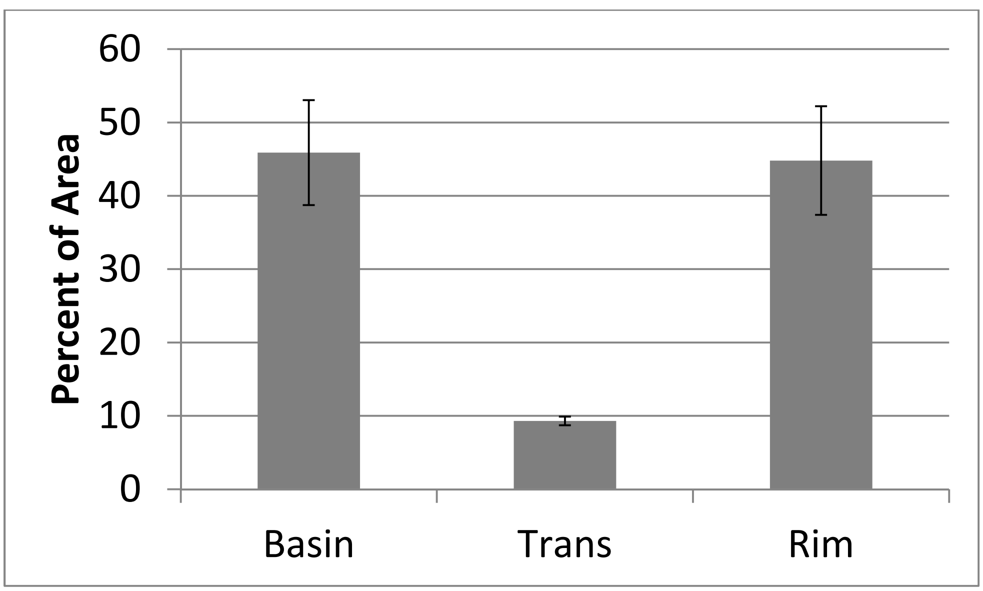

Figure 4-12. Proportions of the Delmarva Bay landscape occupied by basin, transition zone (trans) and rim as determined from mapping of the soils at all five pairs of sites (n=10).

sequestration of 4.39 ± 1.67 kg C m^{-2}, there would be the potential of sequestering 549,000 ± 209,000 Mg of carbon, in the upper meter, if all of the rims that have been impacted by agriculture were to be restored.

Observed Variance

Soils represent a dynamic environment and can change drastically over short distances. In the basins of the Delmarva Bays, we observed pockets of silt loam textures and loam textures. Although, we observed no significant effect on carbon stocks as a function of these two textural groupings, there was, nevertheless, a great deal of spatial variability in the carbon stocks between the multiple profiles located in each individual basin. Including both PCC and NAT sites, the mean coefficient of variation (CV) among carbon stocks of replicate profiles was 21 % (Fig. 4-13). The NAT sites tended to have more variation with a mean CV of 26 % while the PCC sites were more consistent with a mean CV of only 17 %. The reduced variation in the PCC sites may be the result of the decreased carbon stocks bringing the values closer together.

Even when comparing duplicate bulk density samples for a single horizon, there was still variation. Across all sites, there was a mean CV between duplicate bulk density samples of 7.0 % (Fig. 4-14). Also, the carbon analysis on duplicate samples had a mean CV of 19 % (Fig. 4-15). As mentioned earlier, to improve accuracy, when we observed any duplicate carbon analysis with a CV greater

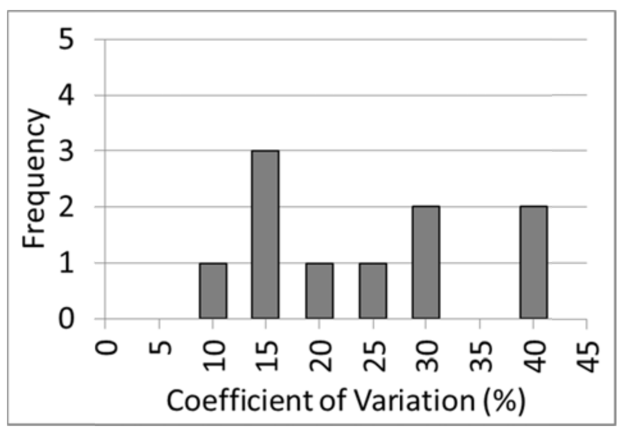

Figure 4-13. Histogram of the coefficient of variation for carbon stocks among replicate basin profiles at each site (n=10), including the PCC outlier BT (CV = 39 %) and it's paired NAT site (JL) (CV = 23 %).

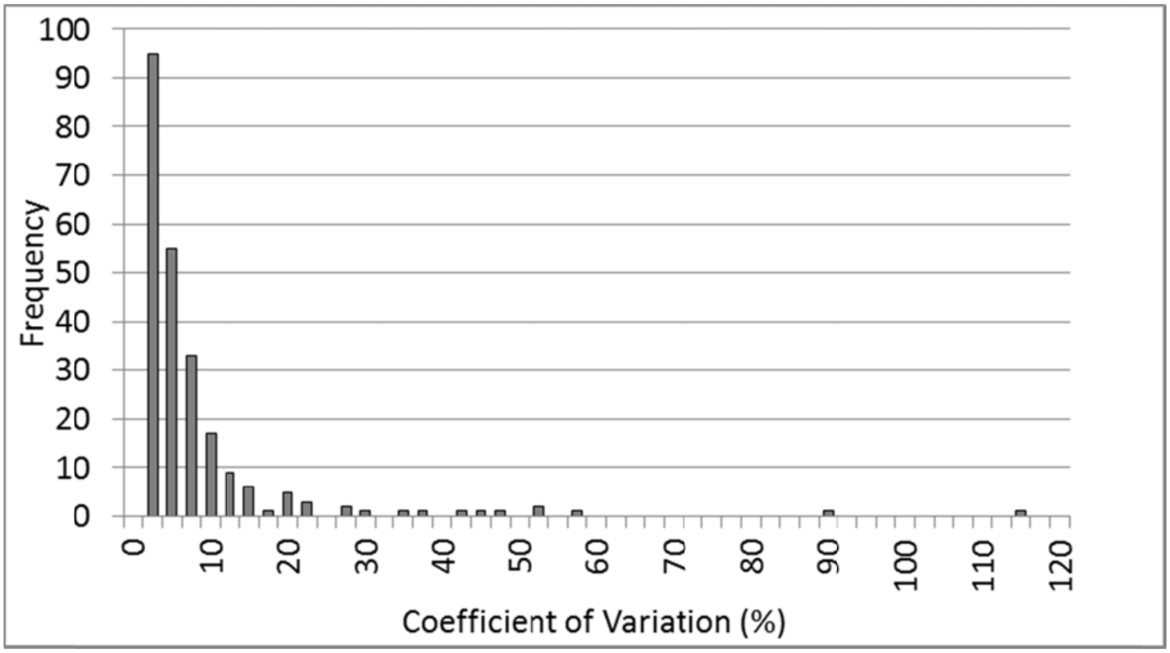

Figure 4-14. Histogram showing the coefficient of variation for bulk density between duplicate samples collected within the same soil horizon. Includes all horizons across all land managements (n=437 pairs; mean = 7.0 %; median = 3.3%).

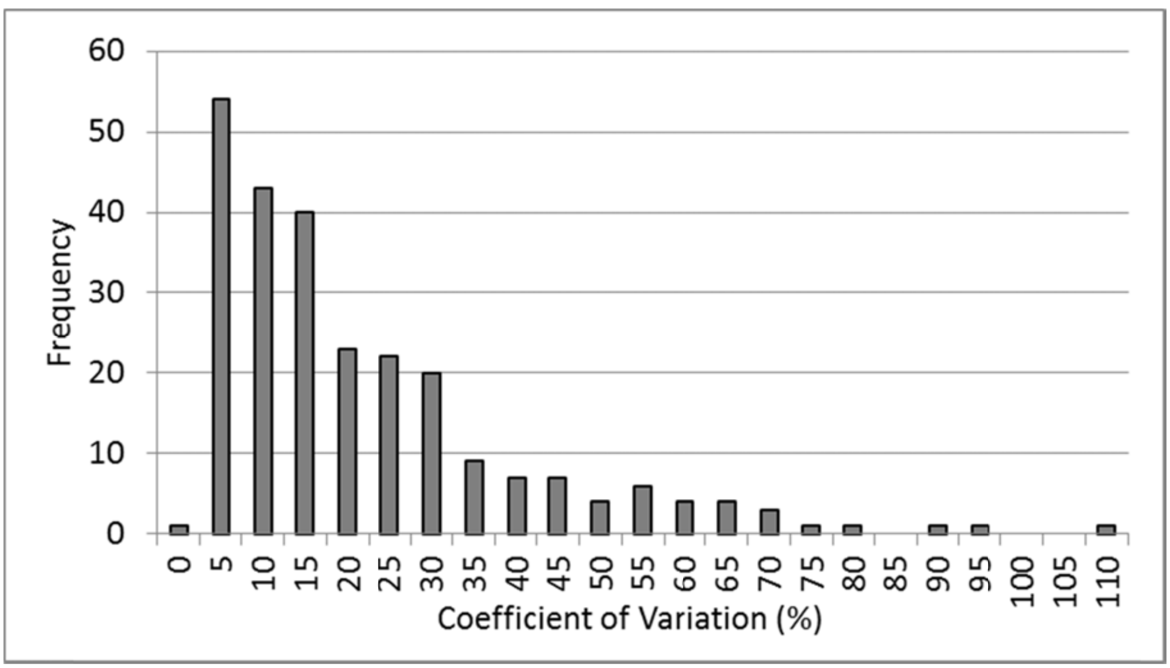

Figure 4-15. Histogram of the coefficient of variation for carbon contents between the duplicate samples collected in the same horizon. Includes all horizons across both land managements (n=252 pairs; mean = 19.2 %; median = 12.8 %).

than 20 %, we also included the carbon data from the bulk soil sample for that horizon when calculating carbon stocks. It should also be noted that about 70 % of the cases of very high CV (>40%) for duplicate carbon analyses are for samples below 1% carbon.

Basin Fill

Evidence of silty basin fill was found at all four NAT sites (Table 4-3). However the ST site had minimal inputs of basin fill in the profiles described but when mapping the soils at the site, two low-lying areas were observed that contained the silty basin fill. The concentration of the silty basin fill in a slightly lower spot in the basin was also evident at the AB and EN sites, although each of these sites included a profile description in the material. The silty basin fill at the EV site was the dominant condition of the basin, except along the edges where some sandier material had washed in from the rim

The silty basin fill was observed at three of the four PCC sites. The CF site where it was not observed, had a loamy texture, which could represent the mixing of the silty basin fill with sandy rim materials. Our observations of silty basin fill at 7 out of 8 sites was greater than was observed by Stolt and Rabenhorst (1987a; 1987b) who reported silty basin fill at 29 out of 53 sites.

Recent Soil Erosion and Deposition

The intended purpose of quantifying total inventories of Cs-137 was to document the amount of recent soil erosion and deposition. It was hypothesized that at each site the rim would have lower ^{137}Cs inventories than the reference and that the basin would be greater than both the reference and the rim due to erosional processes moving the sediment and sorbed ^{137}Cs. The reference site had a ^{137}Cs inventory of 1029 ± 106 Bq m^{-2}, which was lower than most of the samples. The reference site is less than half the value for a reference site in an unpublished study in the same region conducted by Ritchie and McCarty which had a mean of 2526 Bq m^{-2}. Surprisingly, their reference site is greater than the majority of our data set, but was comparable to other data collected from wetlands across the Mid-Atlantic region, which will be reported in chapter 5. Therefore, with both of the reference inventories bracketing our data we are unable to determine if either of these references were representative, and thus they could not be used to make any quantitative comparisons.

The total inventories of ^{137}Cs for the basin and rim positions of the NAT Delmarva Bays are presented in Figure 4-16. The error bars represent the counting uncertainty associated with the measurement of ^{137}Cs activity of the soil sample. Sites in which the counting uncertainties between the rim and basin overlap were considered to be similar, which was the case for the EN site. Only one site (EV) was observed to follow the expected trend of the basin having a greater inventory of ^{137}Cs than the rim, while two sites (ST and AB) showed the opposite trend. It was

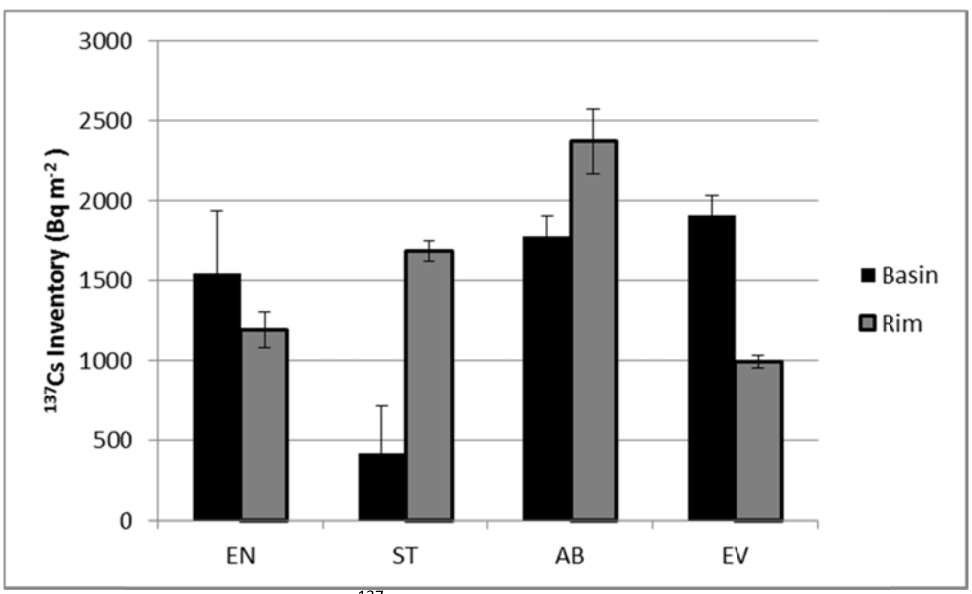

Figure 4-16. Total inventories of ^{137}Cs in the upper 30 cm of the soils in the basin and rim positions for four NAT Delmarva Bays (natural forested ecosystems). Error bars represent the counting uncertainty associated with the measurement of ^{137}Cs activity.

hypothesized that the NAT sites would have had less sediment redistribution compared to the PCC sites, but, even if no sediment redistribution had occurred then the rim and basin should have similar inventories. The fact that the rim soils contain more ^{137}Cs than the basin soils means there is some yet unaccounted for factor. A study conducted in Norwegian grasslands demonstrated great spatial variability in the distribution of ^{137}Cs. They identified “hot spots” where the ^{137}Cs activity was highly elevated (Haugen, 1992), making it difficult to collect a representative sample for an area. It has been shown that in forested ecosystems ^{137}Cs can be concentrated at the base of trees as a result of interception of rainfall by the leaves and transport of the ^{137}Cs to the tree base via stem flow (Waller and Olson, 1967). Takenaka et al. (1998) observed great spatial variation during sampling in proximity to a red pine with a mean activity of 45.4 Bq kg^{-1} and a standard deviation of 25.9. It is possible that pedoturbation from uprooted trees could easily contribute to this high degree of spatial variation. Therefore, it is likely that the sampling technique utilized in our study, where a composite sample from six 2 cm diameter cores collected within a one square meter area, was inadequate to create a representative sample at the forested sites.

The total ^{137}Cs inventories for the PCC sites are presented in Figure 4-17. Two of the four sites (CF and BF) demonstrated the anticipated trend of the basin having a greater inventory than the rim. However, the other two sites had similar inventories in the rim and basin. All of the PCC sites have been in agriculture since prior to the initiation of ^{137}Cs deposition and therefore the ^{137}Cs deposition should have occurred more evenly across the landscape. Furthermore, cultivation of the soil should have been continually mixing the ^{137}Cs within the plow zone, reducing spatial variability. With such a small sample size, it is difficult to draw any conclusions, however, the data appears to be less variable than at the NAT sites. With two of the sites clearly

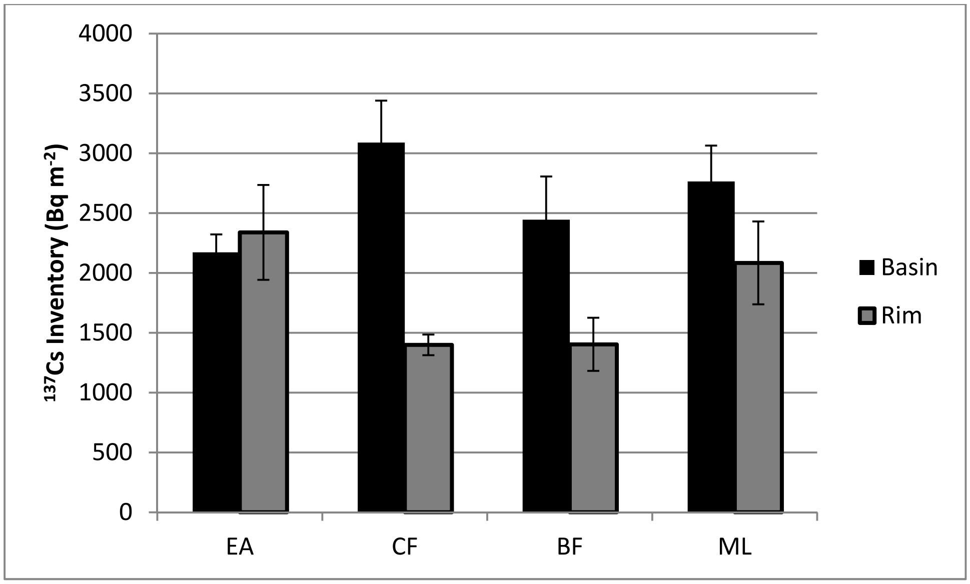

Figure 4-17. Total inventories of ^{137}Cs in the upper 30cm of soils in the basin and rim positions for four PCC Delmarva Bays (agricultural land use). Error bars represent the counting uncertainty associated with the measurement of ^{137}Cs activity.

having greater inventories in the basin, and a third consistent with that trend, and the fourth one having nearly the same values in the basin as the rim, it does appear that there has been some erosion and sediment transport at the PCC sites.

Further examination of the soils of the NAT and PCC sites, during identification and mapping of the hydric soil boundary, revealed evidence of over thickened A-horizons towards the fringe of the basin suggesting that much of the deposition occurred in those areas rather than in the basin interior. Our sampling of the basin, however, was often done near the center of the basin where there is little to no slope, and therefore may not have been in the best location to capture and recognize the deposited materials. For example at the ML site, the basin soils had silt loam textures while the soils of the rim had sandy loam textures. During mapping of the site, a zone of soil around the perimeter of the basin was found to have a loam surface texture underlain by silt loam, demonstrating that this outer ring of the basin had received sediment from the rim. Similar occurrences were observed at other PCC sites as well as some NAT sites, which may have been harvested for timber in the recent history. These observations do not preclude the possibility that some finer materials from the rim could have been transported to the basin. Nevertheless, there remains the distinct possibility that relatively little material was transported to the center of the basin. Thus, sampling toward the outer edge of the basin may have been a better location to capture the evidence of recent soil erosion and deposition.

Conclusions

Following the conversion to agriculture, the soils of both the basin and rim have lost approximately 48 and 64 % of their stored carbon, respectively. In the basin this loss (11 kg C m^{-2}) was facilitated primarily by the loss of wetland hydrology from artificial drainage, and secondarily by the change in vegetative community and cultivation. The loss of carbon in the rim (4 kg C m^{-2}) was mainly from the change in vegetative community and cultivation. No significant difference was observed in carbon stocks between depths of 1-2 m as a function of land use (natural vs. prior converted to cropland). However, in the basin, there still is a significant quantity of soil carbon stored below the first meter with an additional 4.5 kg C m^{-2} from 1-2 m, approximately 17 % of the total quantity of carbon to 2 m. The rim had very little additional carbon (0.5 kg C m^{-2}) in the zone from 1-2 m, which corresponds to approximately 11 % of the total quantity of stored carbon to a depth of 2 m. Also, we have confirmed that for non-hydric soils, as well as some hydric soils, soil OC values change very little between depths of 1 and 2 m, and thus collecting samples to a depth of 100 cm should be adequate to permit estimations of carbon stocks between 1 and 2 m. However, for some of the wetter hydric soils, sampling to 100 cm may not be sufficient, as soil OC values are still changing between the depths of 1 and 2 m.

It is anticipated that through the restoration of cultivated Delmarva Bays to their natural hydrological and vegetative wetland condition, there is the potential to sequester approximately 11 kg C m^{-2} in the basin and 4 kg C m^{-2} in the soils of the rim. The justification of restoring the rims solely for carbon sequestration may be limited, in part due to the loss of crop land. However, the restoration of the basin for carbon sequestration in combination with the services of nutrient removal from the surrounding fields, as well as habitat for wildlife could potentially justify the restoration.

Attempts to measure the amount of recent soil erosion and deposition in Delmarva Bay landscapes using inventories of ^{137}Cs were unsuccessful due to our sampling approach. Future sampling strategies will need to address both the high degree of spatial variability associated with ^{137}Cs deposition and also possible variations in the locations of sediment deposition within the basin area.

Chapter 5 - Soil Carbon and Recent Soil Erosion in Depressional Wetlands Under Different Managements in the Mid-Atlantic Coastal Plain

Introduction

Wetlands are critical environments that have greatly declined in abundance over the past 200 years, decreasing by 53% nationally (Mitsch and Gosselink, 2007). Recent attention has been drawn to the conservation, restoration, and creation of wetlands due to their numerous environmental benefits. The sequestration and storage of carbon is one ecosystem service that is of particular interest since it has been found that the concentration of atmospheric carbon dioxide (CO_2), which can contribute to climate change, has been increasing rapidly over the last decades and is expected to continue to rise at increasing rates over the next several decades (Raupach et al., 2007). Attempts to mitigate the rise in CO_2 have been made by promoting carbon sequestration through adjustments to agricultural practices that increase soil cover and decrease soil disturbance, and through the restoration of ecosystems, particularly forests and wetlands (Lal, 2004). Wetlands are effective carbon sinks because their primary productivity exceeds the rate of decomposition. The presence of a high water table creates an anaerobic environment which results in less efficient microbial oxidation of carbon, which inhibits decomposition and allows carbon to accumulate in the system (Collins and Kuehl, 2001).

It has been found that small contributions of low carbon sediment into a wetland can stimulate carbon sequestration (McCarty and Ritchie, 2002). One method to quantify the amount of soil erosion and deposition that occurs is through the use of ^{137}Cs, which is a radionucleotide that does not occur naturally and originated from nuclear testing. It was distributed globally from the atmosphere and began to deposit around 1952 (Robbins et al., 1978), with the peak of deposition occurring around 1963 (Longmore, 1982). In the soil, ^{137}Cs adsorbs to soil particles, similarly to potassium, which makes it immobile in the soil except when soil particles are physically moved (Davis, 1963). Therefore, it can be used to help evaluate how much soil erosion and deposition have occurred since the 1960s.

The U.S. Department of Agriculture (USDA) is promoting restoration of ecosystems through conservation programs such as their Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP). In these programs farmers receive incentives to restore farm land that is environmentally critical, such as prior converted cropland and agricultural land in close proximity to streams that could act as a riparian buffer (NRCS, 2011). In wetland situations, the primary goals of these conservation practices is to return wetland functions and to create habitat for wildlife (NRCS, 2011). The Conservation Effects Assessment Project (CEAP) is a collection of collaborative projects that aim to evaluate the effectiveness of the various conservation practices utilized through implemented conservation programs. The Mid-Atlantic Region (MIAR) Wetlands project focuses on the conservation practices that involve freshwater depressional wetlands along the Mid-Atlantic Coastal Plain, assessing wetland ecosystems and the services they provide (NRCS, 2011). The MIAR project is several subprojects undertaken by various investigators and includes the ecosystem services of: 1) denitrification (Hunt, P.G. and J. Miller; USDA-ARS Coastal Plains Soil, Water, and Plant Research Center), 2) carbon sequestration and sedimentation (this study), 3) phosphorus mitigation (Church, C.D. and P.J.A. Kleinman; USDA-ARS Pasture Systems and Watershed Management Research Unit), 4) amphibian biodiversity and abundance (Mitchel, J.C.; Mitchell Ecological Research Service), and 5) regional water quality (Denver, J.M., S.W. Ator, A.E. LaMotte, and R.J. Shedlock; USGS).

The objective of this study was to assess the effectiveness of current wetland restoration practices on the Mid-Atlantic Coastal Plain that are utilized in these conservation reserve programs, with regard to carbon sequestration and sedimentation.

Materials and Methods

As part of the CEAP MIAR project, 48 wetland sites were selected along the Mid-Atlantic Coastal Plain in Delaware, Maryland, Virginia, and North Carolina. These sites were divided between the land uses of natural (NAT), prior converted cropland (PCC), and restored wetlands (RSW) with 14, 16 and 18 sites respectively. The NAT sites included those that contained mostly woody vegetation and some with herbaceous vegetation. The PCC sites have been historically cultivated and all have been recently cultivated and planted to crops within a year of starting the study. All of the RSW sites were restored between 5 to 10 years prior to the project.

At each site, a minimum of two soil profile descriptions were made from shallow excavated pits, and a bucket auger was used for deeper observations. The profile that was determined by field observations to best represent the wetland area was identified and sampled for further analysis. In the selected profile, duplicate bulk density samples were collected from each horizon to a depth of 100 cm using the core method (Blake and Hartage, 1986). Where water tables impeded the use of the core method and the soil material was soft enough, a 10 cm half core was collected using a McCauley sampler. Bulk density samples were dried at 60°C until reaching a constant weight. After obtaining the bulk density, the samples were then homogenized and subsampled. A portion of the sample was finely ground on a roller mill by placing it in a glass vial with two steel rods for 24 to 48 hours. Carbon analysis was performed in duplicate using the dry combustion method (Nelson and Sommers, 1996) on a LECO TruSpec CN Analyzer.

Total carbon stocks in each horizon were calculated using the bulk density, the percent carbon, and thickness of the horizon, and reported on a 1 m^2 area basis. Duplicate analyses for each horizon were then averaged. All of the horizons in the profile to a depth of 1 m were then summed to obtain the total carbon stocks (kg C m^{-2}). Total carbon stocks were analyzed using an ANOVA based on mean values for each land use class, followed by Tukey's test to separate means. We observed that the sites in North Carolina had soils that were organic rich histosols or at a minimum had histic epipedons. These soils differed greatly from soils in other parts of the study area which were predominantly mineral soils. Therefore the North Carolina sites were analyzed independently. The North Carolina region contained three sites for each land use while the remaining (DE, MD, and VA) region included 11 NAT, 13 PCC, and 15 RSW sites.

We attempted to estimate the amount of recent soil erosion and deposition at each site by measuring the inventory of ^{137}Cs. Total inventories were measured at the lowland basin position, associated with the representative profile, as well as an upland position, usually located on a shoulder landscape position. Samples were collected for each position to a depth of 30 cm using a 1.9 cm push probe at six random points within one meter of each other. The depth of 30 cm was used to ensure sampling the full thickness of the plow layer. The samples collected at the six random points were compiled to create one composite sample for each landscape position. Each composite sample was air dried and homogenized before being analyzed by Viktor Polyakov, USDA-ARS Tucson, AZ using the radionuclide analysis method described by McCarty et al. (2009).

Results and Discussion

Soil Properties

MD, DE, and VA Sites

In general, the soils at the sites in the DE, MD, and VA region had loamy surface textures that transition into coarser substrata. The NAT sites commonly contained thin Oe horizons, and occasionally an Oa horizon, over deep A horizons. One out of the eleven NAT sites had a profile that was classified as a histosol, and one other had a histic epipedon. Typical colors for the O and A horizons were values of 3 or less with chromas of 2 or less, and very frequently with chromas of 1. Of the nine NAT sites, four of the natural wetlands were poorly drained and five were very poorly drained. Mean bulk density for the upper 30 cm of the profile was 0.92 g cm^{-3}.

All of PCC sites were cultivated and therefore lacked organic horizons. At six of the thirteen sites the deepest A horizon occurred shallower than 30 cm, although some were still found to have A horizons that extended deeper than the plow zone. Of the thirteen sites, three sites had A horizons that extended down to about 40 cm and four were deeper than 60 cm, one of which had A horizons that extended to 89 cm. Colors (value/chroma) of the Ap horizons varied greatly from 3/1 to 5/3, and some subsurface A horizons were darker with colors of 2/1. Drainage classes are based upon morphological characteristics that form under natural, undrained conditions. Therefore in situations where soils have been drained for agriculture, an assigned drainage class may not accurately depict the hydrology that is currently present, but may provide clues to the hydrology that was present prior to drainage. These sites exhibited a wide range of drainage classes. Of the thirteen sites, two were very poorly drained, five were poorly drained, five were somewhat poorly drained and one was moderately well drained. Mean bulk density for the upper 30 cm was 1.53 g cm^{-3}.

The RSW sites were found to have been created using two different restoration techniques. Wetlands were either restored by plugging artificial drainage structures to return the original hydrology, or alternatively through scraping to lower the soil surface closer to the water table in order to increase hydroperiod. Of the 15 sites, 10 were restored with the scraping technique which resulted in thin A horizons that were no deeper than 14 cm. Also, those sites generally had matrix colors for A horizons with values of 4 or more, and at three sites, human transported materials were found at the surface as evidenced by coarser material that had been brought into the site after the scraping had occurred. These scraped sites have a mean bulk density for the upper 30 cm of 1.66 g cm^{-3}.

Those sites that were restored by plugging of drainage structures had thicker A horizons. Four such sites had A horizon thickness in the range typical of plowing (20-30 cm) and another had even thicker A horizons extending to a depth of 45 cm. Colors of these A horizons ranged between 2/1 and 4/1 with a single Ap horizon as bright as 5/3. These plugged sites have a mean bulk density for the upper 30 cm of 1.53 g cm^{-3}. The mean bulk density for the upper 30 cm of all of the restored wetlands across both restoration techniques is 1.59 g cm^{-3}.

Data for bulk density in comparison to organic carbon in the O and A horizons of the DE, MD, and VA sites are presented in Figure 5-1. In general, there is an inverse relationship between bulk density and percent carbon. When soil carbon levels are below 3 or 4%, bulk densities range between 1.1 and 1.8 g cm^{-3}, while samples with carbon levels that are greater than 10% have bulk densities that are below 0.6 g cm^{-3}.

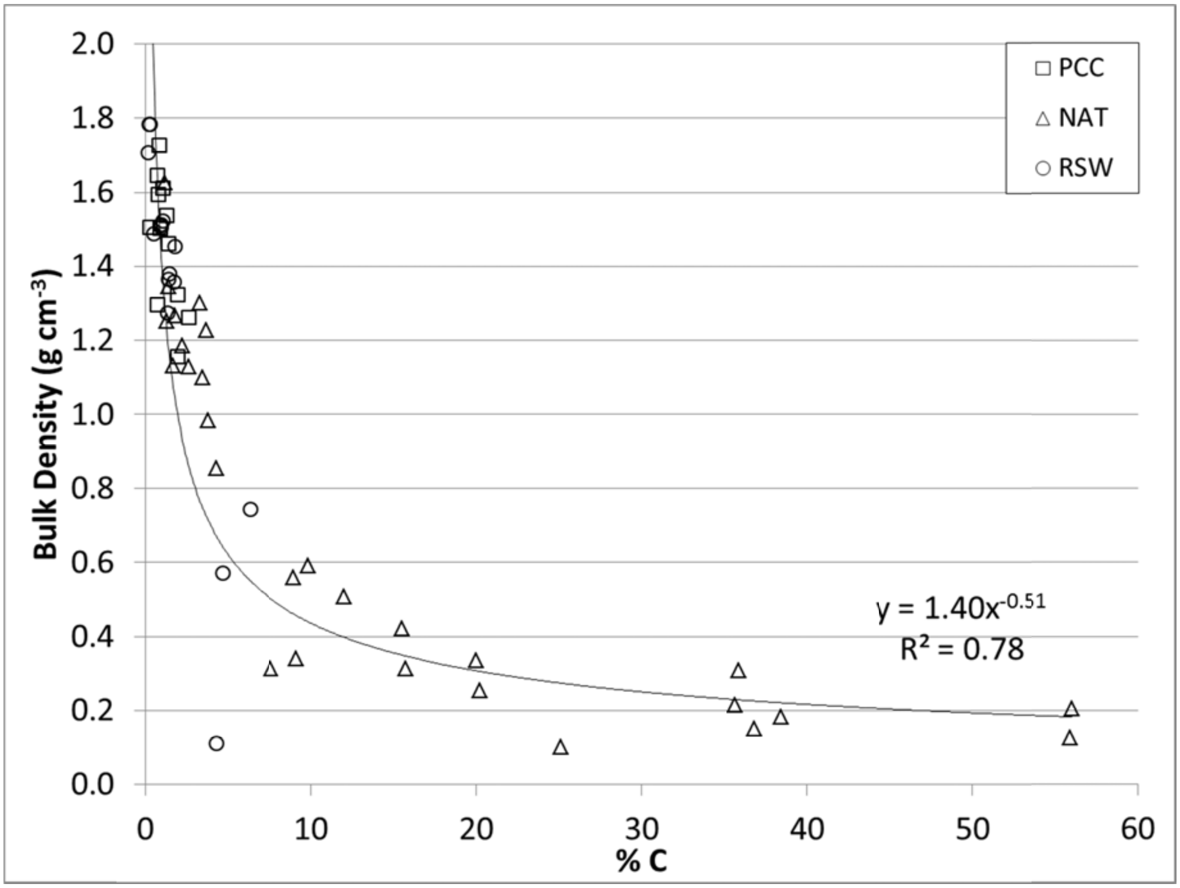

Figure 5-1. Carbon content and bulk density of O and A horizons from natural, agricultural and restored wetlands on the coastal plain of DE, MD, and VA

NC Sites

As mentioned earlier, soils at the North Carolina sites were organic-rich and at seven of the nine sites, the soils qualified as histosols and one had a histic epipedon and another had an Umbric epipedon. Therefore all of the soils in the North Carolina region are very poorly drained. The terrain in the North Carolina region is very subtle, so even in the "upland" (or higher) areas the soils were still histosols or had histic epipedons. Two of the NAT sites contained an Oe horizon over multiple Oa horizons where bulk densities for the organic horizons ranged from 0.13 to 0.36 g cm^{-3}.

The PCC sites in the North Carolina region were organic-rich, with one site having histic epipedons, another being a histosol, and the third containing both a soil with a histic epipedon and one that was a histosol. The bulk density of Oa horizons at these sites were greater than the NAT sites, with values ranging from 0.46 to 0.86 g cm^{-3} and more specifically with Oap and Ap horizons that had bulk densities of 0.73, 0.86, and 0.86 g cm^{-3}.

The RSW sites in the North Carolina region also were organic rich with two sites containing histosols and one site having a histic epipedon. Bulk densities in the Oa horizons range from 0.29 to 0.73 g cm^{-3}with bulk densities of 0.29, 0.37, and 0.57 g cm^{-3} in the surface Oap horizons.

Bulk density compared to percent carbon for the O and A horizons of the NAT, PCC and RSW sites for NC are presented in Figure 5-2. Although the relationship is not quite as strong as

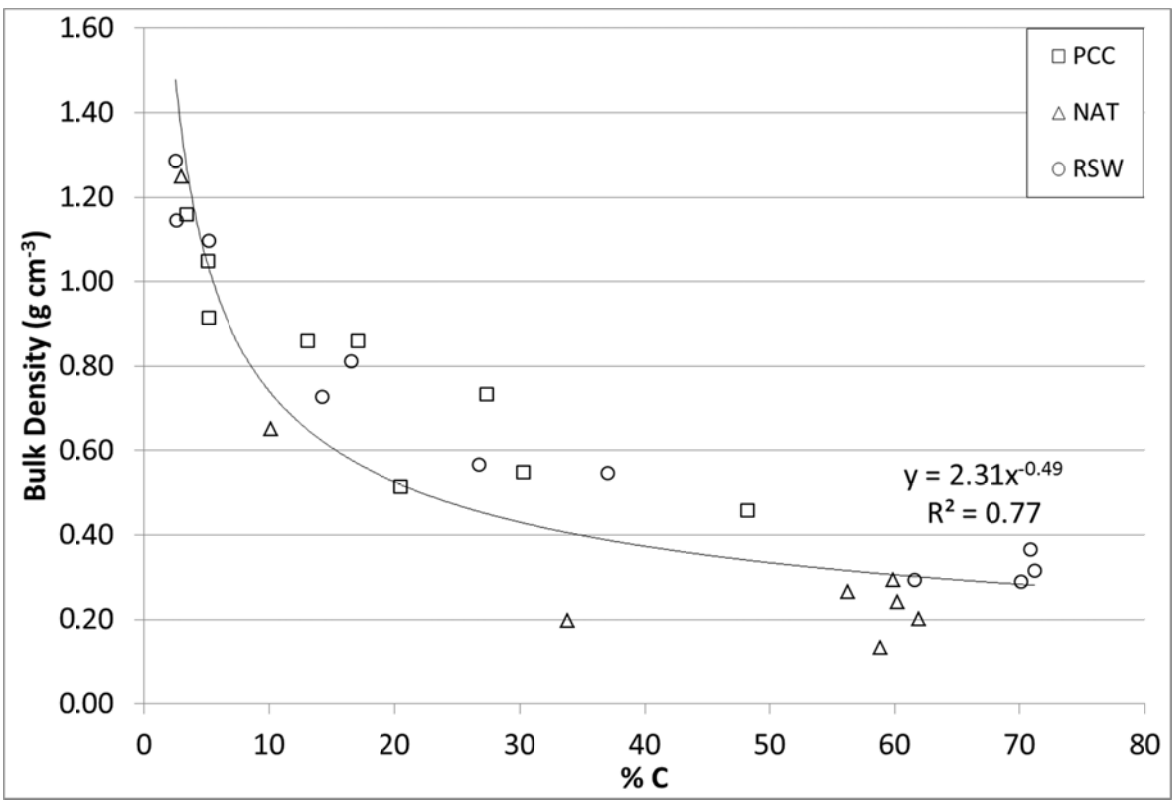

Figure 5-2. Carbon content and bulk density of O and A horizons from the natural, agricultural and restored wetland sites on the coastal plain of NC.

the DE, MD, and VA sites, the data show a similar relationship of decreasing bulk density as carbon levels increase. These NC soils are mostly organic soils and have fewer samples with lower carbon contents. The relationship between bulk density and carbon in the natural NC sites appears similar to the natural sites from DE, MD, and VA. Unlike the DE, MD and VA sites, many of the PCC and RSW NC sites include soil horizons that are organic soil materials. The bulk densities of these horizons appears to be considerably higher than natural counterparts with the same level of organic carbon, which probably is a result of plowing and cultivation, and partial oxidation.

Soil Carbon Stocks

MD, DE, and VA Sites

Carbon stocks for the natural, prior converted cropland, and restored wetland sites in DE, MD, and VA are presented in Figure 5-3. As anticipated, the NAT sites were found to have significantly greater carbon stocks (21.5 ± 5.2 kg C m^{-2}) than both the PCC (7.95 ± 1.93 kg C m^{-2}; p = <0.01) and RSW sites (4.82 ± 1.13 kg C m^{-2}; p = <0.001). The loss of carbon following the conversion of the natural forested ecosystem to agricultural was expected due to the loss of wetland hydrology with drainage and also the change in vegetative community and the increased rates of oxidation associated with cultivation. The loss of approximately 63 % of carbon following the conversion of the wetlands to agriculture was slightly more than the 20 to 40 % loss in carbon stocks others had reported (Anderson, 1995; Davidson and Ackerman, 1993; Gleason et al., 2008; Mann, 1986), but is more consistent with results observed in Chapter 4 where a loss of 11 kg C m^{-2} (48 %) was observed. One major difference is that most of these studies were not conducted on wetlands. In non-wetland situations the primary effect is from the

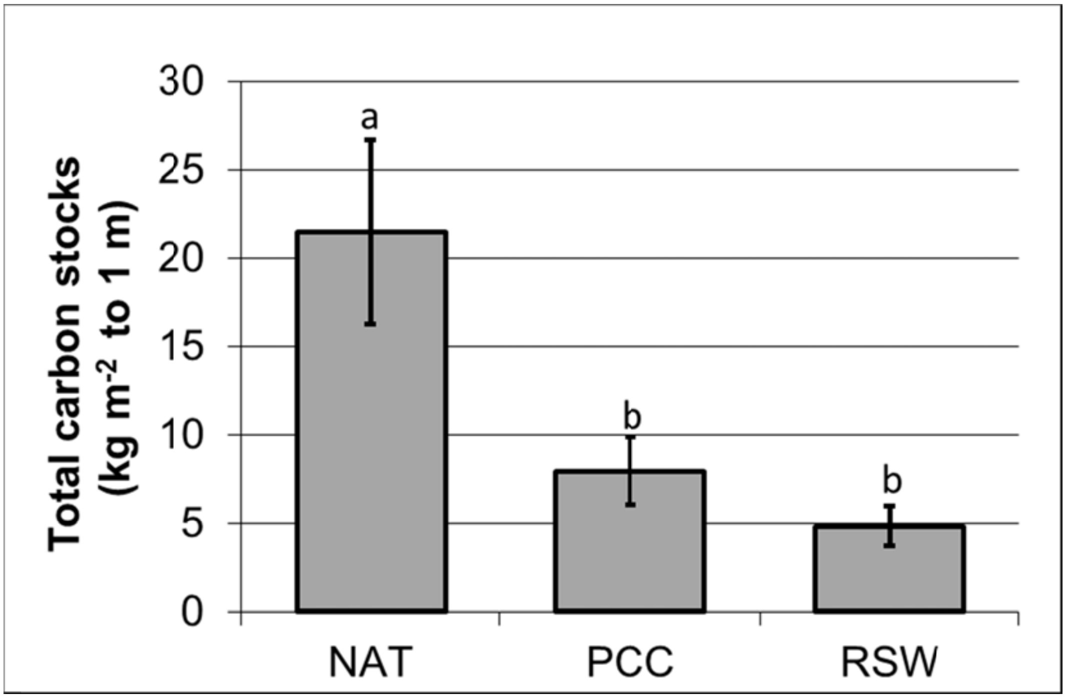

Figure 5-3. Mean total carbon stocks for natural (NAT, n=11), prior converted to cropland (PCC, n=13), and restored (RSW, n=15) depressional wetlands located in the coastal plain of Delaware, Maryland, and Virginia. Designations using the same lowercase letter indicate that there is no significant difference between the data.

change in vegetation and tillage. Therefore, the drainage and conversion of a wetland to agriculture would be anticipated to have a greater effect on carbon stocks due to the additional change in hydrology.

It was hypothesized that RSW sites would have higher carbon stocks than PCC sites as a result of the returned hydrology. Restored wetlands would be expected to continue to accumulate carbon until a steady sate was reached, with carbon levels near those of the natural wetlands. Surprisingly, the carbon stocks for the RSW sites were not statistically different from the PCC sites and appeared to be slightly lower (Fig. 5-3). Several factors could be contributing to this effect, mostly associated with the techniques that were used to restore the wetlands. As mentioned earlier, ten of the fifteen sites were restored by scraping the soil surface in order to bring it closer to the water table. This technique effectively removes the carbon rich surface horizons and brings the subsoil (Bg) horizons near the surface. This often results in lower carbon stocks. One could argue that the removal of the carbon rich material might accelerate carbon sequestration in the restored wetland. However, the organic rich horizons that are removed are usually used to form dykes or berms to retain water or as mounds to create micro-topography. Often these materials end up in an aerobic environment, which would enhance the oxidation of the soil carbon. Similar results were observed in a study by Bruland et al. (2003) where restored wetlands in Carolina Bays were found to have 36% less carbon in the upper 40 cm than their agricultural counterparts which they attributed to grading and scraping in order to fill ditches and create micro-topography. In the Prairie Pothole region, Gleason et al. (2008) also found that carbon stocks in restored wetlands were significantly lower than their agricultural paired sites or were no different.

Plugging artificial drainage structures in order to restore hydrology was the other technique used to restore the remaining five wetlands in this study. This technique causes less disturbance to the soil and has no observable negative effects on carbon stocks. When restoration was done by the plugging technique, the carbon stocks (6.06 ± 1.50 kg C m^{-2}) were found to be greater (using an alpha of 0.1) than when the scraping technique was used (2.70 ± 0.38 kg C m^{-2}; p=0.09) (Fig 5-4). This comparison used a small sample size (plugged n=5; scraped n=9) and it is possible that if a larger sample size was used the statistical difference may be strengthened, and therefore this may warrant further investigation. One site (MDC-R-Bs) was removed from the analysis because the scrapped portion of the wetland was ponded during the time of sampling resulting in sampling just outside the scraped region, possibly where material was dumped. The scraping technique was the preferred method in MD and DE with five out of seven and three out of three RSW sites restored this way in each state respectively. In VA the

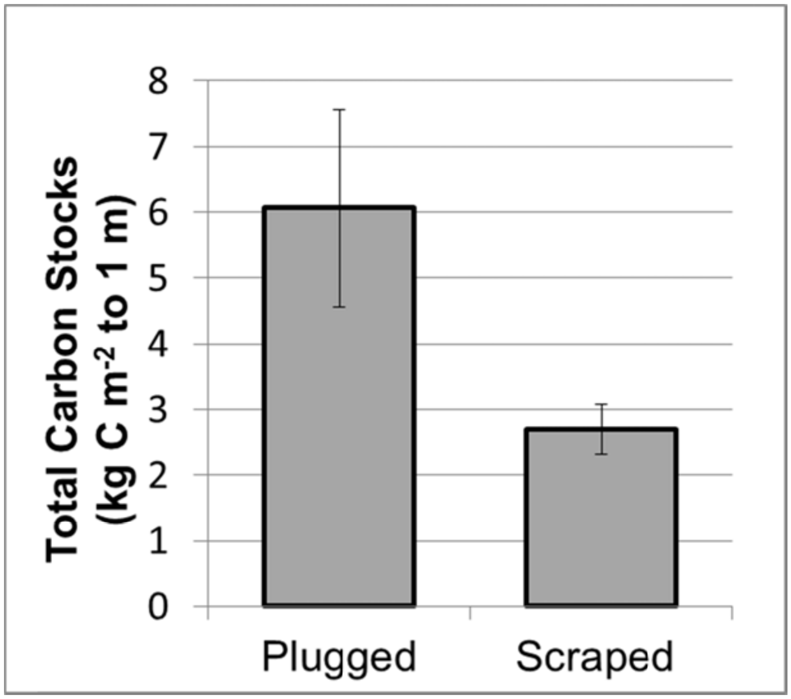

Figure 5-4. Mean total carbon stocks for the wetland restoration practices of plugging drainage (n=5) and scraping (n=9) utilized in the coastal plain region of DE, MD, and VA. Means were statistically different using an alpha of 0.1.

plugging method was preferred with only one out of four sites being scraped. In other regions such as the southeastern coastal plain, the scraping technique is not utilized where they prefer the plugging technique in depressional wetland restorations (DeSteven, 2011).

In addition to removing the carbon, the scraping technique can have other negative impacts on the soil. The use of heavy machinery also causes compaction resulting in elevated bulk densities. High bulk densities can inhibit root growth (Shierlaw and Alston, 1984), and root growth is one of the primary methods by which carbon is added to wetland soils. Elevated bulk densities can also result in perching of water and create a hydrological disconnect between the surface and groundwater tables. This was observed at two restored sites that contained ponded water. When a 2 m deep well was created just beyond the edge of the pond, at an elevation of only a few inches above the pond, no water table was observed, although within the well, some seepage was observed entering the well through the surface (A) horizons. Some of the surface A horizons were human transported materials brought in after scraping, and usually consisted of loamy sand material. Therefore, these coarse-textured materials were not ponded due to surface sealing, but rather the water table was perched over a soil layer that had been compacted from the heavy machinery used to “restore” the wetland. This raises the question of whether these sites should be considered to be successfully restored since none of the NAT sites in the study had perched water tables but rather were fed by groundwater. Therefore these restored sites do not technically have pre-disturbance hydrologic conditions which is a requirement for “restored” wetlands (SWS, 2000). The shallow perched water table in these systems also affects other wetland functions, such as denitrification, because it limits the depth of the anaerobic zone beneath the wetland and impedes the movements of groundwater into and out of the wetland. Therefore adjustments should be made to ensure that wetland restoration is accomplished using less destructive methods to promote wetland hydrologic conditions without removing the carbon that is present and maintaining hydrological connectivity with the groundwater.

NC Sites

In NC, the soil carbon stocks between the NAT (73.3 ± 27.4 kg C m^{-2}), PCC (75.5 ± 4.5 kg C m^{-2}), and RSW sites (114.6 ± 42.6 kg C m^{-2}) were not to found to differ significantly (Fig. 5-5), although, the effects of land use were observable in properties of the upper horizons (bulk density and mass of carbon per centimeter). Typical bulk densities of undisturbed organic horizons are about 0.1-0.2 g cm^{-3} (Bruland et al., 2003; Caldwell et al., 2007; Ewing and Vepraskas, 2006). This means that even the natural sites, with bulk densities of 0.13-0.36 g cm^{-3} have likely experienced some degree of subsidence, probably due to drainage ditches in near proximity to the natural sites (Daniel, 1980). Nonetheless the NAT sites have not been impacted

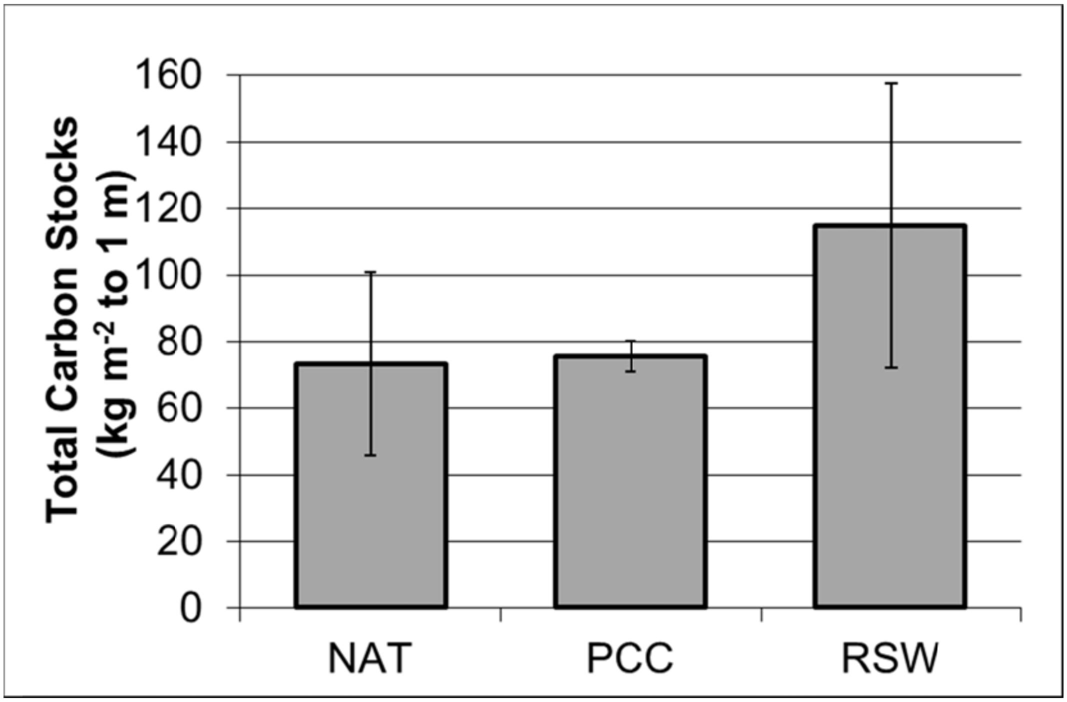

Figure 5-5. Mean total carbon stocks for natural (NAT, n=3), prior converted to cropland (PCC, n=3), and restored (RSW, n=3) depressional wetlands located in the coastal plain of North Carolina. No significant difference was observed between land uses.

to the same degree as those that have been cultivated, which have bulk densities of 0.73-0.86 g cm^{-3} in the surface plowed horizons. All three PCC sites have a lower percent carbon in the surface plow layer (Oap) than in the immediately underlying horizon (Oa), and in one case (NC-PC-MT) the surface horizon appears to have lost enough carbon that it now is a mineral horizon (Ap). Therefore, there is evidence that suggests that primary subsidence and compaction due to dewatering, as well as secondary subsidence caused by loss of carbon due to oxidation (Ewing and Vepraskas, 2006), have occurred in the PCC sites. Thus, one could infer that these sites may have lost carbon following the conversion to agriculture.

The carbon stocks of the RSW were not significantly different from the PCC sites. However, when the soil properties were examined two of the three RSW sites had elevated carbon levels (percent) in the surface horizons relative to the immediately subjacent horizons and bulk densities in these surface horizons (0.29, 0.57, and 0.73 g cm^{-3}) were lower than those of soils in the PCC sites.

Recent Soil Erosion and Deposition

MD, DE, and VA Sites

The intended purpose of quantifying the total inventories of ^{137}Cs was to document the occurrence of recent soil erosion and deposition. It was hypothesized that at each site, the upland position would have lower ^{137}Cs inventories than the reference and that the lowland position would have greater ^{137}Cs inventories than both the reference site and the upland position due to the erosion of sediment which carries the sorbed ^{137}Cs. Surprisingly, nearly every sample analyzed was greater than the reference site which had an inventory of 1029 ± 106 Bq m^{-2}. The inventories of our reference site are less than half the value (2526 Bq m^{-2}) for a reference site in an unpublished study that was conducted in the same region by Ritchie and McCarty, which is more comparable to the rest of the data set. Therefore, we conclude that there must have been some kind of soil disturbance at the cemetery in the recent history causing this abnormally low level of ^{137}Cs.

Total ^{137}Cs inventories for the upland and lowland positions for the eleven NAT sites from DE, MD, and VA are shown in Figure 5-6. Six of the eleven sites had inventories that were similar in both the upland and the lowland positions (MDC-N-AB, MDC-N-BC, MDD-N-CF, MDQA-N-AF, VASH-N-CD, and VASX-N-TNC1) (Fig. 5-6). Similar inventories are defined by overlapping error bars for the upland and lowland sample at a site. The error bars represent the counting uncertainty associated with the measurement of ^{137}Cs activity. Two NAT sites had higher inventories in the lowland than the upland (DENC-N-BB and MDC-N-BeW), while three

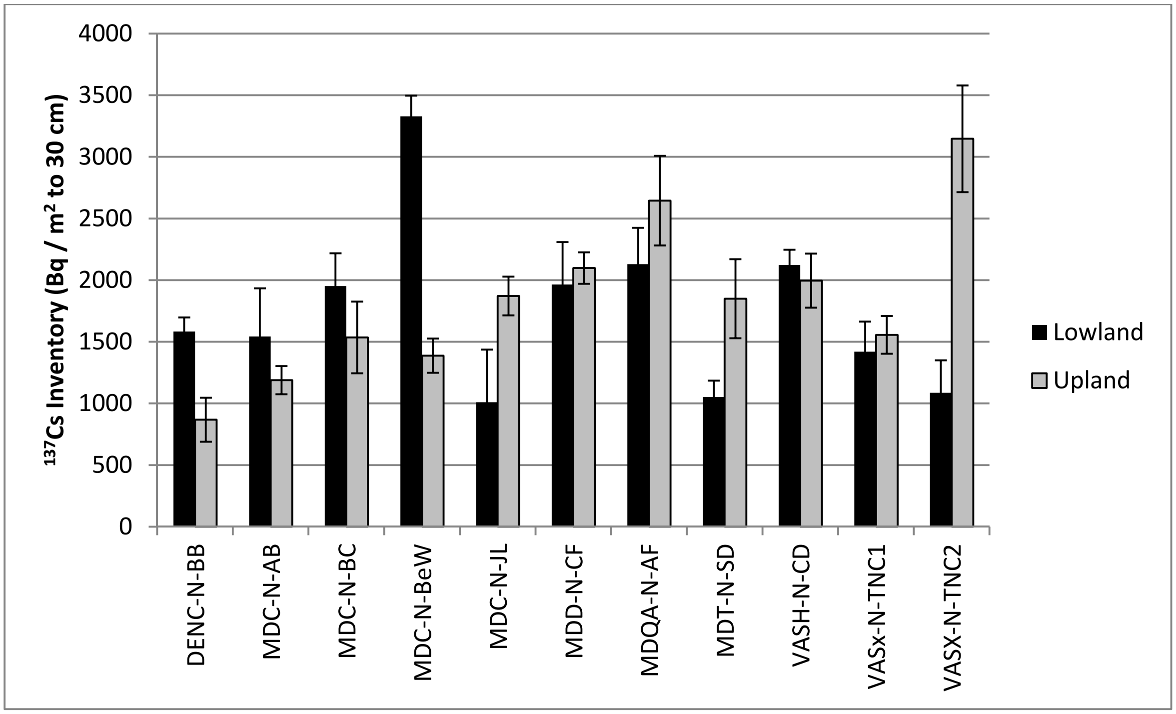

Figure 5-6. Total inventories for ^{137}Cs at the natural sites in DE, MD, and VA. Samples were collected at each site from an upland position (source of sediment) and a lowland position (area of deposition). Error bars indicate the counting uncertainty associated with the measurment of ^{137}Cs activity.

sites had lower inventories in the basin (MDC-N-JL, MDT-N-SD, and VASX-N-TNC2) than the upland. In the NAT sites, it was anticipated that there would be little movement of sediment due to the continuous presence of a stable vegetative community. However, it was not anticipated that there would be any sites with greater inventories in the upland position than the lowland, because even if no erosion had occurred they should at least be comparable. These NAT ecosystems have been forested since before the deposition of ^{137}Cs occurred. Therefore, this forces the question of how such data could be obtained from a stable forested ecosystem. A study conducted in Norway on grasslands demonstrated great spatial variation in ^{137}Cs distribution, including “hot spots” (Haugen, 1992), which led to the conclusion that it would be difficult to get a representative sample in a small area. The spatial variability could be even greater in a forested ecosystem, such as is in this study. Pedoturbation from uprooted trees and also the concentration of ^{137}Cs at the base of trees from stem flow during deposition (Waller and

Olson, 1967) could increase spatial variation. In a study conducted by Takenaka et al. (1998) samples collected in spatial proximity to a red pine had a mean activity of 45.4 Bq kg^{-1} had a standard deviation of 25.9. Therefore, it is our conclusion that the sampling design we used in the NAT sites, a composite of six cores taken in a square meter area, was too small an area and too few samples, from which to capture a representative sample.

Total ^{137}Cs inventories for the PCC sites in DE, MD, and VA are presented in Figure 5-7. It was hypothesized that in the PCC sites where erosional processes would be more active causing redistribution, that greater quantities of ^{137}Cs would be observed in the lowland position than in the upland position. At six of the 13 sites, the ^{137}Cs inventories were similar in the upland and lowland positions. In one site, ^{137}Cs levels were lower in the lowland. Only in 6 of the 13 PCC sites did ^{137}Cs inventories follow the expected trend with greater values in the lowland than the upland. It was anticipated that the ^{137}Cs inventory of the upland samples would

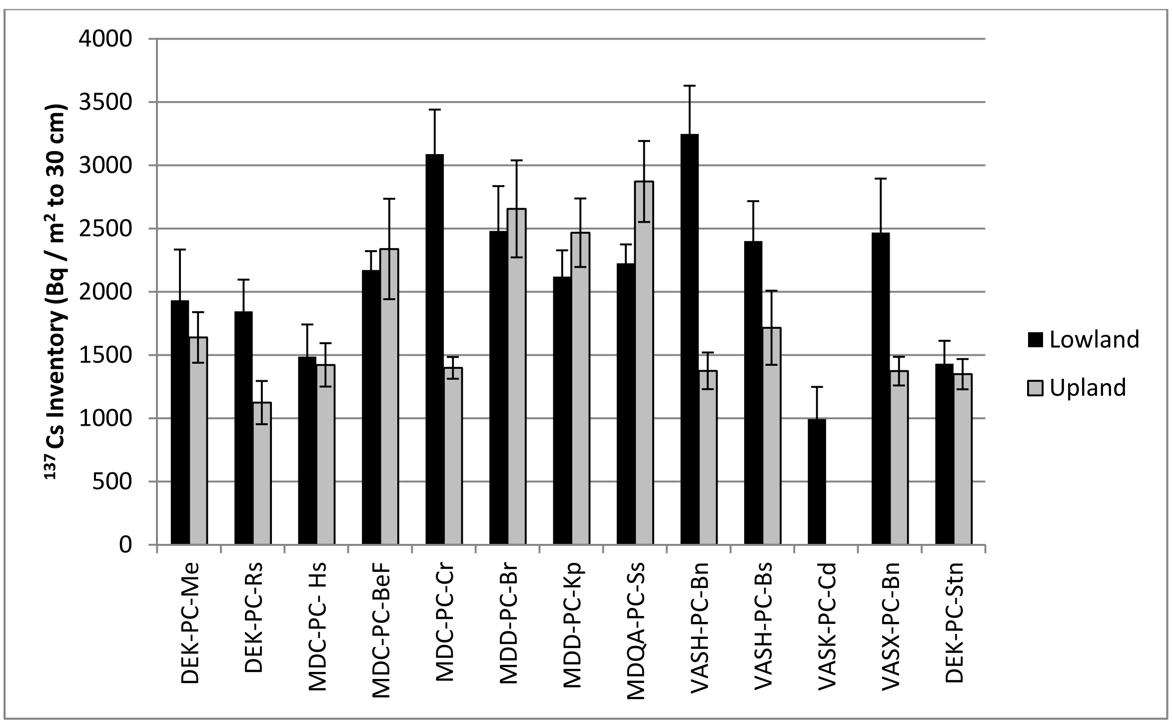

Figure 5-7. Total inventories for ^{137}Cs at the prior converted to cropland sites in DE, MD, and VA. Samples were collected at each site from an upland position (source of sediment) and a lowland position (area of deposition). Error bars indicate the counting uncertainty associated with the measurment of ^{137}Cs activity.

be lower than the reference site, and the lowland samples would be greater (Ritchie et al., 2007). However only two sites fit that trend. All of the PCC sites have been in agriculture for longer than 60 years, most likely for a century or more. Therefore the deposition of ^{137}Cs should have occurred in the absence of trees and therefore should have occurred more evenly across the landscape. However, according to Haugen (1992), a square meter area may have been too small of an area to provide a representative sample in a grassland ecosystem. Therefore there is still a lot of spatial variability even in the absence of trees. Another confounding factor is that at some of the sites, A-horizons extended deeper than 30 cm. Therefore by having a fixed sampling depth of 30 cm, some of the ^{137}Cs may have been missed and therefore may have resulted in some of the lowland values being lower than they should have been.

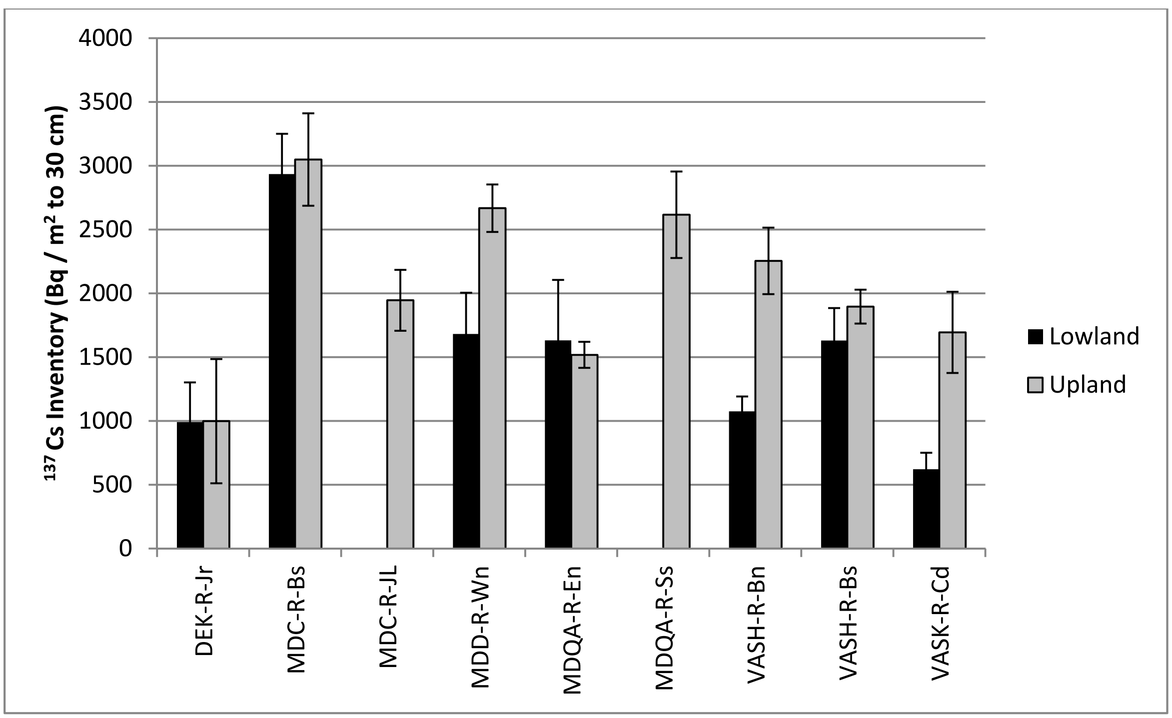

Figure 5-8. Total inventories for ^{137}Cs at the restored wetland sites in DE, MD, and VA. Samples were collected at each site at an upland position (source of sediment), and at a lowland position(area of deposition). Error bars indicate the counting uncertainty associated with the measurment of ^{137}Cs activity. The absence of data for a lowland measurement iindicate that the inventory was zero.

Total ^{137}Cs inventories for the RSW in DE, MD, and VA are presented in Figure 5-8. Before analysis, 6 of the 15 RSW sites were removed because it was known that the soil at the sites had been disturbed in the restoration process. Thus, only 9 of the 15 total RSW sites were analyzed. At 4 of the 9 sites similar ^{137}Cs inventories were observed at in both upland and lowland positions (DEK-R-Jr, MDC-R-Bs, MDQA-R-En, and VASH-R-Bs). In the remaining five sites, the ^{137}Cs inventories were greater at the upland than lowland position, contrary to expectation. At two of these five RSW sites that were analyzed (MDC-R-JL and MDQA-R-Ss), no measurable ^{137}Cs was observed in the lowland. At both of these sites there was evidence of disturbance from the restoration process. The other three sites which had less ^{137}Cs in the lowland, may have been disturbed, although the disturbance is not nearly as great as the other two sites, where essentially the A-horizons were entirely stripped from the sites. With no RSW sites following the anticipated trend of greater inventories in the lowland position, including those restored by plugging rather than scraping, one is forced to consider the adequacy of the sampling technique and strategy in light of the issue of spatial variability.

NC Sites

Total ^{137}Cs inventories for the NC Region for the NAT, PCC, and RSW sites are presented in Figure 5-9. One of the RSW sites was removed prior to analysis due to known disturbance that occurred during the restoration. Therefore, the analysis consisted of three NAT, three PCC, and two RSW sites. As stated before, the expected trend is that there would be lower inventories in the upland areas and elevated inventories in the lowland. Only a single site among all of the NC sites followed that trend, and in fact, the values for the two positions at that site were similar. The other 7 sites had ^{137}Cs inventories that were greater in the upland. The

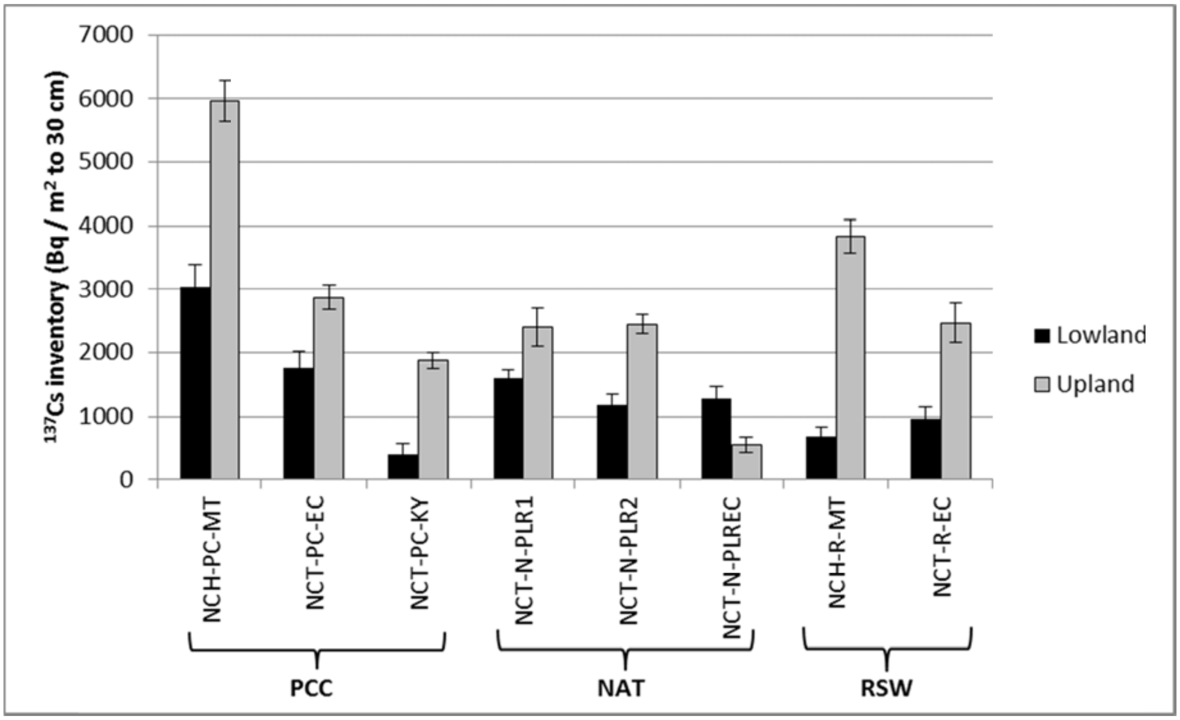

Figure 5-9. Total inventories for ^{137}Cs at prior converted to cropland (PCC), natural (NAT), and restored wetland sites (RSW) in North Carolina. Samples were collected at each site at an upland position (source of sediment) and a lowland position (area of deposition). Error bars indicate the counting uncertainty associated with the measurment of ^{137}Cs activity.

proportion of sites with inventories that are greater in the upland were not nearly so lop sided in DE, MD, and VA where the soils were mostly mineral. Thus, one must wonder if there is a phenomenon occurring in these organic soils where ^{137}Cs is mobilized and transported to the areas of slightly higher topography. The application of ^{137}Cs methodologies in organic soils, such as at these sites, has not been thoroughly studied. Also, some unusually elevated activities and inventories were observed at some of these sites. These may be "hot spots" similar to what Haugen (1992) had observed. The analysis of recent soil erosion and deposition in the North Carolina Region raised more questions than it answered. Nevertheless, this confounding data further emphasizes the necessity for further study of both spatial variability and also the behavior of ^{137}Cs in organic soils, in order to improve the application.

Conclusions

The drainage and conversion of wetlands to agriculture has great impacts on soil carbon stocks, as seen in the Delaware, Maryland, and Virginia sites with an observed loss of 13.5 kg C m^{-2}, or a loss of approximately 63% of the stored soil carbon. However, the popular practice in these areas of restoring wetlands by scraping the soil to bring the surface closer to the groundwater appears to be ineffective in sequestering carbon and may have negative impacts on other wetland ecosystem services. Therefore alternative methods to restore wetlands, such as plugging of drainage structures which causes less site disturbance, should be used to promote the effective restoration of wetlands for soil related ecosystem services.

The goal of quantifying recent soil erosion and deposition using ^{137}Cs proved to be problematic. The irregular data suggests that the sampling strategy used was unsuitable given the amount spatial variability of ^{137}Cs in soils of the region. This study has emphasized the need for more research in order to improve our understanding of the spatial distribution of ^{137}Cs, in the soil, especially in forested ecosystems.

Chapter 6 - Conclusions

The identification and quantification of Delmarva Bay landforms, which commonly contain wetlands, can enhance our environmental and conservation efforts. Using available LiDAR data, Delmarva Bays on the Delmarva Peninsula were identified and counted. The approximately 17,000 Delmarva Bays estimated to occur on the Delmarva Peninsula is about an order of magnitude greater than previous estimates. A representative subset of Delmarva Bays (about 6.5 % of the population) was selected for morphometric analysis. Eighty percent of these depressions were found to have an area ranging between 0.41 to 4.94 ha, vertical relief ranging between 0.54 to 2.10 m, and a major to minor axis ratio between 1.09 to 2.19. Also within this sampled subset, it was observed, based on aerial photography, that approximately 65 % of the Delmarva Bays have been impacted by agriculture by currently having some portion of the land form under agricultural production.

Using the morphometric data as a guide, pairs of Delmarva Bay wetlands were selected to compare the impact of agriculture and drainage on soil carbon storage. Each pair included one natural wetland and one drained wetland that was previously converted to agriculture that were similar in area and in relief, and were in geographic proximity to each other. The drainage and conversion of Delmarva Bay wetlands to agriculture appeared to lower the soil carbon stocks in both the wetland basin soils and in the upland rim soils. In the basin, approximately 48% of the soil carbon was lost following the conversion to agriculture.

Also as part of this thesis project, the carbon stocks in 48 depressional wetlands in the mid-Atlantic coastal plain between DE and NC (14 natural, 16 prior converted to cropland, 18 restored) were documented and compared (Mid-Atlantic Conservation Effects Assessment Program – CEAP). A loss of approximately 63 % of the soil carbon was also observed in the

CEAP wetlands following their conversion to agriculture. The loss of soil carbon following conversion of wetlands to agriculture can primarily be attributed to the loss of wetland hydrology. Nevertheless, the change from a forested vegetative community to cultivated agriculture with stimulated rates of microbial oxidation from cultivation could have also occurred in the wetlands. There was no significant hydrologic change on the rims during the conversion to agriculture, but a loss of approximately 64 % of the soil carbon was observed as a result in a change of the vegetative community and cultivation.

With recent concern over climate change, interest has grown in finding ways to reduce atmospheric levels of greenhouse gases such as CO_2. One possible way to accomplish this is through the restoration of soils that have lost carbon following the conversion to agriculture, particularly wetlands where the carbon lost following artificial drainage is especially high. In these soils, were the natural hydrology and vegetation returned through restoration processes, one could expect soil carbon to be sequestered. Following the assumption that these soils would eventually return to the levels of soil carbon they had prior to disturbance (conversion to agriculture) one could predict the potential for carbon sequestration for these soils. Based on this study, we estimate that restoration of wetland hydrology and natural vegetation in Delmarva Bay landscapes, could result in sequestration of approximately 11 kg C m^{-2} in the basin soils and 4 kg C m^{-2} in the soils of the rim. Based on our observations in the CEAP study, similar levels of potential carbon sequestration (14 kg C m^{-2}) through wetland restoration are predicted. Surprisingly, in the CEAP study, which also examined carbon stocks of wetlands restored 5 to 10 years ago, there was no significant increase in the C stocks relative to those converted to agriculture. The primary reason for this seems related to the restoration technique (used in 2/3 of the sites) where the soil surface was removed during excavations to bring the water table closer to the soil surface, but which also removes the carbon-rich surface soil, and creates a deficit in the soil C stocks. This technique also compacts the soil which impedes root growth, limiting C contributions to the soil. We propose that this technique should be discontinued for restoration of wetlands in favor of the technique of plugging existing drainage ditches which has no detrimental impact on the soil C stocks. A second possible reason for the lack of significant difference in C stocks between restored and prior converted cropland in the CEAP project is that these restoration projects were only five to ten years old, which simply may not be long enough for the effects of restoration to be observed on C sequestration.

Both of the Delmarva Bay and CEAP field studies included a component that attempted to examine the quantity of recent soil erosion and deposition using inventories of ^{137}Cs. In both studies, we were unable to draw any conclusions on the quantity of sediment that had been redistributed in the landscape. However, the results did illustrate the need for better understanding of the spatial variability of ^{137}Cs, particularly in forested ecosystems. The results in the NC region also posed other questions about the behavior of ^{137}Cs in organic soils where seven of eight sites had greater inventories in the upland areas as well as some unusually high inventories.

Appendix A: Site Locations and Labels

Sites associated with the CEAP project are under a confidentiality agreement with the landowner which inhibits the publication of site locations and landowner information.

Four sites are shared between the Delmarva Bay carbon study and the CEAP depressional wetland study. The following table shows the designation used for each site, and the profiles that overlapped for carbon analysis.

CEAP Site Label	CEAP Profile Label	Delmarva Bay Label	Delmarva Bay Profile Label
MDC-PC-Cr	A	CF	DB1
MDC-PC-BeF	A	BF	DB1
MDC-N-AB	A	AB	DB1
MDC-N-JL	A	JL	DB1

Delmarva Bay Study Sites

The sites for the Delmarva Bay carbon study has two letters followed by a DB and a number. The first two letters corresponds to the site. The DB corresponds the Delmarva Bay study, and the number (ex. EN DB1) that follows indicates the landscape position, with 1-3 (and 6) corresponds to the basin, 4 corresponds to the transition zone, and 5 corresponds to the rim. A general key to the sites is presented in the following table.

Site	Pair	Land Use	County, State
EN	1	NAT	Queen Anne's Co., MD
EA	1	PCC	Queen Anne's Co., MD
ST	2	NAT	Caroline Co., MD
CF	2	PCC	Caroline Co., MD
AB	3	NAT	Caroline Co., MD
BF	3	PCC	Caroline Co., MD
EV	4	NAT	Queen Anne's Co., MD
ML	4	PCC	Caroline Co., MD
JL	5	NAT	Caroline Co., MD
BT	5	PCC	Caroline Co., MD

CEAP Study Sites

The names for the sites associated with the CEAP depressional wetland study were labeled by the USDA-ARS. They are designed to provide information about the site location and land use at a glance. The label is divided into three parts (1-2-3). The first part is used to indicate site location with the first two letters indicating the state and the remaining letters for the county. For example MDC would be located in Caroline County, Maryland. The second part indicates the land use as being natural (N), prior converted to cropland (PC), or restored (R). The third part is a two or three letter designation to the individual site. Therefore, the code for VASH-PC-BN would be for a prior converted site in Southampton Co., Virginia.

Appendix B: Profile Descriptions, Delmarva Bay Study

Textural Class and % clay are reported as field textures. Textures in parentheses and marked with an asterisk indicate texture provide from lab analysis. Textures in only parentheses indicate an adjusted texture based upon lab data for other horizons.

Natural Sites

EN DB1 Basin 11/8/2010
Queen Anne's County, MD
Mapped Soil Series: Corsica
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4	--	--		5YR 2.5/1	
A1	18	SiL (SiCL)*	10 (37)*		10YR 2/1	
A2	49	SiL (SiCL)*	24 (36)*	 med, distinct, 15%	7.5YR 2.5/1 10YR 5/1	
AB	73	SiCL (SiCL)*	32 (34)*	 med, prom, 25% m-fine, prom, 18%	10YR 3/1 2.5Y 7/1 10YR 5/6	
Bg	113	L (SiL)*	25 (27)*	 med-co, prom, 34%	5Y 6/1 10YR 5/8	
BCg	155	SiCL (SiL)	29 (22)*	 m-f, prom, RP, 28%	5Y 6/1 7.5YR 5/8	
Cg	190+	SiL (SiL)*	25 (23)*	 f, prom, RP, 18%	5Y 6/1 10YR 4/6	2mm sand lens @ 186 cm

Additional Notes
Soil Drainage Class: very poorly drained
Hydric soils indicators: A12, F13
Taxonomy: Cummulic Humaquept

Water Table Depth
41 cm

EN DB2 Basin 11/8/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	--	--		5YR 2.5/2	
A	18	L	10		7.5YR 3/2	
Ag	32	L	16		10YR 4/2	
				co, distinct, 38%	10YR 3/2	
Bg	87	SiL	22		5Y 7/1	
				med, prom, 35%	7.5YR 5/8	
2BCg	107	S	1		2.5Y 6/2	
3CBg	130	CL	34		5Y 7/1	
				med, prom, 22%	7.5YR 5/8	
3Cg	143	CL	34		5Y 7/1	
		sandier		f, prom, RP, 10%	7.5YR 5/8	
4C1	158	SL	6		10YR 5/8	
				co, prominent, 15%	N 8/0	
4C2	193	LS	4		10YR 6/6	
					5Y 7/2	
4C3	200+	SL	6		10YR 5/8	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: none

lack of redox in Ag misses F3

Misses A12 and F13 from Ag color

Taxonomy: Humic Endoaquept

Water Table Depth

173 cm

EN DB3 Basin 11/8/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	--	--		7.5YR 2.5/2	
A	14	SiL (SiCL)	10 (28)		10YR 2/1	
Ag	32	SiL (SiCL)	16 (30)	 coarse, prom, 22%	10YR 5/1 10YR 3/2	
BAg	63	SiCL	34	 Med, prom, 35% med, dist, RP, 10%	2.5Y 5/1 10YR 5/6 10YR 3/1	
Bg1	82	SiL	24	 med, prom, 15% med, distinct, 8%	5Y 6/1 10YR 5/6 10YR 4/1	
Bg2	100	SiL	27 (23)	 med, prom, 35%	5Y 6/1 10YR 5/6	
Bg3	150	SiL	27 (23)	 med, prom, 15%	5Y 7/1 10YR 5/6	
2Cg	175	LS	4		10YR 6/1	
2Cg2	195+	SL	6	 med, prom, 12%	2.5Y 7/1 10YR 5/6	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: A11 and F3

Auger refusal through 240 cm, no sands reached

Note Taker = Phil Clements

Taxonomy: Humic Endoaquept

Water Table Depth

Not reached

EN DB4 Transition Zone 11/10/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	2	--	--		7.5YR 2.5/2	
A	8	SiL (L)*	10 (11)*		7.5YR 3/2	
BE	19	L	13		2.5Y 6/2.5	
			(10)	fine, prom, RP, 5%	10YR 6/6	
Bw	29	L	14		2.5Y 6/3	
		(L)*	(10)*	med, prom, 38%	10YR 6/6	
2Bg	58	LS	5		2.5Y 7/2	
				med, prom, 12%	10YR 5/8	
				med, prom, 23%	10YR 6/6	
2Bw'2	78	SL	8		10YR 6/4	
		(SL)*	(6)*	med, prom, 8%	7.5YR 5/8	
				fine, prominent, 3%	2.5Y 7/2	
3Bw'3	82	SL	16		7.5YR 5/8	
				fine, prominent, 5%	2.5Y 7/2	
3Bw'4	103	L	18		2.5Y 6/3	
		(SL)*	(13)*	med-co, prom, 25%	2.5Y 7/1	
				med, prom, 12%	10YR 5/8	
3Bw'5	131	SL	17		10YR 5/4	
				med, prom, 18%	10YR 5/6	
				med, prom, 15%	5Y 7/1	
3BC	146	LS	4		10YR 6/6	
				fine-m, faint, 25%	10YR 5/6	
4Bgb	156	SiL	22		5Y 7/1	
				fine, prominent 5%	10YR 6/6	
4Bwb	165	SiL	20		7.5YR 5/8	
				med, distinct, 35%	10YR 5/8	
5Cg	172	fSL	14		5Y 7/1	
6CB	195+	SL	10		2.5Y 6/4	ilmenite
				med, prom, 5%	7.5YR 5/8	
				med, distinct, 5%	2/5Y 7/2	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Aeric Endoaquept

Water Table Depth

not reached

EN DB5 Rim 11/10/2010

Queen Anne's County, MD

Mapped Soil Series: Ingleside

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
AE	5	SL (SL)*	8 (5)*		10YR 4/2	0.5 cm of duff
EB	37	SL	7		10YR 6/4	
Bw1	58	LS (SL)*	5 (4)*		10YR 5/4	
Bw2	99	LS (SL)	4	 med, prom, 10%	10YR 5/6 10YR 6/3	
Bw3	143	SL (SL)*	14 (6)*	 med, prom, 10% med, prom, 15%	10YR 5/4.5 10YR 6/2 7.5YR 5/8	
Bw4	165	SL	8	 med, prom, 8%	10YR 6/4 7.5YR 5/8	
Bw5	195+	L	14	 med, prom, 15%	10YR 5/8 10YR 7/2	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Taxonomy: Typic Dystrudept

Water Table Depth

Not reached

ST DB1 Basin 10/13/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	16	--	--		7.5YR 2.5/3	
A	43	L (SCL)*	12 (20)*		7.5YR 2.5/1	
Bg	83	LS (SL)*	4 (8)*	 med, prom, 10% fine, prom, 5%	2.5Y 6/2 10YR 6/3 10YR 4/4	
BC	119	LS (S)*	3 (5)*	 med, distinct, 5%	2.5Y 7/3 2.5Y 7/1	Ilmenite bands
Cg1	147	LS (S)*	3 (6)*		2.5Y 6/2	0.25% ilmenite
Cg2	200+	LS (S)*	3 (6)*		2.5Y 5/2	1% ilmenite

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A11, F13

Taxonomy: Typic Humaquept

Water Table Depth

90 cm

ST DB2 Basin 10/13/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	10	--	--		2.5YR 2.5/3	
A	34	L	10 (20)		7.5YR 2.5/1	
Bg	56	LS (SL)	5 (8)		10YR 6/2	
Bg2	85	LS	3	coarse, 60%	2.5Y 7/2	
		(S)		med-co, prom, 35%	10YR 6/8	
				med, prom, 5%	10YR 7/8	
Bg3	125	SL	9		10YR 6/1	
		(S)	(6)	distinct, 30%	10YR 7/2	
BCg	175	LS	4		2.5Y 7/1	0.25% ilmenite
		(S)		Med, prom, 3%	10YR 6/8	
Cg	200+	LS (S)	3		10YR 7/1	0.25% ilmenite

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A11, F13

Taxonomy: Humic Endoaquept

Water Table Depth

130 cm

ST DB3 Basin 10/13/2011

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	18	--	--	5YR 2.5/2	
A1	37	L/SiL	10 (20)	7.5YR 2.5/1	
A2	67	L	10 (20)	10YR 2/1	
BAg	103	L	17	7.5YR 4/1 ? 10YR 6/2 ? 7.5YR 5/8	
Bg	127	L	13	10YR 5/1 ? 10YR 5/6	
CBg	166	SiL	10	2.5Y 41 ? 10YR 5/6	
2Cg	166+	?	?	?	did not retreive-auger refusal

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Auger refusal through 240 cm, no sands reached

Note Taker = Phil Clements

Taxonomy: Cumulic Humaquept

Water Table Depth

130 cm

ST DB4 Transition Zone 12/15/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Chris Palardy

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	9	--	--		7.5YR 2.5/2	
A	23	L (SL)*	12 (10)*		10YR 2/2	
Bw	36	L (SL)	12		2.5Y 5/4	
Bg	59	L (SL)*	17 (10)*	 med, prom, 33%	2.5Y 7/2 10YR 6/6	
2BC	111	LS	4	 med, prom, 28% co, prom, 25% co, prom, 10%	10YR 6/6 7.5YR 5/8 2.5Y 7/2 10YR 6/2	
3CBg	137	SCL (SL)*	29 (14)*	 med, prom, 4%	5Y 7/1 7.5YR 5/8	
3Cg	160	coSC (SL)	36 (16)	 med, prom, 25%	2.5Y 6/1 7.5YR 5/8	
4Ab1	180	coSC	36		7.5YR 5/1	
4Ab2	190	LcoS	10	 fine, prom, 3%	7.5YR 6/1 10YR 6/6	
4Bwb	200+	coSL	15	 med, prom, 14% med, prom, 8%	10YR 6/4 7.5YR 5/8 7.5YR 6/1	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Humic Endoaquept

Water Table Depth

162 cm

ST DB5 Rim 12/15/2010

Caroline County, MD

Mapped Soil Series: Hambrook

Description conducted by Daniel Fenstermacher and Chris Palardy

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	7	--	--		7.5YR 2.5/2	
AE	17	SL (SL)*	5 (5)*		10YR 5/2	70% uncoated sand grains
Bt1	45	SL	8		10YR 5/4	
Bt2	66	SL (SL)*	14 (7)*		10YR 5/6	
Bt3	95	SCL (SL)*	25 (11)*		7.5YR 5/6	
BC	132	LS	4		10YR 5/6	
				med, distinct, 4%	10YR 7/6	<--Lamellae?
CB	164	LS	6		10YR 5/6	
		(LS)	(8)*	med, prom, 25%	2.5Y 7/2	<--Lamellae?
				medium, faint, 7%	10YR 5/6	
Cg	190+	LS	3		2.5Y 7/2	
				cemented iron, 7%	10YR 5/6	
				15%	10YR 6/6	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Taxonomy: Typic Hapludult

Water Table Depth

Not reached

AB DB1 Basin 10/1/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	9	--	--	5YR 2.5/2	
Oa	22	--	--	10YR 2/1	
A1	53	SiL (SiL)*	 (16)*	10YR 2/1	
A2	72	SiL	12 (17)	2.5Y 2.5/1	
BCg	150	SiL (SiL)* pockets: L	10 (19) 10	5Y 5/1 fine, prom, RP 15% 10YR 5/8 5Y 4/1 10% 5YR 4/6 10YR 5/2	Upper Gradual change to: Lower sand lenses

Additional Notes

CEAP-MIAR project MDC-N-AB site, uses same profile

~10m in from forest line

Soil Drainage Class: very poorly drained

Histic Epipedon

Hydric soils indicators: A2, A12

Taxonomy: Histic Humaquept

Water Table Depth

47 cm above ground

AB DB2 Basin 10/4/2010

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	8	--	--	7.5YR 2.5/2	
A1	32	L (SL)	8 (17)	7.5YR 2.5-/1	
A2	56	L (SL)	15	10YR 3/1	
Ag	90	L (SL)	15	10YR 4/1 med, RP, 10% 10YR 2/1	
Bg	138	LS	4	10YR 5/2 med, prom, 15% 10YR 5/6	
CBg	175	LS	5	10Y 6/1	
Cg	200+	LS	4	5GY 6/1	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Cumulic Humaquept

Water Table Depth

80 cm

AB DB3 Basin 10/4/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	7	--	--		7.5YR 3/3	
A	27	L (SL)	8 (17)		7.5YR 2.5/1	
A2	47	L (SL)	12		10YR 2/1	
Ag	84	SL	13		10YR 4/1	
				med, distinct, 22%	10YR 4/4	
				co, distinct,10%	10YR 3/1	
Bg	120	LS	4		10YR 5/2	
				med, prom, 15%	10YR 4/6	
2Ab	139	SCL	24		10YR 3/2	
3Bg	151	LS	5		10YR 5/2	
3CBg1	165	LS	3		5Y 6/2	Ilmenite bands 15%
3CBg2	179	LS	3		5Y 5/2	
3Cg	200+	fSL	7		5GY 6/1	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Fluvaquentic Humaquept

Water Table Depth

51 cm

AB DB6 Basin 10/4/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	11	--	--		7.5YR 2.5/2	
A	40	L (SL)*	8 (17)*		10YR 2/1	
Bg1	78	SL	7		2.5Y 6/2	
		(LS)*	(5)*	fine, distinct, 2%	10YR 7/3	
Bg2	95	SL (SL)*	8 (11)*		10Y 6/1	
BCg	157	LS	4		2.5Y 6/2	ilmenite 0.5%
		(S)*	(5)	coarse, 15%	10YR 6/4	
Cg	190+	SL (LS)	9 (5)		5GY 6/1	ilmenite 1%

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Typic Humaquept

Water Table Depth

68 cm

AB DB4 Transition Zone 11/22/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	6	--	--		5YR 2.5/2	
A1	22	LS (LS)*	6 (6)*		10YR 2/1	
A2	51	LS	5		10YR 2/2	
Bw	68	S (S)*	2 (2)*		10YR 5/4	
Bg	105	S (S)*	2 (4)*	 med, prom, 5% co, distinct, 15%	2.5Y 6/2 10YR 5/8 10YR 6/6	
Cg1	130	S	1		7.5YR 5/2	ilmenite 35%
Cg2	190+	S	2		10YR 6/2	ilmenite 15%

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Taxonomy: Oxyaquic Humudepts

Water Table Depth

60 cm

AB DB5 Rim 11/22/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	6	--	--		2.5Y 2.5/2	
AE	21	LS (SL)*	3 (5)*		10YR 2/1	
AB	29	LS	4		10YR 3/3	
Bw	55	LS (S)*	3 (2)*	 fine, prom, 3%	2.5Y 5/4 7.5YR 5/8	
BC	94	S	2	 med, prom, 42%	2.5Y 6/4 10YR 5/6	
C	131	S (S)*	1 (4)*	 med, distinct, 8% med, prom, 15%	2.5Y 6/4 10YR 6/6 5Y 7/2	 Conc. surrounds depletions
Cg	195+	S	1		5Y 7/1	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Taxonomy: Psammentic humudept

Water Table Depth

110 cm

EV DB1 Basin 11/17/2010

Queen Anne’s County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oi	6	--	--	10YR 2/2	
Oa	16	--	--	10YR 2/2	
Oa2	34	--	--	10YR 2/1	SBK
A2	50	SiL (SiCL)	10 (29)	10YR 3/1	0.7<N<1
Bg1	70	SiL (SiCL)	15 (29)	2.5Y 5/2 10YR 5/6	
Bg2	120	SiL (SiCL)	18 29	2.5Y 4.5/1.5 10YR 4/6	
2Cg	120+	sandy			Auger Refusal

<u>Additional Notes</u>

Soil Drainage Class: very poorly drained

Histic Epipedon

Hydric soils indicators: A2

Taxonomy: Histic Humaquept

<u>Water Table Depth</u>

3 cm

EV DB2 Basin 11/17/2010

Queen Anne’s County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	4	--	--	5YR 2.5/1	
A1	16	SiL (SiCL)	15 (29)	10YR 2/1	
A2	36	SiL (SiCL)	15 (29)	N 2.5/0	
A3	61	SiL (SiCL)	12 (29)	2.5Y 3/1 med, faint, 3% 2.5Y 4/1	
Bg	86	SiL (SiCL)	22 (29)	2.5Y 5/2 f, prom, RP 3% 10YR 5/6 f-m, prom, 10% 10YR 6/6	around 5/6 color
Cg	147	SiL (SiCL)	16 (29)	10Y 5/1 m, prom, RP, 3% 10YR 6/6	
2Ab	155	SL	8	2.5Y 4/1	
3Ab2	162+	L	13	2.5Y 4.5/1	

<u>Additional Notes</u>

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Cumulic Humaquept

<u>Water Table Depth</u>

4 cm

EV DB3 Basin 11/17/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	9	--	--		5YR 2.5/1	
Oa	36	--	--		10YR 2/1	
A/B	50	SiL	18		10YR 3/1	
		(SiCL)*	(29)*	m-co, prom, 15%	2.5Y 6/2	
				f-m prom RP, 3%	7.5YR 5/6	
Bg1	57	SiL	18		2.5Y 6/2	
		(SiCL)*	(29)*	m, prom RP 10%	7.5YR 5/6	
				20%	10YR 3/1	
Bg2	81	CL	30		2.5Y 5/2	
		(SL)*	(13)*	fine, dist, RP, 4%	10YR 5/6	
2CBg	113	SL	8	70%	2.5Y 5/2	
		(LS)*	(6)*	coarse, dist, 29%	10YR 4/2	
				fine, faint, 1%	10YR 4/4	
3Cg1	123	fSL (LfS)*	4 (3)*		5GY 4.5/1	
3Cg2	145+	fSL (LfS)*	4 (4)*		5GY 6/1	Auger Refusal

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Auger refusal through 240 cm, no sands reached

Taxonomy: Histic Humaquept

Water Table Depth

3 cm

EV DB4 Transition Zone 12/16/2010

Queen Anne’s County, MD

Mapped Soil Series: Pineyneck

Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	8	--	--		5YR 2.5/2	
A	20	L (SL)*	10 (14)*		7.5YR 2.5/1	
Bw	32	L	14		2.5Y 5/3 10YR 4/2	
				med-fine, RP	7.5YR 4/6	
Bg	67	L	26	55%	2.5Y 6/2	
		(SL)*	(18)*	med, prom, 45%	7.5YR 5/8	
2BCg	114	SiL	26		2.5Y 7/1	
				med, prom, 43%	7.5YR 5/8	
3C1	143	LS (LS)*	5 (6)*		2.5Y 7/1	
3C2	170+	S	1		2.5Y 7/3	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Aeric Endoaquept

Water Table Depth

75 cm

EV DB5 Rim 12/16/2010

Queen Anne's County, MD

Mapped Soil Series: Ingleside

Description conducted by Daniel Fenstermacher, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	--	--		7.5YR 2.5/2	
A	15	LS (LS)*	7 (5)*		2.5Y 4/3	
Bw1	28	LS	8		2.5Y 5/4	
		(LS)*	(5)*	m-co, prom, 5%	2.5Y 4/3	
Bw2	70	LS	9		2.5Y 6/6	
Bw3	100	LS	7		2.5Y 7/4	
				med, faint, 8%	2.5Y 6/6	
				fine, prom, 4%	10YR 6/6	
Bw4	130	SL	12		10YR 6/6	
		(SL)*	(9)*	med, dist, 15%	7.5YR 6/8	
				med, prom, 8%	2.5Y 6/4	
Bw5	157	SL	16		10YR 6/6	
				m-co, prom, 20%	7.5YR 5/8	
				med, prom, 9%	5Y 7/2	
2CBg	193+	SiL	24		2.5Y 7/1	
				med, prom, 18%	10YR 5/8	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Taxonomy: Typic Udipsamment

Water Table Depth

Not reached

JL DB1 Basin 8/7/2009

Caroline County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4					
A	22	L	10		10YR 2/1	Friable
Bg1	39	L	14		2.5Y 5/1.5	Firm
				fine, prom, 35%	10YR 4/6	
				15%	2.5Y 4/1	mixing from above?
Bg2	58	SiL	16		2.5Y 5/1	Firm
				fine, prom, 40%	7.5YR 5/8	
Bg3	84	SCL	24	50%	10YR 4/1	Very Firm
				40%	2.5Y 7/1	
				prominent, 10%	10YR 5/6	
Bg4	99	CL	28		2.5Y 7/1	Very Firm
				45%	10YR 5/1	
				few, prom, RPs	7.5YR 5/8	
2Bg5	115	CoSL	18		10YR 5/1	
					5PB 4/1	few
				5%	7.5YR 4/6	
2Cg1	148	SL, 10% Gr	8		2.5Y 7/1	> mixed matrix
					2.5Y 6/2	
				10%	N 7/0	
				10%	2.5Y 6/4	
				8%	10YR 4/1	
2Cg2	166	FSL	15		N 7/0	occasional Decomposing Root Channels OM mixed
2Cg3	190+	LCoS	3		5Y 7/1	Very Soupy
				Few, fine, p, RP	7.5YR 5/8	(structure less)
					2.5Y 4/1	maybe contamination

Additional Notes

CEAP-MIAR project MDC-N-JL site, uses same profile

Soil Drainage Class: poorly drained

Hydric soils indicators: A11 and F3

Taxonomy: Humic Endoaquept

Water Table Depth

8/7/2009 ponded

JL DB2 Basin 9/29/2010

Caroline County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	14				7.5YR 2.5/2	
A1	42	L	9		10YR 2/1	
A2	72	L	15		10YR 3/1	
					10YR 3/2	
					10YR 5/2	
AB	85	CL	30		2.5Y 3/1	
		(L)	(15)	f, p, RP, 10%	7.5YR 5/8	
				fine, prom, 5%	10YR 5/6	
				m-c, prom, 22%	2.5Y 5/2	
Bg1	116	SCL/L	25		2.5Y5/2	
		(SL)	(13)	f-m, p., RP, 20%	10YR 5/6	
				f, dist, RP, 8%	2.5Y 5/6	
2Bg2	139	SL	8		10YR 5/2	
			(10)	f, dist, RP, 5%	10YR 5/4	
2BCg	165	LS	3		2.5Y 6/2	
			(10)	med, dist, 8%	10YR 7/4	
2CBg	200+	LS	3		5GY 7/1	slightly coarser texture
			(10)	m-co, dist, 10%	2.5Y 8/3	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Cumulic Humaquept

Water Table Depth

137 cm

JL DB3 Basin 9/29/2010
Caroline County, MD
Mapped Soil Series: Corsica
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	10				7.5YR 2.5/2	
A	35	SiL (SL)*	10 (15)*		10YR 2/1	
Bg1	88	CL	30		10YR 5/1	
		(L)*	(14)*	m-c, p, RP, 23%	10YR 6/8	
Bg2	111	coSCL	34		7.5YR 5/1	
		(SL)*	(13)*	fine, distinct, 1%	7.5YR 5/8	
				m-fine, dist, 5%	10YR 7/6	
BC	137	LcoS	7		10YR 6/8	
		(LS)*	(10)*	med, prom, 35%	2.5Y 7/2	
Cg1	170	fSL (LfS)*	6 (11)*		10Y 7/1	
Cg2	200+	LS (LS)*	3 (12)*		10Y 8/1	5% Ilmenite Bands

Additional Notes

Soil Drainage Class: very poorly drained
Hydric soils indicators: A12, F13
Taxonomy: Typic Humaquept

Water Table Depth

130 cm

JL DB4 Transition Zone 11/19/2010

Caroline County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	8	-	-		5YR 2.5/2	
A	10	LS (LS)*	8 (2)		10YR 2/2	
AE	31	SL	10		10YR 3/2	
		(LS)	(5)	m, dist, RP, 8%	5YR 3/4	
BE	60	SL	11		2.5Y 6/4	
		(LS)*	(6)*	med, dist, 15%	10YR 5/6	
Bt	85	SL	17		2.5Y 6/3	
		(SL)*	(7)	med, prom, 35%	10YR 5/8	
CBg	103	LS	4		2.5Y 5/4	
				med, dist, 40%	2.5Y 6/2	
Ab	120	LS	4		10YR 3/3	slightly coarser texture
				med, dist, 35%	10YR 4/4	
Bwb	140	S	2		10YR 4/6	
C	183+	S	1		10YR 4/4	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Taxonomy: Inceptic Hapludult

Water Table Depth

76 cm

JL DB5 Rim 11/19/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	5	-	-		7.5YR 3/4	
A	11	LS (SL)*	5 (5)*		7.5YR 2.5/2	Wavy
AE	31	SL	8		2.5Y 4/3	
Bt1	55	SL (SL)*	12 (8)*	med, dist, 5%	2.5Y 5.5/4 10YR 5/6	weakly expressed clay Films
Bt2	77	SL	16	med, prom, 15%	2.5Y 5/4 10YR 5/6	slightly stronger clay bridges
BC	110	LS (LS)*	5 (6)*	med, prom, 35%	7.5YR 5/8 2.5Y 6/2	
CB	129	LS slightly Coarser	4	med, prom, 10% med, prom, 5%	10YR 5/6 2.5Y 7/1 7.5YR 5/8	
C	171	S (S)*	2 (2)*		2.5Y 6/4	
Cg	200+	LfS	3		5Y 6/2	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Taxonomy: Typic Hapludult

Water Table Depth

93 cm

EA DB1 Basin 11/10/2010
Queen Anne’s County, MD
Mapped Soil Series: Whitemarsh
Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	12	SiL (SiL)*	11 (15)*		10YR 4/2	
Ap2	27	SiL	16		10YR 5/2	
		(SiL)	(17)*	med, dist, 38%	7.5YR 4/4	
Bg1	64	SiL	25		10YR 5/1	
		(SiCL)*	(31)*	med, prom, 8%	10YR 4/6	
				med, prom, 2%	7.5YR 5/8	
Bg2	99	SiL	27		2.5Y 5/1	
		(SiCL)*	(37)*	co, prom, 20%	7.5YR 5/8	
				med, prom, 10%	10YR 4/6	
				dist, 5%	7.5YR 4/2	Ped faces
Bw	167	SiL	24		10YR 5/6	few coarse frags
		(SiCL)*	(29)*	med, prom, 35%	N 7/0	@ 130 cm
BCg	200	SiL	18		5Y 7/1	
		(SiL)*	(24)*	m-co, prom, 35%	7.5YR 5/8	
CBg	250	SiL	18		5Y 7/1	
		(SiL)*	(23)*	med, prom, 18%	7.5YR 5/8	
2Cg	263	LS (SL)*	2 (12)*		5Y 8/2	
2C	280	S	1		7.5YR 5/8	
		(S)*	(6)*		10YR 6/6	

Additional Notes
Soil Drainage Class: poorly drained
Hydric soils indicators: F3
Taxonomy: Typic Endoaquept
Water Table Depth
210 cm

EA DB2 Basin 11/10/2010

Queen Anne's County, MD

Mapped Soil Series: Whitemarsh

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	7	SiL	12 (15)		10YR 4/2	
Ap2	28	SiL	15		2.5Y 5/2	
				f, dist, RP, 28%	10YR 4/6	
Bg1	63	SiCL	34		2.5Y 5/2	
				med, prom, 23%	10YR 5/8	
				prominent, 8%	7.5YR 4/2	Ped faces
Bg2	95	SiCL	33		2.5Y 7/1	
				co, prom, 35%	10YR 5/8	
				prom, 4%	7.5YR 4/2	Ped faces
Bg3	133	SiL	22		2.5Y 6.5/1	
				med, prom, 21%	10YR 6/6	
Bg4	156	SiL	25		2.5Y 6/1	
				med, prom, 15%	10YR 6/6	
				med, prom, 8%	7.5YR 5/8	
CBg	170	L	18		2.5Y 7/1	
				fine, prom, 3%	10YR 5/6	
2Cg1	185	fSL	10		2.5Y 7/2	
				med, prom, 28%	10YR 5/6	
2Cg2	195+	S	2		10YR 5/6	
			(6)	fine, prom, 4%	2.5Y 7/1	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Taxonomy: Typic Endoaquept

Water Table Depth

117 cm

EA DB3 Basin 11/10/2010

Queen Anne's County, MD

Mapped Soil Series: Whitemarsh

Description conducted by Daniel Fenstermacher, Phil Clements, and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	11	SiL	10		10YR 4/2	
Ap2	35	SiL	13		2.5Y 4/2	
				fine, prom, 28%	10YR 4/4	
Bg1	76	SiCL	35		2.5Y 6/1	
				Med, prom, 26%	10YR 5/8	
				prom, 4%	7.5YR 4/2	Ped faces
Bg2	120	SiL	25		2.5Y 7/1	
				f-m, prom, 8%	10YR 6/8	
				m-co, prom, 15%	10YR 6/6	
BCg	133	SiL	18		2.5Y 6/1	
				med, promt, 15%	10YR 6/8	
				med, prom, 10%	10YR 6/6	
2CBg	146	SL	10		10YR 5/8	
				med, dist, 15%	10YR 6/6	
2Ab	155	SL	8		7.5YR 4/2	
2Bwb	168	LS	5		10YR 6.5/6	
3BC	178	SCL	30		7.5YR 5/8	
4CBg	189	SL	14		10YR 6/2	
5C	195+	SCL	25		7.5YR 5/8	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Taxonomy: Typic Endoaquept

Water Table Depth

93 cm

EA DB4 Transition Zone 1/10/2011

Queen Anne's County, MD

Mapped Soil Series: Whitemarsh

Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	26	L (SL)*	10 (7)*		10YR 4/3	
Bw1	48	L (SL)	12	 med, distinct, 5%	2.5Y 5/2.5 10YR 6/8	
Bw2	68	L (SL)*	15 (15)*	 med, prom, 38% med, distinct, 5%	2.5Y 6/3 10YR 5/6 2.5Y 6/2	
2Bw3	99	SiL	18	med, prom, 37% med, prom, 20% med, prom, 40% med, prom, 3%	2.5Y 6/1 2.5Y 6/3 10YR 5/6 5YR 3/6	
2BCg	124	SiL	25	 med, prom, 10% med, prom, 15%	2.5Y 6/1 10YR 5/8 10YR 5/6	2% ilmenite bands
2Cg	158	SiL (L)*	15 (19)*	 med, prom, 8%	2.5Y 6/1 10YR 5/8	
3C	170	LS	6	 med, prom, 25%	2.5Y 6/1 5YR 4/6	
3Csm	171	LS	6	iron cemented	5YR 3/4	placic horizon not enough to sample
3C`	190+	SL	8	co, prom, 45% co, prom, 55%	2.5Y 7/1 10YR 5/6	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Aquic Dystrudept

Water Table Depth

not reached

EA DB5 Rim 1/10/2011

Queen Anne’s County, MD

Mapped Soil Series: Ingleside

Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	26	SL (SL)*	8 (7)*		10YR 4/4	
Bw	67	LS	6		10YR 5/5	
CB	102	LS (S)*	3 (4)*		10YR 5.5/5	
C1	115	S	1 (4)		2.5Y 7/4	
C2	124	S (S)*	1 (4)*		10YR 5/5	
2Bwb1	158	SCL	34		10YR 5/2.5	
				med, prom, 35%	10YR 5/6	
				fine	N 2/0	Mn concentrations
2Bwb2	190+	SCL	29		2.5Y 6/2	
				med, prom, 18%	10YR 5/4	
				fine, prom, 2%	5YR 4/6	
				med, prom, 3%	7.5YR 5/8	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Taxonomy: Typic Udipsamment

Water Table Depth

132 cm

CF DB1 Basin 11/3/2009

Caroline County, MD

Mapped Soil Series: Hurlock

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	40	L	12		10YR 3/2	
		(SL)*	(12)*	fine 2%	7.5YR 4/4	
				med faint 1%	10YR 4/2	
ABg	66	SL	19		10YR 5/2	
		(SL)*	(18)*	med 8%	7.5YR 4/6	
				med 5%	2.5Y 6/4	
Bg1	102	SCL	24		2.5Y 6/1	
		(SCL)*	(21)*	4%	7.5YR 5/6	
				15%	2.5Y 7/4	
Bg2	136	fSL	15		2.5Y 6/1	
		(L)*	(13)*	fine 2%	10YR 5/6	
				medium 5%	2.5Y 6/4	
CBg	176+	LCoS (S)*	2 (4)*		2.5Y 6/2	

Additional Notes

CEAP-MIAR project MDC-PC-Cr site, uses same profile

Bulk Density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: None

Too deep for F3

Not dark enough for A12 or F13

Taxonomy: Typic Humaquept

Water Table Depth

11/3/2009 18 cm

CF DB2 Basin 10/18/2010
Caroline County, MD
Mapped Soil Series: Hurlock
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	31	L	10		10YR 3/3	
Bg	73	L	8		10YR 5/2	
				fine, prom, 15%	7.5YR 4/6	
2Bg2	94	CL	29		10YR 7/1	
				med, prom, 35%	7.5YR 5/8	
3Bg3	111	Gr SC	37	coarse, 60%	10YR 6/2	20% gravels
				30%	7.5YR 5/1	
				med, prom, 20%	7.5YR 5/8	
3BC	141	Gr SCL	28	48%	10YR 7/2	20% gravels
				co, prom, 35%	10YR 7/6	
				co-m, prom, 17%	7.5YR 6/8	
4Cg1	179	SL	6		7.5YR 7/2	some ilmenite
				med, dist, 25%	7.5YR 6/8	
4Cg2	200+	LS	3		10YR 8/1	0.25% ilmenite
				med, dist, 25%	10YR 7/6	

Additional Notes

Soil Drainage Class: very poorly drained
Hydric soils indicators: none
misses A11 by 1cm and color
misses A12 by color
misses F13 by color
Taxonomy: Typic Humaquept

Water Table Depth

117 cm

CF DB3 Basin 10/18/2010

Caroline County, MD

Mapped Soil Series: Hurlock

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	25	L	10		10YR 3/2	
A	54	L	10		10YR 3/2	10% gravels
				f-m, d, RP, 15%	5YR 4/6	
Bg	78	CL	29		10YR 7/1	14% gravels
				f-m, p, RP, 15%	7.5YR 5/8	
Bw	100	Gr fSL	13	30%	7.5YR 7/3	21% gravels
				35%	10YR 4/2	
				35%	10YR 4/6	
BCg	122	LfS	3		10YR 6/1	ilmenite bands
				co, prom, 21%	10YR 6/6	
CBg	143	LS	3		10YR 6/2	ilmenite
				med, prom, 15%	10YR 6/6	
Cg1	166	SL	10		10YR 6/2	ilmenite
				co, prom, 15%	2.5Y 7/4	
				co, prom, 10%	10YR 6/8	
Cg2	190+	LS	2		2.5Y 7/2	ilmenite
				5%	10YR 7/6	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: none

misses A12 and F13 by color

too deep for A11

Taxonomy: Typic Humaquept

Water Table Depth

93 cm

CF DB4 Transition Zone 1/14/2011
Caroline County, MD
Mapped Soil Series: Ingleside
Description conducted by Daniel Fenstermacher and Chris Palardy

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	20	L (SL)*	10 (10)*		10YR 3/2	
Ap2	42	L	12		10YR 2.5/2	
		(SL)*	(13)*	f, dist, RP, 28%	5YR 4/4	
Bg	70	L (SL)	14		10YR 5/2	
BCg	108	SL	8		10YR 7/2	
		(SL)*	(13)*	fine, faint, 5%	10YR 6/6	
C	190+	S	1		2.5Y 7/3	2% ilmenite bands

Additional Notes
Soil Drainage Class: somewhat poorly drained
Hydric soils indicators: none
Taxonomy: Typic Humaquept
Water Table Depth
not recorded

CF DB5 Rim 1/14/2011
Caroline County, MD
Mapped Soil Series: Ingleside
Description conducted by Daniel Fenstermacher and Chris Palardy

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	25	SL (SL)*	8 (7)*		10YR 4/3	
Bt	46	SL (SL)*	12 (15)*		7.5YR 5/8	
BC	72	LS (LS)*	4 (6)*		10YR 6/5	
C1	104	S	2		2.5Y 7/4	
			(5)	medium, dist, 2%	10YR 5/6	
C2	132	S (S)*	1 (5)*		10YR 6/6	
C3	147	LS	4		10YR 5/8	
				med, prom, 5%	10YR 6/4	
C4	180+	S	1		2.5Y 7/3	
				med, prom, 24%	10YR 6/8	

Additional Notes
Soil Drainage Class: well drained, no wet substratum
Hydric soils indicators: none
Taxonomy: Inceptic Hapludult
Water Table Depth
Not reached

BF DB1 Basin 7/23/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Dr. Martin C Rabenhorst

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	36	SiL/L	11		10YR 2/1	
		(L)*	(27)*		No Redox	
A1	58	SiL	17		N 2.5/0	
		(SiCL)*	(36)*		10YR 2/1	
				15% distinct	10YR 3/3	
A2	89	SiL	23		2.5Y 2/1	
		(C)*	(44)*	25% Distinct	10YR 3/3	
Bg1	108	SiCL	28	60%	2.5Y 6/2	
		(C)	(41)	30%	N 2.5/0	
				10% prominent	7.5YR 4/6	
Bg2	130	SiL	22		2.5Y 5/2	N<0.7
		(SiCL)*	(33)*	20%	5YR 4/6	loosing structure
					7.5YR 4/6	
BC	165	SiL	18	50%	2.5Y 4/3	
			(25)	35%	2.5Y 5/1	
				15%	5YR 4/6	
					7.5YR 4/6	
Cg1	185	SiL	18	50%	5GY 4/1	Striations start,
			(25)	50%	5Y 4/1	sedimentation layers
				upper part some	7.5YR 4/1	
Cg2	245	SiL	18		2.5Y 4/1	0.7<N<1
			(25)		No Redox	Samples taken to 215cm
Cg3	285+	SiL	18		5Y 5/1	Sand Lenses 2.5mm
			(25)		No Redox	

Additional Notes

CEAP-MIAR project MDC-PC-BeF site, uses same profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Cumulic Humaquept

Water Table Depth

7/23/2009	50cm
9/10/2009	just under surface
3/9/2010	ponded
4/6/2010	ponded
5/4/2010	ponded

BF DB2 Basin 10/11/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	22	SiL	22		10YR 3/1	
A1	45	SiL	23		2.5Y 3/1	
				fine, distinct, 3%	10YR 5/6	
A2	70	SiC	42		2.5Y 3/1	
				f-m, distinct, 15%	10YR 5/6	
Bw	114	SiL	25	coarse, 60%	7.5YR 5/8	
				med, prom, 10%	2.5Y 7/1	
				med, prom, 30%	10YR 3/1	
Bg	124	SiL	19		5Y 6/1	
				co, distinct, 30%	5Y 6/4	
				f, prom, RP, 5%	10YR 5/6	
BC	130	SL	7		2.5Y 3/2	
BCg	143	SiL	10		5Y 6/1	
			(20)	f-m, prom, RP, 8%	5YR 3/4	
				med, prom, 10%	5Y 6/1	
				f, prom, RP 10%	7.5YR 5/8	
CBg	190+	SiL	10		5Y 5/2	High N Value 0.7<N<1
			(20)	f, prom, RP 12%	10YR 6/8	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators:F13

Misses A12 by 0.5 value in upper 30cm

Taxonomy: Cumulic Humaquept

Water Table Depth

shallow, not recorded

BF DB3 Basin 10/11/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	18	L/SiL (L)*	18 (19)*		10YR 2/1	
A1	37	SiL (L)*	18 (27)*		10YR 2/1	
A2	78	SiCL	38		N 2.5/0	
		(C)*	(48)*	m-co, dist, 28%	10YR 3/3	
				med, prom, 3%	10YR 5/3	
				fine, dist, RP, 5%	10YR 6/6	
Bg	112	SiL	18		2.5Y 6/2	
		(L)*	(26)*	co, prom, 10%	2.5Y 5/4	
				med, prom, 5%	10YR 5/8	
				f, prom, RP, 4%	5YR 3/4	
BCg	142	SiL	9		2.5Y 6/2	
		(SiL)*	(26)*	f, prom, RP, 4%	10YR 5/6	
				med, prom, 15%	2.5Y 6/4	
Cg	178+	SiL	8		2.5Y 5/1	N<0.7
		(SiL)*	(20)	fine, dist, RP, 10%	10YR 5/6	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Auger refusal through 240 cm, no sands reached

Taxonomy: Cumulic Humaquept

Water Table Depth

4 cm

BF DB4 Transition Zone 10/27/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	12	SL (SL)*	8 (5)*		10YR 4/2	
Ap2	22	SL	9		2.5Y 4/2	
E	47	SL (SL)*	13 (8)*		2.5Y 5/3	
Bg	90	SL	13		5Y 6/1	
				co, prom, 25%	7.5YR 5/8	
				med, prom, 15%	10YR 5/8	
Bw	109	LS	7		10YR 5/6	
		(LS)*	(11)*	med, prom, 15%	2.5Y 6/2	
				medium, dist, 10%	7.5YR 5/8	
BCg	159	vfSL	7		2.5Y 6/1	
C	192+	LS/S	2		2.5Y 6/3	ilmenite
				10%	10YR 5/8	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Aeric Endoaquept

Water Table Depth

134 cm

BF DB5 Rim 10/27/2010

Caroline County, MD

Mapped Soil Series: Ingleside

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	15	SL (LS)*	10 (4)*		10YR 4/2	
Ap2	29	SL	10 (6)		2.5Y 5/3	
Bw1	56	SL (SL)*	13 (8)*		10YR 5/4	
Bw2	92	SL	14		10YR 6/4	
				medium, dist, 8%	10YR 5/6	
Bw3	113	SL	13		10YR 6/3	
		(LS)*	(6)*	coarse, distt, 35%	10YR 5/6	
Bw4	146	SL	5		10YR 6/3	
		(LS)		prominent, 10%	10YR 5/6	
				prominent, 35%	2.5Y 7/1	
Cg	168	S	1		5Y 4/1	a lot of ilmenite
		(S)*	(3)*	med, prom, 10%	10YR 6/4	
				45%	2.5Y 6/2	
C	186	LS	4		10YR 5/6	
		(S)		5%	7.5YR 5/8	
Cg2`	195+	S	1		2.5Y 7/1	
				medium, 10%	10YR 6/4	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Taxonomy: Typic Dystrudept

Water Table Depth

164 cm

ML DB1 Basin 11/12/2010

Caroline County, MD

Mapped Soil Series: Corsica

Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	18	L	18		10YR 2/1	
Ap2	31	CL	36		10YR 3/1	
ABg	55	SiCL	34		10YR 4/2	
				f, prom, RP, 25%	7.5YR 4/6	
				m-fine, prom, 15%	2.5Y 6/3	
BAg	92	LS	3		7.5YR 4/2	
				med-co, dist, 5%	10YR 4/6	
BC	114	LS	2		10YR 5/3	ilmenite
				m-co, prom, 38%	7.5YR 4/6	
Cg	155+	LS (S)*	3 (5)*		10Y 6/1	ilmenite

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: F13

misses A12 by 0.5 chroma

misses A11 by 1cm

Taxonomy: Typic Humaquept

Water Table Depth

71 cm

ML DB2 Basin 11/15/2010
Caroline County, MD
Mapped Soil Series: Corsica
Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	27	SiL (L)*	16 (23)*		10YR 2/1	
Bg	52	SiCL	34		2.5Y 6/1	
		(L)*	(26)*	med, prom, 20%	7.5YR 4/6	
				Prom, 5%	10YR 2/1	ped faces
2Bg2	84	LS	2		2.5Y 6/2	
		(S)*	(5)*	co, prom, 30%	2.5Y 6/4	
				med, distinct, 8%	10YR 6/6	
2BC	113	LS	3		10YR 6/6	
		(LS)*	(6)*	med, distinct, 20%	7.5YR 5/8	
				med, prom, 8%	2.5Y 5/1	
3Cg	190	SiL	10		2.5Y 4/1	N>1
		(L)*	(14)*	fine, prom, 1%	10YR 5/6	
4Cg	191+	sandy				No sample

Additional Notes

Soil Drainage Class: very poorly drained
Hydric soils indicators: A11, F13
Taxonomy: Fluvaquentic Humaquept

Water Table Depth

48 cm

ML DB3 Basin 11/15/2010
Caroline County, MD
Mapped Soil Series: Corsica
Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	18	SiL	18		10YR 2/1	
A	28	SiL	25		10YR 3.5/1	
Bg1	44	SiCL	37		2.5Y 5/2	
			(28)	fine-m, prom, 17%	10YR 5/6	
2Bg2	70	LS	5		2.5Y 6/2	
				med, prom, 35%	10YR 5/6	
2BC	85	LS	4		10YR 5/6	
				med, prom, 23%	2.5Y 6/2	
3CBg	109	L sandy pockets	12		10YR 5/2	
				med, prom, 15%	7.5YR 5/8	
4CBg	123	LS	3		2.5Y 6/2	
				?	10YR 6/6	
4Cg	170+	S	1		2.5Y 6/2	

Additional Notes

Soil Drainage Class: very poorly drained
Hydric soils indicators: none
misses A11 and F13 by 0.5 value
misses F3 by 3 cm
Taxonomy: Typic Humaquept

Water Table Depth

66 cm

ML DB4 Transition Zone 1/7/2011
Caroline County, MD
Mapped Soil Series: Woodstown
Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	21	SL (SL)*	8 (10)*		10YR 2/1	mod SBK, Friable
Ap2	33	L (SL)	10		10YR 2/1	strong SBK, firm
AB	53	LS (S)*	4 (6)*		10YR 3/3	
Bw	86	LS	3		10YR 5/3	finer material pockets
		(S)		med, faint, 15%	10YR 7/1	1% ilmenite
Ab	102	LS (S)	4		10YR 3/2	
Bwb	168	S	2		2.5Y 5/3	0.5% ilmenite
C	185+	S	1		10YR 5.5/2	0.25% ilmenite

Additional Notes

Soil Drainage Class: moderately well drained
Hydric soils indicators: none
Taxonomy: Aquic Humudept

Water Table Depth

61 cm

ML DB5 Rim 1/7/2011

Caroline County, MD

Mapped Soil Series: Woodstown

Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	23	SL (SL)*	8 (5)*		10YR 4/3	
Bw	50	L	12		2.5Y 6/5	
				fine, distinct, 8%	2.5Y 7/2	
				med, prom, 15%	10YR 5/8	
BC	91	LS	4		10YR 6/5	1% ilmenite
		(S)*	(3)*	med, prom, 15%	2.5Y 7/2	
				med, prom, 5%	10YR 5/8	
CBg	110	S	3		2.5Y 7/2	1% ilmenite
				med, prom, 24%	10YR 6/6	
C1	140	S	2		2.5Y 6/4	1% ilmenite
		(S)*	(3)*	med, prom, 5%	2.5Y 7/2	
				Med, prom, 3%	10YR 5/8	
C2	180+	S	2		10YR 5/6	1% ilmenite

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Taxonomy: Aquic Dystrudept

Water Table Depth

115 cm

BT DB1 Basin 11/12/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Ap1	22	SiL (L)*	12 (27)*	10YR 2/1	SBK
Ap2	33	SiL (CL)*	12 (29)*	10YR 2/1 m, prom, 1.5% 7.5YR 2.5/3	SBK ped faces
A (Oa)*	58	--	--	10YR 2/1	granular
Bg	105	SiL (SiL)*	18 (26)*	10YR 5/1 f, prom, RP, 11% 10YR 5/6	
BCg	161	SiL (SiL)*	14 (16)*	10YR 5/1 f, prom, RP, 15% 10YR 5/6	
CBg	195	SiL (SiL)*	10 (11)*	5Y 5/1 f, prom, RP, 15% 10YR 4/6	0.7<N<1 some as nodules
Cg	350+	SiL	(11)		N>1 Auger refusal no sands reached

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Fluventic Humaquept

Water Table Depth

18 cm

BT DB2 Basin 11/12/2010

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	8	SiL (L)	10 (27)		10YR 2/1	SBK, Friable
Ap2	27	SiL (CL)	10 (29)		10YR 2/1	SBK, Firm
A (Oa)*	44	--	--	 medium, faint, 1%	10YR 2/1 7.5YR 2/2	granular
A	66	SiL	13		10YR 2/1	
Bg1	105	SiL	16	 f, prom, RP, 15%	10YR 5/1 7.5YR 5/8	
Bg2	165	SiL	14	 m, prom, RP, 15%	10YR 5/1 7.5YR 5/6	
BCg	190	SiL	12	 m, prom, RP, 15%	2.5Y 5/1.5 10YR 5/6	0.7<N<1
Cg	330	SiL	(11)			N>1, Auger refusal
2Cg?	330+	sandy				

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Taxonomy: Cumulic Humaquept

Water Table Depth

22 cm

BT DB3 Basin 11/12/2010
Caroline County, MD
Mapped Soil Series: Hammonton-Fallsington-Corsica Complex
Description conducted by Daniel Fenstermacher, and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	22	SiL (L)	12 (27)		10YR 2/1	
Ap2	38	SiL (CL)	27 (29)		10YR 2/1	few gravels @ 66 cm
Bg1	100	SiL	18 (26)	 co, distinct, 23% fine, prom, 8%	10YR 6/1 10YR 7/4 10YR 5/6	sand lense @100 cm
BCg	145	SiL	12 (16)	 co, distinct, 15% fine, prom, 3%	10YR 6/1 10YR 6/6 7.5YR 5/8	
CBg	190	SiL	14	 fine, prom, 5%	10YR 4.5/1 10YR 5/6	
Cg	200	SiL	(11)			N>1, Auger Refusal
2Cg	200+	sandy				Auger refusal

Additional Notes
Soil Drainage Class: very poorly drained
Hydric soils indicators: A12, F13
Taxonomy: Typic Humaquept
Water Table Depth
55 cm

BT DB4 Transition Zone 1/7/2011
Caroline County, MD
Mapped Soil Series: Hammonton-Fallsington-Corsica Complex
Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	23	L (SL)*	11 (7)*		10YR 2/1	friable, weak SBK/gran light and fluffy
Ap2	40	L/SL (SL)*	10 (13)*		10YR 2/1	friable/firm, mod SBK
Bw	62	LS (S)*	4 (4)*	 Med, distinct, 10% med, prom, 8%	2.5Y 6/3.5 2.5Y 7/2 10YR 6/6	
BCg	83	LS (S)	3	 med, prom, 5%	10Y 7/1 2.5Y 6/6	0.5% ilmenite
CB	120	LS (S)*	2 (6)*	 med, prom, 15%	2.5Y 6/5 2.5Y 7/2	1% ilmenite
C	180+	S	1		5Y 7/1	1.5% ilmenite,

Additional Notes
Soil Drainage Class: somewhat poorly drained
Hydric soils indicators: none
Taxonomy: Aquic Humudept
Water Table Depth
88 cm

BT DB5 Rim 1/7/2011

Caroline County, MD

Mapped Soil Series: Ingleside

Description conducted by Daniel Fenstermacher and Mark Matovich

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	21	SL (SL)*	10 (5)*		10YR 4/3	
Bt1	40	SL	14		10YR 4/4.5	clay films observed
		(SL)*	(7)*	f, RP/faces, 3%	10YR 4/3	
Bt2	74	LS (SL)*	6 (12)*		7.5YR 4/6	weak clay films present
C1	120	S	1		2.5Y 7/4	1% ilmenite
C2	163	S	1		2.5Y 7/3	1% ilmenite
C3	195+	S	1.5	10YR-2.5Y 6/4		2% ilmenite

Additional Notes

Soil Drainage Class: well drained, no wet substratum

Hydric soils indicators: none

Taxonomy: Typic Hapludult

Water Table Depth

not reached

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study

Natural Sites

Horizons used in both the Delmarva Bay and CEAP study are indicated by + in the Site ID

Site	Horizon	Bottom Depth (cm)	Bulk Density ($g\ cm^{-3}$)	Bulk Density St. Dev.	% C	% C St. Dev.
EN DB1	Oe	4	0.18	0.01	44.92	4.22
EN DB1	A1	18	0.62	0.03	9.38	1.21
EN DB1	A2	49	1.16	0.00	1.52	0.05
EN DB1	AB	73	1.35	0.09	0.51	0.01
EN DB1	Bg	113	1.46	0.14	0.35	0.20
EN DB1	BCg	155	--	--	0.10	0.02
EN DB1	Cg	190	--	--	0.09	0.00
EN DB2	Oe	3	0.12	0.01	52.60	1.93
EN DB2	A1	18	1.18	0.13	3.93	0.86
EN DB2	Ag	32	1.41	0.03	1.08	0.22
EN DB2	Bg	87	1.75	0.00	0.08	0.01
EN DB2	2BCg	107	1.73	0.05	0.03	0.00
EN DB2	3BCg	130	--	--	0.06	0.01
EN DB2	3CBg	143	--	--	0.04	0.00
EN DB2	4C1	158	--	--	0.10	0.07
EN DB2	4C2	193	--	--	0.02	0.00
EN DB2	4C3	200	--	--	0.02	0.00
EN DB3	Oe	3	0.27	0.02	32.22	3.29
EN DB3	A	14	0.67	0.02	9.68	0.22
EN DB3	Ag	32	1.34	0.08	0.69	0.09
EN DB3	BAg	63	1.23	0.01	0.42	0.01
EN DB3	Bg1	82	1.63	0.08	0.14	0.06
EN DB3	Bg2	100	1.60	0.08	0.07	0.02
EN DB3	bg3	150	--	--	0.05	0.00
EN DB3	2Cg	175	--	--	0.03	0.01
EN DB3	2Cg2	195	--	--	0.03	0.00
EN DB4	Oe	2	0.25	0.00	27.64	6.49
EN DB4	A	8	0.92	0.17	3.95	0.34
EN DB4	BE	19	1.63	0.05	0.24	0.12
EN DB4	Bw1	29	1.69	--	0.10	0.01
EN DB4	2Bg2	58	1.76	0.03	0.04	0.01
EN DB4	2Bw2`	78	1.86	0.06	0.03	0.01
EN DB4	2Bw3`	82	1.83	0.05	0.03	0.01
EN DB4	3Bwb1	103	--	--	0.02	0.01
EN DB4	3Bwb2	131	--	--	0.02	0.00

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study NAT sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
EN DB4	3BCg	146	--	--	0.02	0.00
EN DB4	4Bgb	156	--	--	0.04	0.00
EN DB4	4Bgb3`	165	--	--	0.03	0.00
EN DB4	5Cg	172	--	--	0.04	0.00
EN DB4	5CB	179	--	--	0.02	0.00
EN DB5	AE	5	0.95	0.09	3.24	0.20
EN DB5	EB	37	1.33	0.07	0.38	0.05
EN DB5	Bw1	58	1.64	0.02	0.08	0.01
EN DB5	Bw2	99	1.76	0.04	0.04	0.01
EN DB5	Bw3	143	--	--	0.03	0.00
EN DB5	B24	165	--	--	0.03	0.00
EN DB5	Bw5	195	--	--	0.04	0.00
ST DB1	Oe	16	0.10	0.00	60.12	0.34
ST DB1	A	43	0.89	0.02	6.37	0.44
ST DB1	Bg	83	1.71	0.06	0.25	0.17
ST DB1	BC	119	1.68	0.08	0.08	0.05
ST DB1	Cg1	147	--	--	0.05	0.01
ST DB1	Cg2	200	--	--	0.06	0.01
ST DB2	Oe	10	0.04	0.05	56.95	2.11
ST DB2	A	34	1.25	0.00	4.40	1.32
ST DB2	Bg1	56	1.84	0.05	0.07	0.01
ST DB2	Bg2	85	1.80	0.15	0.03	0.01
ST DB2	Bg3	125	1.76	0.06	0.04	0.00
ST DB2	BCg	175	--	--	0.03	0.00
ST DB2	Cg	200	--	--	0.04	0.01
ST DB3	Oe	18	0.11	0.00	57.47	0.13
ST DB3	A1	37	0.92	0.08	4.52	0.51
ST DB3	A2	67	1.47	0.03	1.06	0.23
ST DB3	Bag	103	1.84	0.16	0.37	0.20
ST DB3	Bg	127	--	--	0.36	0.03
ST DB3	CBg	166	--	--	0.75	0.01
ST DB4	Oe	9	0.07	0.01	52.05	3.24
ST DB4	A	23	0.94	0.02	3.49	0.11
ST DB4	Bw	36	0.93	0.08	1.84	0.61
ST DB4	Bg	59	1.67	0.00	0.10	0.00
ST DB4	2BC	111	1.73	0.08	0.03	0.00
ST DB4	3CB	137	--	--	0.05	0.00
ST DB4	3CB	160	--	--	0.06	0.00
ST DB4	4Ab	180	--	--	0.04	0.00

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study NAT sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density ($g\ cm^{-3}$)	Bulk Density St. Dev.	% C	% C St. Dev.
ST DB4	4Ab2	190	--	--	0.03	0.00
ST DB4	4Bw	200	--	--	0.03	0.00
ST DB5	Oe	7	0.08	0.01	46.65	0.83
ST DB5	AE	17	1.01	0.05	1.66	0.20
ST DB5	Bt1	45	1.35	0.02	0.31	0.06
ST DB5	Bt2	66	1.71	0.12	0.08	0.01
ST DB5	Bt3	95	1.57	0.01	0.10	0.02
ST DB5	BC	132	--	--	0.05	0.00
ST DB5	CB	164	--	--	0.03	0.00
ST DB5	CB2	190	--	--	0.04	0.00
AB DB1$^+$	Oe	9	0.21	0.02	56.05	0.39
AB DB1$^+$	Oa	22	0.31	0.09	15.70	1.13
AB DB1$^+$	A1	53	0.34	0.03	9.13	0.44
AB DB1$^+$	A2	72	1.10	0.19	3.43	0.57
AB DB1$^+$	BCg	150	1.21	0.04	1.71	0.16
AB DB2	Oe	8	0.12	0.06	48.90	4.32
AB DB2	A1	32	1.04	0.06	4.33	0.19
AB DB2	A2	56	1.41	0.13	0.84	0.34
AB DB2	Ag	90	1.80	0.04	0.09	0.02
AB DB2	Bg	138	1.80	0.04	0.06	0.01
AB DB2	CBg	175	--	--	0.04	0.00
AB DB2	Cg	200	--	--	0.05	0.00
AB DB3	Oe	7	0.13	0.04	53.40	1.10
AB DB3	A1	27	0.80	0.03	6.23	0.77
AB DB3	A2	47	1.16	0.01	2.10	0.41
AB DB3	Ag	84	1.69	0.01	0.36	0.05
AB DB3	Bg	120	1.77	0.07	0.29	0.06
AB DB3	2Ab	139	--	--	1.15	0.03
AB DB3	3Bg	151	--	--	0.14	0.01
AB DB3	3CBg	165	--	--	0.07	0.00
AB DB3	3CBg	179	--	--	0.06	0.00
AB DB3	3Cg	200	--	--	0.05	0.00
AB DB4	Oe	11	0.18	0.01	32.00	3.16
AB DB4	A	40	1.00	0.02	4.99	0.32
AB DB4	Bg	78	1.84	0.12	0.08	0.00
AB DB4	Bg2	95	1.73	0.09	0.04	0.01
AB DB4	BCg	157	--	--	0.05	0.00
AB DB4	Cg	190	--	--	0.08	0.01
AB DB6	Oe	6	0.18	0.01	46.06	8.16

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study NAT sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density ($g\ cm^{-3}$)	Bulk Density St. Dev.	% C	% C St. Dev.
AB DB6	A1	22	1.15	0.01	3.59	0.16
AB DB6	A2	51	1.41	0.02	0.94	0.12
AB DB6	Bw	68	1.69	0.01	0.05	0.01
AB DB6	Bg	105	1.75	0.23	0.06	0.00
AB DB6	Cg1	130	--	--	0.07	0.01
AB DB6	Cg2	190	--	--	0.04	0.00
AB DB5	Oe	6	0.12	0.00	50.05	6.97
AB DB5	AE	21	1.01	0.15	3.03	0.95
AB DB5	Bh	29	1.13	0.04	1.62	0.25
AB DB5	Bw	55	1.47	0.03	0.14	0.03
AB DB5	BC	94	1.82	0.10	0.03	0.01
AB DB5	CB	131	--	--	0.02	0.00
AB DB5	Cg	195	--	--	0.02	0.00
EV DB1	Oi	6	0.08	0.00	45.60	0.81
EV DB1	Oa	16	0.25	0.06	17.87	2.19
EV DB1	A1	34	0.28	0.12	17.55	2.74
EV DB1	A2	50	0.54	0.02	7.16	2.04
EV DB1	Bg1	70	1.00	0.20	3.29	2.51
EV DB1	Bg2	120+	1.29	0.03	1.54	0.44
EV DB2	Oe	4	0.10	0.06	49.57	0.69
EV DB2	A1	16	0.37	0.08	12.26	2.01
EV DB2	A2	36	0.44	0.05	11.92	0.77
EV DB2	A3	61	0.96	0.03	1.75	0.05
EV DB2	Bg	86	1.50	0.04	0.34	0.04
EV DB2	Cg	147	1.73	0.17	0.35	0.02
EV DB2	2Ab	155	--	--	0.33	0.08
EV DB2	3Ab2	162	--	--	0.55	0.01
EV DB3	Oe	9	0.17	0.02	41.75	4.08
EV DB3	Oa	36	0.35	0.03	14.77	0.24
EV DB3	A/B	50	0.78	0.04	3.28	0.63
EV DB3	Bg1	57	1.03	0.12	0.93	0.09
EV DB3	Bg2	81	1.18	0.21	1.05	0.12
EV DB3	2CBg	113	--	--	0.12	0.00
EV DB3	Cg1	123	--	--	0.08	0.01
EV DB3	Cg2	145	--	--	0.07	0.01
EV DB 4	Oe	8	0.17	0.06	44.92	11.59
EV DB 4	A	20	0.79	0.08	6.35	1.12
EV DB 4	Bw	32	1.45	0.12	0.62	0.24
EV DB 4	Bg	67	1.46	0.02	0.20	0.01

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study NAT sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
EV DB 4	BCg	114	1.34	0.06	0.33	0.07
EV DB 4	C1	153	--	--	0.06	0.00
EV DB 4	C2	170	--	--	0.04	0.00
EV DB 5	Oe	3	0.35	0.31	27.47	1.93
EV DB 5	A	15	1.09	0.02	2.05	0.30
EV DB 5	Bw1	28	1.30	0.17	0.45	0.15
EV DB 5	Bw2	70	1.52	0.05	0.09	0.01
EV DB 5	Bw3	100	1.67	0.00	0.03	0.01
EV DB 5	BC	130	--	--	0.03	0.00
EV DB 5	BC2	157	--	--	0.03	0.00
EV DB 5	2CBg	193	--	--	0.06	0.00
JL DB1^{+}	Oe	4	0.51	0.09	11.51	1.99
JL DB1^{+}	A	22	0.86	0.09	4.30	0.25
JL DB1^{+}	Bg1	29	1.41	0.07	0.69	0.39
JL DB1^{+}	Bg3	84	1.49	0.17	0.26	0.02
JL DB1	Bg4	99	--	--	3.80	0.11
JL DB1	2Bg5	115	--	--	0.13	0.02
JL DB2	Oe	14	0.10	0.00	54.52	0.22
JL DB2	A1	42	1.19	0.03	2.50	0.13
JL DB2	A2	72	1.48	0.00	0.57	0.01
JL DB2	AB	85	1.40	0.16	0.43	0.09
JL DB2	Bg1	116	1.61	0.17	0.20	0.02
JL DB2	2Bg2	139	--	--	0.08	0.00
JL DB2	2BCg	165	--	--	0.08	0.00
JL DB2	2CBg	200	--	--	0.03	0.00
JL DB3	Oe	10	0.07	0.01	32.51	6.43
JL DB3	A	35	0.80	0.07	5.06	0.01
JL DB3	Bg1	88	1.78	0.00	0.18	0.02
JL DB3	Bg2	111	1.91	0.03	0.11	0.01
JL DB3	BC	137	--	--	0.03	0.00
JL DB3	Cg1	170	--	--	0.03	0.00
JL DB3	Cg2	200	--	--	0.02	0.00
JL DB4	Oe	8	0.11	0.01	44.35	2.25
JL DB4	A	10	0.74	0.22	8.39	0.72
JL DB4	AE	31	1.29	0.00	1.42	0.08
JL DB4	BE	60	1.72	0.00	0.10	0.02
JL DB4	Bt	85	1.88	0.06	0.03	0.02
JL DB4	CBg	103	1.77	0.05	0.05	0.01
JL DB4	Ab	120	--	--	0.35	0.03

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study NAT sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
JL DB4	Bwb	140	--	--	0.33	0.02
JL DB4	C	183	--	--	0.14	0.01
JL DB5	Oe	5	0.16	0.04	43.84	14.60
JL DB5	A	11	0.39	0.06	8.89	3.50
JL DB5	AE	31	1.24	0.03	1.00	0.39
JL DB5	Bt1	55	1.50	0.00	0.34	0.05
JL DB5	Bt2	77	1.75	0.04	0.09	0.01
JL DB5	BC	110	1.80	0.04	0.04	0.00
JL DB5	CBg	129	--	--	0.06	0.01
JL DB5	C	171	--	--	0.04	0.00
JL DB5	C2	200	--	--	0.05	0.00

Prior Converted Cropland Sites

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study PCC sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
EA DB1	Ap1	12	1.35	0.03	1.55	0.10
EA DB1	Ap2	27	1.31	0.03	1.20	0.08
EA DB1	Bg1	64	1.44	0.06	0.27	0.05
EA DB1	Bg2	99	1.54	0.02	0.11	0.03
EA DB1	Bw	167	--	--	0.05	0.00
EA DB1	BCg	200	--	--	0.07	0.00
EA DB2	Ap1	7	1.34	0.17	1.54	0.24
EA DB2	Ap2	28	1.48	0.11	0.91	0.10
EA DB2	Bg1	63	1.37	0.05	0.27	0.02
EA DB2	Bg2	95	1.64	0.03	0.09	0.01
EA DB2	Bg3	133	--	--	0.05	0.00
EA DB2	Bg4	156	--	--	0.09	0.01
EA DB2	CBg	170	--	--	0.06	0.00
EA DB2	2Cg1	185	--	--	0.03	0.00
EA DB2	2Cg2	195	--	--	0.03	0.00
EA DB3	Ap1	11	1.35	0.02	1.23	0.10
EA DB3	Ap2	35	1.39	0.10	0.86	0.34
EA DB3	Bg1	76	1.66	0.03	0.12	0.01
EA DB3	Bg2	120	1.63	0.00	0.07	0.00
EA DB3	BCg	133	--	--	0.05	0.00
EA DB3	2CBg	146	--	--	0.04	0.00
EA DB3	2Ab	155	--	--	0.03	0.00
EA DB3	2Bwb	168	--	--	0.02	0.00
EA DB3	3BCg	178	--	--	0.05	0.00
EA DB3	4CB	189	--	--	0.04	0.00
EA DB3	5CB	195	--	--	0.07	0.02
EA DB4	Ap	26	1.59	0.08	0.62	0.12
EA DB4	Bw	48	1.70	0.02	0.18	0.02
EA DB4	Bw2	68	1.74	0.07	0.09	0.01
EA DB4	Bw3	99	1.68	0.06	0.07	0.01
EA DB4	BCg	124	--	--	0.03	0.00
EA DB4	Cg	158	--	--	0.03	0.00
EA DB4	2C	170	--	--	0.03	0.00
EA DB4	2C2	190	--	--	0.02	0.03
EA DB5	Ap	26	1.65	0.01	0.59	0.02
EA DB5	Bw	67	1.73	0.03	0.09	0.05
EA DB5	CB	102	1.63	0.10	0.02	0.01

Appendix C: Bulk Density and Carbon Data, Delmarva Bay Study PCC sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
EA DB5	C1	115	--	--	0.01	0.00
EA DB5	C2	124	--	--	0.01	0.00
EA DB5	2Bwb1	158	--	--	0.04	0.00
EA DB5	2Bwb2	190	--	--	0.03	0.00
CF DB1$^+$	Ap	40	1.59	0.01	0.81	0.10
CF DB1$^+$	AB	66	1.66	0.03	0.19	0.02
CF DB1$^+$	Bg1	102	1.83	0.02	0.09	0.01
CF DB1	Bg2		--	--	0.13	0.01
CF DB1	CBg		--	--	0.03	0.00
CF DB2	Ap	31	1.59	0.05	0.97	0.17
CF DB2	Bg	73	1.77	0.02	0.16	0.03
CF DB2	2Bg2	94	1.58	0.05	0.18	0.02
CF DB2	3Bg3	111	1.76	0.05	0.06	0.01
CF DB2	3Bw	141	--	--	0.05	0.00
CF DB2	4BCg	179	--	--	0.03	0.00
CF DB2	4CBg	200	--	--	0.02	0.00
CF DB3	Ap	25	1.59	0.04	0.76	0.03
CF DB3	A	54	1.58	0.02	0.36	0.02
CF DB3	Bg	78	1.78	0.03	0.13	0.01
CF DB3	Bw	100	1.74	0.06	0.04	0.00
CF DB3	BCg1	122	--	--	0.02	0.00
CF DB3	BCg2	143	--	--	0.04	0.00
CF DB3	BCg3	166	--	--	0.03	0.00
CF DB3	CBg	190	--	--	0.02	0.00
CF DB4	Ap1	20	1.48	0.08	0.98	0.04
CF DB4	Ap2	42	1.55	0.04	0.62	0.13
CF DB4	Ag	70	1.67	0.01	0.20	0.07
CF DB4	BCg	108	1.82	0.04	0.09	0.01
CF DB4	C	190	--	--	0.03	0.00
CF DB5	Ap	25	1.62	0.11	0.33	0.08
CF DB5	Bt	46	1.66	0.01	0.16	0.01
CF DB5	BC	72	1.58	0.08	0.03	0.00
CF DB5	C1	104	1.58	0.06	0.03	0.01
CF DB5	C2	132	--	--	0.02	0.00
CF DB5	C3	147	--	--	0.02	0.00
CF DB5	C4	180	--	--	0.02	0.00
BF DB1$^+$	Ap	36	1.26	0.06	2.60	0.05
BF DB1$^+$	A1	58	0.92	0.00	3.38	0.14
BF DB1$^+$	A2	89	0.93	0.08	2.73	0.49

Appendix B: Bulk Density and Carbon Data, Delmarva Bay Study PCC sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
BF DB1	Bg1	108	--	--	0.39	0.05
BF DB1	Bg2	130	--	--	1.37	0.01
BF DB1	BC	165	--	--	1.48	0.01
BF DB1	Cg1	185	--	--	1.97	0.01
BF DB1	Cg2	215	--	--	2.07	0.06
BF DB2	Ap	22	1.21	0.00	3.05	0.11
BF DB2	A1	45	0.97	0.03	2.66	0.52
BF DB2	A2	70	1.02	0.05	1.78	0.07
BF DB2	Bw	114	0.88	0.08	0.74	0.03
BF DB2	Bg	124	--	--	0.87	0.02
BF DB2	Bc	130	--	--	0.22	0.02
BF DB2	BCg	143	--	--	0.95	0.01
BF DB2	CBg	190	--	--	1.30	0.01
BF DB3	Ap	18	1.17	0.08	3.30	0.13
BF DB3	A1	37	1.16	0.07	3.47	0.33
BF DB3	A2	78	0.74	0.33	2.02	0.08
BF DB3	Bg	112	0.63	0.00	1.17	0.75
BF DB3	BCg	142	--	--	1.41	0.01
BF DB3	BCg2	178	--	--	0.81	0.06
BF DB4	Ap1	12	1.50	0.02	0.38	0.03
BF DB4	Ap2	22	1.57	0.02	0.07	0.01
BF DB4	E	47	1.94	0.01	0.05	0.00
BF DB4	Bg	90	1.77	0.01	0.03	0.00
BF DB4	Bw	109	--	--	0.03	0.00
BF DB4	BCg	159	--	--	0.01	0.00
BF DB4	C	192	--	--	0.42	0.08
BF DB5	Ap1	15	1.56	0.04	0.11	0.02
BF DB5	Ap2	29	1.79	0.01	0.10	0.01
BF DB5	Bw1	56	1.78	0.01	0.03	0.00
BF DB5	Bw2	92	1.81	0.05	0.02	0.00
BF DB5	Bw3	113	--	--	0.02	0.00
BF DB5	Bw4	146	--	--	0.02	0.00
BF DB5	Cg	168	--	--	0.02	0.00
BF DB5	Cg	186	--	--	0.02	0.00
BF DB5	Cg`	195	--	--	1.20	0.01
ML DB1	Ap1	18	1.43	0.05	2.49	0.16
ML DB1	Ap2	31	1.46	0.03	1.37	0.22
ML DB1	Abg	55	1.29	0.03	0.78	0.10
ML DB1	BAg	92	1.85	0.02	0.10	0.03

Appendix B: Bulk Density and Carbon Data, Delmarva Bay Study PCC sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
ML DB1	BC	114	1.82	0.10	0.04	0.00
ML DB1	Cg	155	--	--	0.03	0.00
ML DB2	Ap	27	1.26	0.06	3.60	0.31
ML DB2	Bg	52	1.45	0.11	0.67	0.13
ML DB2	2Bg2	84	1.75	0.01	0.03	0.00
ML DB2	2BCg	113	1.71	0.10	0.07	0.03
ML DB2	3Cg	190	--	--	0.55	0.02
ML DB3	Ap	18	1.19	0.03	4.25	0.19
ML DB3	A	28	1.41	0.01	1.28	0.14
ML DB3	Bg	44	1.54	0.14	0.48	0.10
ML DB3	2Bg2	70	1.79	0.00	0.09	0.01
ML DB3	2BC	85	1.75	0.05	0.11	0.08
ML DB3	3CB	109	1.85	0.02	0.07	0.02
ML DB3	4CB	123	--	--	0.03	0.00
ML DB3	4Cg	170	--	--	0.03	0.00
ML DB4	Ap1	21	1.55	0.02	1.75	0.10
ML DB4	Ap2	33	1.59	0.06	1.29	0.13
ML DB4	AB	53	1.65	0.01	0.34	0.08
ML DB4	Bw	86	1.78	0.02	0.05	0.02
ML DB4	Ab	102	--	--	0.08	0.01
ML DB4	Bwb	168	--	--	0.08	0.01
ML DB4	C	185	--	--	0.04	0.00
ML DB5	Ap	23	1.52	0.07	0.57	0.05
ML DB5	Bw	50	1.77	0.04	0.09	0.00
ML DB5	BC	91	1.74	0.02	0.02	0.00
ML DB5	CBg	110	--	--	0.01	0.00
ML DB5	C1	140	--	--	0.02	0.00
ML DB5	C2	180	--	--	0.02	0.00
BT DB1	Ap1	22	0.99	0.01	8.56	0.46
BT DB1	Ap2	33	0.76	0.00	13.28	0.71
BT DB1	A	58	0.82	0.11	16.35	6.21
BT DB1	Bg	105	1.32	0.01	0.94	0.12
BT DB1	BCg	161	--	--	1.39	0.01
BT DB1	CBg	195	--	--	1.36	0.00
BT DB2	Ap1	8	1.02	0.07	7.39	0.95
BT DB2	Ap2	27	0.94	0.02	9.73	0.56
BT DB2	A1	44	0.51	0.06	22.75	3.50
BT DB2	A2	66	1.03	0.06	6.04	0.59
BT DB2	Bg1	105	1.40	0.01	0.91	0.14

Appendix B: Bulk Density and Carbon Data, Delmarva Bay Study PCC sites, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
BT DB2	Bg2	165	--	--	1.31	0.01
BT DB2	BCg	190	--	--	1.62	0.02
BT DB3	Ap1	22	0.85	0.01	10.33	0.97
BT DB3	Ap2	38	1.08	0.21	4.41	1.51
BT DB3	Bg1	100	1.50	0.08	0.29	0.10
BT DB3	BCg	145	--	--	0.18	0.00
BT DB3	CBg	190	--	--	0.32	0.01
BT DB4	Ap1	23	1.43	0.04	1.90	0.06
BT DB4	Ap2	40	1.47	0.01	2.22	0.42
BT DB4	Bw	62	1.71	0.00	0.09	0.01
BT DB4	BCg	83	1.74	0.03	0.05	0.00
BT DB4	CB	120	1.77	0.08	0.03	0.00
BT DB4	C	180	--	--	0.02	0.00
BT DB5	Ap	21	1.54	0.09	0.57	0.04
BT DB5	Bt1	40	1.79	0.05	0.08	0.01
BT DB5	Bt2	74	1.61	0.04	0.05	0.01
BT DB5	C1	120	1.55	0.02	0.02	0.01
BT DB5	C2	163	--	--	0.01	0.00
BT DB5	C3	195	--	--	0.01	0.00

Appendix D: Profile Descriptions, CEAP

DEK-PC-Me 8/26/2010
Kent County, DE
Mapped Soil Series: Othello
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	28	SiL (SiL)*	12 (14)*		10YR 3/2	
Bg	45	CL (L)*	31 (26)*	medium, prom, 28%	10YR 6/2 7.5YR 5/6	
2Bg2	66	SCL (SL)*	30 (19)*	medium, prom, 10%	2.5Y 6/2 7.5YR 5/6	
2Bg3	108	SC (SCL)	38 (30)	medium, prom, 5% medium, prom, 1%	2.5Y 6/2 7.5YR 5/8 5YR 4/6	
3Bg4	115	C (CL)	46 (38)	medium, prom, 18%	2.5Y 7/2 10YR 6/6	
4BCg	135	SCL (SCL)	25 (21)	med-co, prom, 20%	10YR 7/2 7.5YR 4/6	favors bottom
5CBg	162	C (CL)	46 (38)	coarse, prom, 10%	2.5Y 7/1 10YR 6/8	favors top
6Cg	190+	SL	8		5Y 6/2	2% ilmenite

Additional Notes
Bulk Density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric soils indicators: A11

Water Table Depth
8/12/2010 180 cm

DEK-PC-Me 8/26/2010

Kent County, DE

Mapped Soil Series: Othello

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	28	SiL	12		2.5Y 3/2	
Bg	52	CL	31		2.5Y 8/1	
		(L)	(26)	med-co., prom, 30%	10YR 5/6	
				coarse, prom, 25%	2.5Y 5/2	
2Bg2	76	SCL	24		2.5Y 6/2	
		(SL)	(19)		7.5YR 5/8	
2Bg3	112	CoSL	10		2.5Y 7/2	
				medium, prom, 15%	7.5YR 5/8	
				medium, prom, 2%	5YR 4/6	
2C	185+	S	2		2.5Y 7/3	Ilmenite

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

8/26/2010 not reached

DEK-PC-RS 11/3/2009

Kent County, DE

Mapped Soil Series: Carmichael

Profile A (Basin)

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	24	L (SL)*	10 (6)*		10YR 3/2	
Bg1	60	SL	11		2.5Y 7/2	
				medium, 12%	7.5YR 5/8	
Bg2	91	SL	12		7.5YR 7/2	
		(SL)*	(9)*	medium, 2%	7.5YR 5/8	
BCg	152	LS	2		2.5Y 7/21	
					10YR 6/8	
Cg	190+	LS	2		2.5Y 7/1	Ilmenite

Additional Notes

next to center of puddle, outside of puddle

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

11/3/2009 18 cm

DEK-PC-RS 11/3/2009
Kent County, DE
Mapped Soil Series: Ingleside
Profile B
Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	24	L	10		10YR 3/2	
Bg1	61	fSL	14		2.5Y 6/2	
				medium, 15%	7.5YR 5/8	
Bg2	110	fSL	3		2.5Y 6/1	Firm
				medium, 25%	7.5YR 5/8	
CBg	150	LfS	3		2.5Y 7/2	Ilmenite
C	167+	LfS	3		2.5Y 7/3	ilmenite

Additional Notes
10m farther from profile A, away from road
Soil Drainage Class: poorly drained
Hydric soils indicators: F3
Water Table Depth
11/3/2009 29 cm

DEK-PC-RS 11/3/2009
Kent County, DE
Mapped Soil Series: Ingleside
Profile C
Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	28	LS	5		10YR 4/4	
BE	60	LS	5		2.5Y 6/3	
Bw1	94	LS	5		10YR 6/4	
				medium, 5%	7.5YR 5/8	
				medium, 5%	10YR 6/2	
Bw2	110	LS	2		10YR 6/6	
				medium, 5%	7.5YR 5/8	
				medium, 5%	10YR 7/3	
BCg	135+	LS	2		2.5Y 7/2	
				medium 3%	10YR 5/8	

Additional Notes
12m farther from profile B
Soil Drainage Class: moderately well drained
Hydric soils indicators: none
Water Table Depth
11/3/2009 82 cm

DEK-PC-RS 11/3/2009

Kent County, DE

Mapped Soil Series: Unicorn

Profile D

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	24	LS	4		10YR 4/4	
BE	48	SL	8		10YR 6/4	
Bw1	74	SL	11		10YR 5/6	
				fine, 1%	7.5YR 5/6	
Bw2	100	SL	12		10YR 5/6	
				medium, 7%	7.5YR 5/8	
Bw3	145	SL	8		10YR 6/6	
				11%	7.5YR 5/8	
				8%	10YR 6/2	
BC	177	LS	5		2.5Y 7/4	
				medium, 5%	7.5YR 6/8	
				medium, 3%	2.5Y 7/3	
CB	195+	LS	2		2.5Y 7/4	
				medium, 7%	10YR 6/8	
				medium, 9%	2.5Y 7/2	

Additional Notes

10m farther from profile C

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Water Table Depth

11/3/2009 144 cm

DEK-PC-Stn 6/17/2011
Kent County, DE
Mapped Soil Series: Hurlock
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	15	SiL (SiL)	15 (26)*		7.5YR 3/1	
Ap2	27	SiL	18		10YR 2/2	
			(25)	fine, distinct, RP, 3%	7.5YR 4/6	
A	45	SiL	18		10YR 2/1	
			(25)	fine, distinct, RP, 3%	7.5YR 4/6	
Ag	60	SiL	21		10YR 4/2	
		(L)*	(23)*	medium, distinct, 2+%	10YR 5/6	
				medium, distinct, 14%	7.5YR 3/1	
Bg	85	SiL	14		2.5Y 6/2	
			(25)	med-fine, prom, 30%	2.5Y 6/4	
				m, prom, root ch, 10%	10YR 5/6	
				5%	7.5YR 3/1	
BCg	101	SiL	13		5Y 7/1	
		(SiCL)*	(29)*	f, prom, root ch, 12%	2.5Y 7/6	
CBg	118	SiL	10		5Y 5/1	
			(25)	medium, distinct, 6%	2.5Y 6/6	
2C1	14	LS	4		10YR 4/2	
2C2	163	LS	2	coarse, 60%	2.5Y 5/3	
				coarse, 40%	2.5Y 4/1	
2C3	170+	LS	2		2.5Y 7/6	
				co, prominent, 20%	10YR 6/8	

Additional Notes
Bulk Density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric soils indicators: None, almost A12 (Ap1 0.5 value too high)
and almost F6 (needs 5% concentrations in Ap2)
10 m on Deer Antler Rd side of ditch

Water Table Depth
6/17/2011 38 cm

DEK-PC-Stn 6/17/2011
Kent County, DE
Mapped Soil Series: Hurlock
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	18	SiL	15		10YR 3/1	
			(25)	f, distinct, root ch, 4%	10YR 5/6	
A	29	SiL	18		10YR 2/1	
			(25)	f, prom, root ch, 1%	5YR 4/6	
AB	43	SiCL	35		7.5YR 3/1	
				fine, prominent, 7%	7.5YR 4/6	
				med, prominent, 24%	2.5Y 6/4	
Bw	68	SiCL	37	50%	7.5YR 5/8	
				med, prominent, 27%	2.5Y 6/6	
				coarse, prominent, 5%	2.5Y 7/1	
				med, prominent, 18%	7.5YR 3/1	
Bw2	107	SiL	24	co, prominent, 65%	7.5YR 5/8	
				medium, distinct, 14%	2.5Y 6/6	
				med, prominent, 18%	2.5Y 7/1	
				fine, prominent, 3%	7.5YR 2/1	
BCg	129	SiL	12		5Y 6/1	
				f, prom, root ch, 12%	10YR 5/6	
				f, prom, root ch, 3%	10YR 2/1	
CBg	145	SiL	10		5Y 5/1	
				f, prom, root ch, 9%	10YR 5/6	
				f, prom, root ch, 3%	10YR 2/1	
Cg1	175	SiL	8		2.5Y 4/2	
				f, prom, root ch, 7%	10YR 5/6	
				f, prom, root ch, 3%	10YR 2/1	
Cg2	190+	SiL	8		5Y 4/1	
				med, prominent, 4%	10YR 2/1	oozing black stuff

Additional Notes

Soil Drainage Class: poorly drained
Hydric soils indicators: F6
10m on house side of ditch

Water Table Depth

6/17/2011 185 cm

DEK-R-Jr 8/5/2010

Kent County, DE

Mapped Soil Series: Corsica

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	6	L	7		2.5Y 3/1	
Bg	40	LS	4		2.5Y 5/2	
				Co-med, prom, 35%	10YR 6/6	
Bg2	71	SL	10		2.5Y 7/1	
				med, prominent, 5%	10YR 6/8	
Bg3	104	SL	10		10YR 6/2	
				med-f, prominent, 25%	10YR 5/6	
2BCg	155	SC	38		2.5Y 7/2	Firm
				fine, prominent, 10%	10YR 6/8	
2CBg	185+	C	43		5Y 6/2	Very Firm

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

8/5/2010 4 cm above surface

DEK-R-Jr 8/5/2010

Kent County, DE

Mapped Soil Series: Corsica

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	6	L (L)*	10 (13)*		2.5Y 3/2	
Ap	24	L (L)*	11 (16)*	 medium, distinct, 8%	2.5Y 4/1 10YR 5/6	
Bg1	54	LS	6	 med, prominent, 10%	2.5Y 7/1 10YR 5/6	
Bg2	77	SL (SL)*	10 (14)*	 med, prominent, 10%	2.5Y 7/1 10YR 5/6	
Bg3	125	LS	4	 med, prominent 15% coarse, 15%	2.5Y 6/2 10YR 7/6 10YR 5/6	
2BCg	159	C	42	 fine, prominent, 30%	5Y 7/2 10YR 6/8 10YR 6/6	
2CBg	190+	CL	36	 fine, prom, root ch, 1%	10Y 7/1 10YR 6/8	

Additional Notes

Bulk Density collected in association with this profile

Water near surface, but actual water table deeper.

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

8/5/2010 45 cm

DEK-R-Sg 6/30/2010

Kent County, DE

Mapped Soil Series: Fallsington

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	10	L	12 (6)		2.5Y 4/1	
Bg1	74	SL	11		2.5Y 5/1	
			(6)	medium, 18%	7.5YR 5/6	
Bg2	116	fSL	8		2.5Y 8/1	
				fine, 3%	7.5YR 5/6	
2Bg3	126	VGrSL	6		10B 4/1	38% gravels
3BCg	137	LS	4		5Y 8/2	
3CB	151	SiL	10		2.5Y 7/4	
					7.5YR 5/8	
3Cg1	168	SL	16		2.5Y 8/2	
3Cg2	185+	LfS	3		2.5Y 8/1	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

10 m into water from Profile B

Water Table Depth

6/30/2010 30cm above surface

DEK-R-Sg 6/30/2010
Kent County, DE
Mapped Soil Series: Fallsington
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
^AC	4	S (S)*	1 (0)*		2.5Y 5.5/2	
A	41	L (SL)*	12 (6)*		2.5Y 4/1	
Bg	65	SL (SL)*	16 (7)*	 med-co, prom, 15% med, prominent, 10%	2.5Y 7/1 2.5Y 7/6 10YR 5/6	
BCg	116	LS	6	 med, prominent, 1%	2.5Y 7/1 10YR 6/6	
Cg1	140	LfS	5		10YR 8/1	
Cg2	169	LS	4		2.5Y 8.5/1	
C	174	SiL	10	 co, prominent, 45%	5Y 8/3 10YR 6/8	
Cg3`	185	SL	6		N 5/0	8% gravels
Cg4`	190+	GrLS	3	 med, prominent, 3% coarse, 5%	5Y 8/2 10YR 6/8 2.5Y 7/4	20% gravels

Additional Notes
Bulk Density collected in association with this profile
located on an island
Soil Drainage Class: poorly drained ?
Hydric soils indicators: none

Water Table Depth
6/30/2010 not reached

DEK-R-Sg 6/30/2010

Kent County, DE

Mapped Soil Series: Fallsington

Profile C Upland

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	37	SL	10		10YR 4/2	
Btg1	61	SCL	19		2.5Y 4/1	
				med, prominent, 9%	10YR 6/6	
Btg2	109	L	23		10YR 6/1	
				Med, prominent, 23%	10YR 5/6	
BCg	172	SL	14		5Y 6/2	
				fine, prominent, 1%	10YR 6/8	
CBg	185+	fSCL	19		2.5Y 8/1	
				fine, prominent, 4%	10YR 7/8	

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

6/30/2010 not reached

DENC-N-BB 9/29/2009

New Castle County, DE

Mapped Soil Series: Hammonton-Fallsington-Mullica Complex

Hole A

Description conducted by Daniel Fenstermacher and Rosalynd Orr

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	2			5YR 2.5/1	
Oa	10			10YR 2.5/1.5	
A1	39	(SL)*	(12)*	5YR 2.5/1	
A2	68	(L)	(15)	10YR 2/1	
AB	105	(L)*	(17)*	10YR 2.5/1	Firm
Bg	155	(L)	(17)	5Y 5/2	High N value
				5Y 5/1	
BCg	187	(SiL)	(17)	2.5Y 4/2	
CBg	210+	(SiL)	(17)	2.5Y 4/1	

Additional Notes

~10m in from forest line

While poking around, random pockets of sandy material at varying depths

Bulk density collected in association with this profile

Soil drainage class: very poorly drained

Hydric Soils indicators: A12, F13

Water Table Depth

At surface

DENC-N-BB 9/29/2009
New Castle County, DE
Mapped Soil Series: Hammonton-Fallsington-Mullica Complex
Hole B
Description conducted by Daniel Fenstermacher and Rosalynd Orr

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oi	3			5YR 2.5/2	
A1	42	SL	10	7.5YR 2.5/1	Uncoated sand grains
A2	72	Sl	12	7.5YR 2.5/1	75% less uncoated sand grains compared to above
Bh	105	LS	5	7.5YR 3/3	
Bh/BC	133	LS	4	Bh 7.5YR 4/3 BC 10YR 4/3	
BC	193+	LS	2	10YR 5/4	

Additional Notes
~10m into woods
Soil drainage class: very poorly drained
Hydric Soils indicators: None
Water Table Depth
9/29/2009 85cm

DENC-N-BB 9/29/2009
New Castle County, DE
Mapped Soil Series: Ingleside
Hole C
Description conducted by Daniel Fenstermacher and Rosalynd Orr

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	5			7.5YR 2.5/2	
A	10	SL	10	10YR 4/3	
AE	21	SL	12	10YR 5/4	
BE	44	SL	10	10YR 6/6	
Bt1	68	SL	12	10YR 5/6	
Bt2	117	fSCL	23	7.5YR 5/6	
Bt3	158	fSCL	23	7.5YR 6/6 10% 10YR 7/3 3% 7.5YR 5/6	Lamellae present
CB	178	LfS	3	7.5YR 5/8	
CB	195+	LfS	3	10YR 6/8	

Additional Notes
~ 30m up from hole B, near road.
Soil drainage class: well drained, no wet substratum
Hydric Soils indicators: none
Water Table Depth
9/29/2009 did not reach

DENC-R-As 7/27/2010

New Castle County, DE

Mapped Soil Series: Hammonton-Fallsington-Mullica Complex

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	1	-	-		2.5Y 4/2	
Ap	13	SiL	15		10YR 6/2	platy
				med prominent 24%	7.5YR 5/6	
EBg	25	L	16		2.5Y 8/1	
				med-co, prom, 30%	10YR 6/6	
Bw	47	L	14		7.5YR 5/8	
				med, prominent, 15%	2.5Y 7/2	
Bg	68	L	18		10YR 6/2	Hard pieces
				medium, faint, 15%	10YR 6/3	of soil
BCg	101	SL	10		2.5Y 7/2	
				fine, distinct, 18%	10YR 6/6	
CBg	130	SL	8		2.5Y 7/4	
				med, prominent, 12%	10YR 5/6	
				medium, distinct, 20%	2.5Y 7/2	
Cg	185+	LS	3		2.5Y 7/3	10% ilmenite

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

7/27/2010 156 cm

DENC-R-As 7/27/2010

New Castle County, DE

Mapped Soil Series: Hammonton-Fallsington-Mullica Complex

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A1	8	LS (L)*	8 (14)*		5Y 4/2	
A2	19	L (L)*	12 (15)*		5Y 5/3	
Bg1	33	SiC (SiCL)*	42 (31)*	med, prominent 30%	5Y 5/1 7.5YR 5/6	sandy on ped faces
Bg2	90	SiL (SiL)	12 (26)*	med, prominent 40%	5Y 6/2 7.5YR 5/6	
Bw	120	SiL	15 (27)	nodules, 3% med, prominent, 45% medium, faint, 10%	2.5Y 6/3 5YR 4/6 7.5R 5/6 2.5Y 6/2	
BCg	190+	SiL	10 (20)	30% nodules, 2%	2.5Y 7/1 7.5YR 5/6 5YR 4/6	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

7/27/2010 166 cm

MDC-N-AB 10/1/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Hole A

Description conducted by Daniel Fenstermacher and Phil Z

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	9	-	-		5YR 2.5/2	
Oa	22	-	-		10YR 2/1	
A1	53	SiL*	(16)*		10YR 2/1	Very organic
A2	72	SiL	12 (17)		2.5Y 2.5/1	
BCg	150	SiL*	10		5Y 5/1	Gradual change
			(19)*	f, prom, root ch 15%	10YR 5/8	from 5/1 to 4/1
					5Y 4/1	with depth
		pockets:		10%	5YR 4/6	
		L	10		10YR 5/2	sand lenses

Additional Notes

~10m in from forest line

Bulk Density collected in association with this profile

Soil Drainage Class: very poorly drained

Histic Epipedon

Hydric soils indicators: A2

Water Table Depth

10/1/2009 47cm above ground

MDC-N-AB 10/1/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Hole B

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	7	-	-		7.5YR 2.5/3	
A	30	Mucky L/SL	10		10YR 2/1	
AEg	56	SL	8		10YR 4/1	
Bg	104	SCL	20		2.5Y 6/2	
				10%	10YR 6/6	
				2%	10YR 6/8	
BC	126	SL	9		10YR 6/8	
				10%	5Y 6/2	
CBg	142+	SL	8		5Y 7/1	
				med, prom, 8%	10YR 6/6	
				fine, prominent, 2%	7.5YR 6/8	

Additional Notes

Located ~30m into woods

~ 5m into woods, loamy surface going to sandy textures at 40cm dark to 50cm

Soil Drainage Class: poorly drained

Hydric soils indicators: A7, A11

Water Table Depth

10/1/2009 20cm

MDC-N-AB 10/1/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Hole C

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	5	-	-	5YR 3/2	
A	23	SL/L	10	2.5Y 2.5/1	Uncoated Sand Grains
AE	47	SL	8	10YR 4/2 10YR 3/2	
Bh	61	SL	8	5YR 3/3	
Bhs	71	LS	7	2.5YR 2.5/2	
Bhsm	79	LS	7	2.5YR 2.5/1	
Bs`	93	LS	6	7.5YR 3/2	
BC	114	LS	6	2.5Y 6/3	
CB	143	SL	17	10YR 5/8 2.5Y 7.5/1	
Cg	156+	SL	8	2.5Y 5/1 fine, few, prominent 7.5YR 5/8	

Additional Notes

7m up hill from hole B, highest point around just before ditch

Soil Drainage Class: well drained

Hydric soils indicators: none

Water Table Depth

10/1/2009 62cm

MDC-N-BC 9/10/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Pond

Description conducted by Daniel Fenstermacher and Dr. Rabenhorst

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	5	-	-	5YR 2.5/1	
Oa	50	-	-	10YR 2/1	
A	70	SL (LS)*	15 (6)*	10YR 2/2	
Bg	97	SL*	15 (14)*	2.5Y 3/2	
Cg1	116	LS	3	2.5Y 4/1.5	
2Cg2	125	SL	12	2.5Y 4/1	
3Cg3	157	SiL	20	2.5Y 5/1	Few sand lenses N>1
4Cg4	157+	LS		10Y5/1	No sample

Additional Notes

Bulk density collected in association with this profile

Used peat sampler for Oe and Oa

4m from 3 wells and 10m from depth measure, under maple branch in water

Drainage class: very poorly drained

Hydric soils indicators: A1

Water Table Depth

9/10/2009 40 cm above surface

MDC-N-BC 9/10/2009
Caroline County, MD
Mapped Soil Series: Hammonton-Fallsington-Corsica Complex
Mid
Description conducted by Daniel Fenstermacher and Dr. Rabenhorst
14m at 272 deg from pond hole

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	7	-	-	5YR 2.5/1	
A	20	LS	10	10YR 2/1	
Bh	35	LS [SL?]	9	10YR 2/2	Texture questionable due to organics
Bhs	45	LS [SL?]	8	10YR 3/2	Texture questionable due to organics
Bhs2	58	LS	4	10YR 3/3	
BC	82	LS	4	10YR 5/3	
Cg	96	LS	4	2.5Y 5/2	
Cg2	106+	LS	4	5Y 6/2	

Additional Notes
Drainage class: very poorly drained
Hydric soils indicators: None
Water Table Depth
9/10/2009 20 cm

MDC-N-BC 9/10/2009
Caroline County, MD
Mapped Soil Series: Ingleside
Upper Profile
Description conducted by Daniel Fenstermacher and Dr. Rabenhorst
14m at 328 deg from mid hole

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	5	-	-	5YR 2.5/1	
A	18	LFS/FSL	NR	10YR 3/2	
Bw	44	LS/SL	NR	10YR 4/3	
Bw2	75	LS	NR	2.5Y 5/6 Distinct, 10% 10YR 5/8	
BC	98	LS	NR	2.5Y 6/4 Common, faint 2.5Y 6/3	
Cg	132+	LS	NR	2.5Y 6/2 Distinct 15% 2.5Y 5/4	

Additional Notes
Drainage class: moderately well drained
Hydric soils indicators: none
NR = Not Recorded for % clay
Water Table Depth
9/10/2009 20 cm

MDC-N-BeW 10/8/2009

Caroline County, MD

Mapped Soil Series: Woodstown

Hole A

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	8	-	-		5YR 3/2	
A1	30	L (SL)*	10 (19)*		10YR 3/2	
A2	54	L	10		10YR 3/2	
		(L)*	(23)*	medium 5%	7.5YR 4/6	
					7.5YR 3/4	
				medium 2%	10YR 5/1	
Bg1	86	SiL	18		2.5Y 4/1	
		(C)*	(44)*	med dist 30%	7.5YR 3/4	
				med prom 15%	7.5YR 5/6	
2Bg2	116	SCL	22		10YR 4/1	
		(SL)*	(17)*	med prom 20%	7.5YR 6/8	
				med dist 7%	7.5YR 3/4	
2CBg	128	SL	14		5Y 6/1	
		(L)*	(21)*	med prom 7%	10YR 6/8	
					10YR 4/6	
3Cg1	141	SiL	(17)		5Y 6/2	N>1
				Fine,	10YR 4/6	
					10YR 7/8	
				fine centers	5YR 3/4	
4Cg2	154	SL	10		5Y 6/2	
				med prom 13%	5YR 4/6	
				13%	7.5YR 5/6	
					2.5Y 4/4	Loamy sand lens
5Cg3	200+	SiL	18		5Y 5/2	
				favor bottom, 5%	5Y 3/4	ped faces
				favor top, 8%	7.5YR 5/8	ped faces

Additional Notes

Center of wetland

Soil Drainage Class: poorly drained

Hydric soils indicators: none

Misses F13 by 1 chroma, and A12 by 0.5 value

Water Table Depth

10/8/2009 8 cm

MDC-N-BeW 10/8/2009

Caroline County, MD

Mapped Soil Series: Woodstown

Hole B

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	5	-	-		7.5YR 3/2	
A	17	L	10		7.5YR 4/1	
AE	36	L	8		10YR 4/1	
Bg	81	SCL	33		2.5Y 4/1	
				med prom 15%	7.5YR 4/6	
				med prom 2%	7.5YR 7/8	
				med faint 2%	2.5Y 5/1	
BC	95	SCL	33		2.5Y 3/1	
				med prom 8%	7.5YR 4/4	
				few fine prom	7.5YR 5/8	
2CBg	175+	SiL	18		5Y 5/1	
				med prom 12%	10YR 7/6	
				core of above 8%	5YR 5/6	

Additional Notes

9m towards Road, located in wetland right before rising up and out

Infilling of old root channels with sandier darker material (3cm x 10cm root channel)

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

10/8/2009 73 cm

MDC-N-BeW 10/8/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Hole C

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	-	-		2.5YR 2.5/2	
A	19	SL	10		10YR 3/1	some unmasked sand grains
E	30	SL	8		2.5Y 5.5/2	
Bg1	54	SL	10		2.5Y 6/2	
				med, prominent 17%	10YR 7/8	
				med, prominent 10%	7.5YR 5/8	
2Bg2	71	SC	38		2.5Y 5/2	
				7%	5YR 4/6	
				2%	10YR 6/8	
				few	2.5Y 6/1	
3Bg3	78	LS	7		2.5Y 6/1	
3Bg4	107	SL	10		2.5Y 5/1	
				4%	2.5Y 6/1	
				few med prom	7.5YR 6/8	
3BCg	115	LS	7		2.5Y 6/1	
				med distinct 8%	7.5YR 5/8	
3Cg	123	LCoS	7		5Y 8/1	
3C1	135	LCoS	7		7.5YR 5/6	
3C2	157+	LS	7		2.5Y 6/3	

Additional Notes

~ 20m up from hole B toward road

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

9/29/2009 63 cm

MDC-N-JL 8/7/2009

Caroline County, MD

Mapped Soil Series: Corsica

Profile A (Basin)

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4	-	-			
A	22	L	10		10YR 2/1	Friable
Bg1	39	L	14		2.5Y 5/1.5	
				15%	2.5Y 4/1	
				f, prominent, 35%	10YR 4/6	Firm
Bg2	58	SiL	16		2.5Y 5/1	Firm
				many, f, promt, 40%	7.5YR 5/8	
Bg3	84	SCL	24	50%	10YR 4/1	Very Firm
				40%	2.5Y 7/1	
				prominent, 10%	10YR 5/6	
Bg4	99	CL	28	45%	2.5Y 7/1	Very Firm
					10YR 5/1	
				few, prom, root ch	7.5YR 5/8	
2Bg5	115	CoSL	18		10YR 5/1	
				few	5PB 4/1	
				5%	7.5YR 4/6	
2Cg1	148	SL, 10% Gr	8	10%	7/N	> mixed matrix
					2.5Y 7/1	
					2.5Y 6/2	
				10%	2.5Y 6/4	
				8%	10YR 4/1	
2Cg2	166	FSL	15		N 7/0	occasional Decomposing Root Channels
2Cg3	190+	LCoS	3		5Y 7/1	Very Soupy (structureless)
				Few, f, prom, root ch	7.5YR 5/8	
					2.5Y 4/1	Contamination?

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: A11, F13

Water Table Depth

8/7/2009 ponded

MDC-N-JL 8/7/2009

Caroline County, MD

Mapped Soil Series: Corsica

Profile B (mid)

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay		Color	Notes
Oi	5	-	-			
A	37	L	10		10YR 2/1	mucky modified? friable
AE	49	SL	8		2.5Y4/2	
				30%	5Y 6/2	Friable
				10%	10YR 3/1	
EA	63	SL	6	80%	5Y 6/2	Friable
				20% om mixing	10YR 3/1	
E	82	LS	4	Very Friable	5Y 6/1	some thin stratified OM
Bg1	107	CL	31		5Y 6/1	firm
				prom, root ch.35%	10YR 5/6	
Bg2	142	FSL	16		5Y 7/1	Center, fine
				prominent 10%	7.5YR 5/8	Outer, medium
					10YR 5/8	firm
Cg1	158	FSL	12		5Y 7/2	
				f, prom, root ch. 2%	10YR 5/8	Firm
				few faint medium	5Y 6/4	
Cg2	172	LS	4	80%	2.5Y 5/2	Friable
				20% from above	5Y 7/2	
Cg3	185+	SL	8		5Y 7/2	
				faint 10%	5Y 7/1	

Additional Notes

Located 20 m from hole A through woods

Soil Drainage Class: poorly drained

Hydric soils indicators: A12, F13

Water Table Depth

8/7/2009 Not recorded

MDC-N-JL 8/7/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica complex

Profile C (Rim)

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay		Color	Notes
Oi	8	-	-			
A	25	SL/L	10		2.5Y 3/3	Friable
				medium 6%	10YR 3/6	
Bw1	48	SL	8		2.5Y 5/6	Very Friable
				common medium	10YR 5/6	
Bw2	70	SL	7		2.5Y 5/4	
				distinct 15%	10YR 5/6	
				Prominent 5%	10YR 5/8	
BC	112	LS	4		5Y 5/3	
				common coarse	2.5Y 5/4	
					2.5Y 5/3	matrix changes to
BC	143	LS	4	20%	2.5Y 5/3	
					10YR 3/6	
CB	160+	LS	3	20%	10YR 4/6	
					5Y 5/3	

Additional Notes

Located 50 m from profile 1, along transect with 3, on top of rim

Soil Drainage Class: well drained, no wet substratum

Hydric soils indicators: none

Water Table Depth

8/7/2009 Not recorded

MDC-PC-BeF 7/23/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica Complex

Profile A (Basin)

Description conducted by Daniel Fenstermacher and Dr. Martin C Rabenhorst

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	36	SiL/L (L)*	11 (27)*		10YR 2/1	
A1	58	SiL (SiCL)	17 (36)	darker than 15% distinct	N 2.5/0 10YR 2/1 10YR 3/3	
A2	89	SiL (C)*	23 (44)*	 25% Distinct	2.5Y 2/1 10YR 3/3	
Bg1	108	SiCL (C)	28 (41)	60% 30% 10% prominent	2.5Y 6/2 N2.5 7.5YR 4/6	
Bg2	130	SiL (SiCL)*	22 (33)*	 20%	2.5Y 5/2 5YR 4/6 7.5YR 4/6	N<0.7 loosing structure
BC	165	SiL	18 (25)	50% 35% 15%	2.5Y 4/3 2.5Y 5/1 5YR 4/6 7.5YR 4/6	
Cg1	185	SiL	18 (25)	50% 50% upper part some	5GY 4/1 5Y 4/1 7.5YR 4/1	Striations
Cg2	245	SiL	18 (25)		2.5Y 4/1	0.7<N<1
Cg3	285+	SiL	18 (25)		5Y 5/1	Sand Lenses 2.5mm Distinct

Additional Notes

Augering located between center and edge of basin

Transect conducted at 122º

Bulk Density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Water Table Depth

7/23/2009	50cm
9/10/2009	just under surface
3/9/2010	ponded
4/6/2010	ponded
5/4/2010	ponded

MDC-PC-BeF 7/23/2009

Caroline County, MD

Mapped Soil Series: Hammonton-Fallsington-Corsica complex

Profile B (Mid)

Description conducted by Daniel Fenstermacher and Dr. Martin C Rabenhorst

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	23	SiL	11		10YR 2/1	
A	33	SiCL	30		10YR 1/1	
AB	57	SiCL/SiL	27		2.5Y 2.5/1	
				5%	10YR 5/6	
Bg1	75	SiL	24		2.5Y 5/2	
				Conc = 5% total	7.5YR 4/6	
					10YR 5/6	
				10%	2.5Y 5/2	
Bg2	95	SiL	22	45%	10YR 5/8	
				20%	7.5YR 4/6	
				20%	2.5Y 5/2	
				15%	2.5Y3/1	
Cg1	107	SiL	23		5Y 5/1	
				3% total prom	10YR 5/6	
				Faint	2.5Y 6/3	
				3%	2.5Y3/1	
2Cg2	140	LS/SL	8		10YR 5/2	
				20% distinct	10YR 4/4	
3Cg3	180	SiL	18		2.5Y 4/2	
				5% total prom	7.5YR 4/6	
				Prom	10YR 5/6	
3Cg4	240+	L	18		5Y 5/1	Several Sandy strata 1-8mm more towards bottom

Additional Notes

Located 10m from Profile A

Transect conducted at 122º

Located halfway in between profiles A and C

Soil Drainage Class: very poorly drained

Hydric soils indicators: A12, F13

Water Table Depth

7/23/2009 Not Recorded

MDC-PC-BeF 7/23/2009

Caroline County, MD

Mapped Soil Series: Ingleside

Profile C (out of basin)

Description conducted by Daniel Fenstermacher and Dr. Martin C Rabenhorst

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	27	SL	8		10YR 3/2	
BEg	60	SL	9	45%	2.5Y 5/1	clayey material
				45%	2.5Y 6/2	
				10% Prom	7.5YR 4/6	with 5/1material
Btg1	80	SL	18		2.5Y 5/1	
				30% prom.	7.5YR 4/6	
					2.5YR 5/4	
Btg2	118	SCL/L	24		5Y 6/1	
				3% prom.	7.5YR 4/6	
				2% prom.	10YR 5/6	
Btg3	138	SCL	23		2.5Y 5/1	
2BCg	154	SCL/SC	35		10YR 5/2	
				10%	7.5YR 4/6	
2Cg	180	SC/C	45		10Y 5/1	Wood Fragments upper 5cm 10%
3Cg	200+	LFS	4		2.5Y 6/1	Light and fluffy

Additional Notes

Water Perched on top of clayey zone with wood frag. (2Cg)

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Additional Augerings

Profile D 10m up From Profile C
Depletions just below Ap
Herlock Poorly drained
no hydric soils indicator

Profile E 20m up from Profile C
Surface less dark
Brown Ap over light brown Bw
5% Grey depletions at 40cm=somewhat poorly drained
no hydric soils indicator

MDC-PC-Cr 11/3/2009

Caroline County, MD

Mapped Soil Series: Hurlock

Profile A (Basin)

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	40	L	12		10YR 3/2	
		(SL)*	(12)*	fine 2%	7.5YR 4/4	
				med faint 1%	10YR 4/2	
ABg	66	SL	19		10YR 5/2	
		(SL)*	(18)*	med 8%	7.5YR 4/6	
				med 5%	2.5Y 6/4	
Bg1	102	SCL	24		2.5Y 6/1	
		(SCL)*	(21)*	4%	7.5YR 5/6	
				15%	2.5Y 7/4	
Bg2	136	fSL	15		2.5Y 6/1	
		(L)*	(13)*	fine 2%	10YR 5/6	
				medium 5%	2.5Y 6/4	
CBg	176+	LCoS (S)*	2 (4)*		2.5Y 6/2	

Additional Notes

next to center of puddle, outside of puddle

Bulk Density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: none

Too deep for F3

Not dark enough for A12 or F13

Water Table Depth

11/3/2009 18 cm

MDC-PC-Cr 11/3/2009
Caroline County, MD
Mapped Soil Series: Hurlock
Profile B
Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	18	L	11		10YR 3/2	
				fine 1%	7.5YR 3/3	
Ap2	36	L	12		10YR 4/2	
				v. fine 2%	7.5YR 4/3	
				fine 1%	10YR 5/2	
AB	64	SL	16		10YR 4/2	
				fine 5%	7.5YR 4/6	
				med 8%	2.5Y 6.5/1	
Bg	105	LfS	18		2.5Y 6.5/1	
				fine 2%	7.5YR 5/6	
				fine 5%	2.5Y 7/4	
Ab	123	SCL	25		10YR 5/2	
				med 10%	5YR 4/6	
				med 4%	10YR 6/2	
BCbg	158	LfS	2		10YR 5/2	
				med 4%	10YR 4/6	
CBbg	167+	LCoS	2		10YR 6/2	
				med 1%	10YR 6/6	

Additional Notes

10m away from profile A towards the bend in lane farther down from house
Soil Drainage Class: poorly drained
Hydric soils indicators: F3
eroded material deposited on surface, redox forming in former Ap (Ap2)

Water Table Depth

11/3/2009 29 cm

MDC-PC-Cr 11/3/2009

Caroline County, MD

Mapped Soil Series: Ingleside

Profile C

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	31	L/SL	10		10YR 3/3	
A	54	L	10		10YR 3/2	
				v. fine <1%	10YR 4/4	
				faint <1%	10YR 6/2	
A/B	102	SL	10		10YR 3/2	
				Coarse 45%	2.5Y 6/2	Favors bottom
				fine-med 2%	10YR 6/6	favors top
Bw	130	LfS	8		10YR 5/3	
				med 12%	2.5Y 6/2	
				fine 2%	10YR 4/4	
BC	160	LfS	4		10YR 5/4	
				med 10%	10YR 6/2	
				fine 2%	10YR 4/4	Ilmenite
C	200+	LfS	2		10YR 6/3	Ilmenite

Additional Notes

12m farther from profile B

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

11/3/2009 50 cm

MDC-PC-Cr 11/3/2009

Caroline County, MD

Mapped Soil Series: Ingleside

Profile D

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	32	LS	7		10YR 4/4	
				fine <1%	10YR 4/6	
BE	66	SL	8		10YR 5/6	
				fine 1%	10YR 5/8	
Bt	107	SL	12		10YR 5/8	btwn 10 & 7.5YR
					7.5YR 5/8	btwn 5 & 7.5YR
				pockets 2%	10YR 6/3	
BC	142	LS	3		7.5YR 2.5/2	
				2%	7.5YR 5/8	favors top
CB	172	LS	3		7.5YR 4/4	Ilmenite bands
C	195	LS	3		10YR 5/4	
				med 1%	10YR 4/6	
Cg	200+	LfS	3		2.5Y 6/2	
				fine 2%	10YR 5/6	

Additional Notes

10m up from profile C

Soil Drainage Class: well drained no wet substratum

Hydric soils indicators: none

Water Table Depth

11/3/2009 114 cm

MDC-PC-Hs 10/6/2009
Caroline County, MD
Mapped Soil Series: Lenni
Basin Profile A
Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	19	SiL	18		2.5Y 3/1	
		(L)*	(24)*	few fine	10YR 4/4	
A	30	SiL	25		2.5Y 3/1	
		(L)		fine & med 5%	10YR 4/4	
				few	10YR 4/3	
AB	49	SiL/L	17		10YR 3/1	
		(SCL)*	(26)*	15%	7.5YR 6/8	
				5%	10YR 5/1	
Bg1	66	CL	30		2.5Y 6/1.5	
		(SCL)		10%	10YR 5/8	
				5%	2.5Y 5/6	
Bg2	88	L/SiL	22		2.5Y 6/1	
		(SL)*	(14)*	5%	10YR 5/6	
					2.5Y 5/6	
2CBg	120	LS			2.5Y 6/2	
		(S)*	(3)*	diffuse, 3%	2.5Y 6/6	
2Cg1	142	LS (S)	(3)		2.5Y 5/2	
2Cg2	180+	LS			2.5Y 6/1	
		(S)*	(3)	3%	10YR 5/6	

Additional Notes

Bulk Density collected in association with this profile
Soil Drainage Class: very poorly drained
Hydric soils indicators: F6, F13

Water Table Depth

10/6/2009 38 cm

MDC-PC-Hs 10/6/2009
Caroline County, MD
Mapped Soil Series: Lenni
mid profile B
Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	18	SiL	12		10YR 4/2	
				2%	10YR 4/4	
A	73	SiL	26		2.5Y 2.5/1	
				(inc w/ depth) 8%	10YR 5/6	
				med 5%	2.5Y 6/2	
Bg1	94	SiL	23		2.5Y 6/1	
				3%	10YR 6/6	
				5%	10YR 5/6	
2Bg2	114	SL	15		5Y 6/1	
				15%	10YR 5/6	
					2.5Y 6/6	
2BCg	122	SL	12		2.5Y 6/1	
				2%	10YR 4/6	
2CBg	123+	S?	2?		2.5Y 5/1	auger refusal

Additional Notes
20m up towards well
Soil Drainage Class: very poorly drained
Hydric soils indicators: F6

Water Table Depth

10/6/2009 47 cm

MDC-PC-Hs 10/6/2009

Caroline County, MD

Mapped Soil Series: Woodstown

upland profile C

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	29	SL	10		2.5Y 5/3	
				fine 1.5%	10YR 5/8	
E	64	fSL	8		5Y 7/1	
				5%	10YR 6/8	
					2.5Y 6/6	
EBg	104	SL/SCL	18		2.5Y 7/1	
				medium 7%	10YR 5/8	
BEg	130	SL	15		2.5Y 7/2	
				medium 10%	10YR 6/8	
Bt1	158	SL	17		2.5YR 6/4	Clay Bridging
				medium 20%	10YR 5/8	
				medium 15%	2.5Y 6/1	
Bt2	190+	SL/LS	10		10YR 6/8	
				fine 3%	10YR 5/6	
				2%	2.5Y 7/2	clay lamellae

Additional Notes

10m down from well

upland cs-137

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

10/6/2009 64 cm

MDC-R-Bs 6/15/2010

Caroline County, MD

Mapped Soil Series: Corsica

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	10	SiL	14		10YR 2/1	structureless massive
2Bg1	49	SCL	22		10YR 6/1	
				medium, 15%	7.5YR 6/8	
2Bg2	78	SCL	20		10YR 5/1	
				medium, 10%	10YR 6/8	
				medium, 5%	2.5Y 8/3	
3Bg3	125	SL	10		10YR 5/1	
				medium, 4%	10YR 7/6	
				medium, 3%	10YR 7/3	
3CBg	175+	LS	4		10GY 8/1	
					10GY 7/1	
					10GY 6/1	

Additional Notes

Located next to water depth gauge in pond
Drainage class: poorly drained
Hydric soils indicators: A11

Water Table Depth

6/15/2010 22 cm above surface

MDC-R-Bs 6/15/2010

Caroline County, MD

Mapped Soil Series: Corsica

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	13	SiL	13		10YR 3/1	moderate platy
		(L)*	(18)*	med, prom, 16%	5YR 7/2	structure
				fine, 8%	10YR 4/6	
2A	47	CL (SL)	32 (18)		10YR2/1	mod. SBK
2Btg1	69	SC	38		2.5Y 5/1	
		(SL)*	(20)*	8%	5Y 7/1	
				15%	2.5Y 4/1	
2Btg2	105	SC	45		2.5Y 7/2	
		(SCL)	(25)	medium, 5%	7.5YR 5/6	
				fine, 2%	7.5YR 4/6	
2BCg	134	LS	8		2.5Y 6/2	
				medium, 15%	2.5Y 7/2	
2Cg1	152	LS	12		5Y 8/1	
2Cg2	173	LS	10		10Y8/1	
				medium, 7%	2.5Y 7/6	
2Cg3	183+	LS	7		N 8/0	
				develops to	10Y 6/1	
				and	5Y 7/1	

Additional Notes

Bulk Density collected in association with this profile

located 5m out of pond in line with depth gauge

Soil Drainage Class: very poorly drained

Hydric Soils Indicators: F13

Water Table Depth

6/15/2010 87 cm

MDC-R-Bs 6/15/2010

Caroline County, MD

Mapped Soil Series: Corsica

Profile C

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	12	SiL	10		2.5Y 3/1	granular structure
A	47	SiL	10		10YR 2/1	mod. SBK
2AE	72	LS	6		2.5Y 6/2	
2Btg1	91	fSL	10		2.5Y 6/2	
				Coarse, 21%	10YR 6/8	
2Btg2	110	SCL	23		2.5Y 7/2	
				Medium, 6%	10YR 6/6	
2CBg1	123	LS	8		2.5Y 5/1	
				Medium, 8%	10YR 5/6	
2Cg	142	LS	6		10YR 7/1	
2C	165	LS	4		2.5Y6/4	
				24%	7.5YR 5/8	
3Cg'	182	C	60		5Y 7/2	
4C	192+	LS	3		2.5Y 7/6	
				10%	7.5YR 5/8	

Additional Notes

10m farther than B

Soil drainage class: very poorly drained

Hydric soils indicators: F13

Water Table Depth

6/15/2010 87 cm

MDC-R-Bs 6/15/2010

Caroline County, MD

Mapped Soil Series: Hambrook

Profile D

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	9	SiL	11		10YR 2/1	
2AB	23	SL	10		2.5Y4/2	
2Bw1	64	SL	8		2.5Y 7/3	
					10YR 5/6	
2Bw2	80	SL	5		10YR 5/8	
				30%	2.5Y 7.2	
				15%	2.5Y6/4	
2BCg	145	LS	5		5Y 7/2	
				top, 5%	10YR 7/6	
				bottom, 5%	10YR 6/6	
2CBg	165+	LS	4		5Y 7/1	
				medium, 8%	10YR 6/6	

Additional Notes

Located 10m farther than C, on edge of corn field
Soil drainage class: moderately well drained
Hydric soils indicators: none

Water Table Depth

6/15/2010 120 cm

MDC-R-JL 10/1/2009
Caroline County, MD
Mapped Soil Series: Hammonton-Fallsington-Corsica Complex
Profile A
Description conducted by Daniel Fenstermacher and Phil Z

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	1	-	-			not present on 8/17/10 (dry)
A1	11	(SiL)*	(22)*		10YR 4/1	Firm, less than horizon below
A2	45	(SiL)*	(26)*		2.5Y 3/1	Firm
				few fine distinct	7.5YR 3/4	
BAg	63	(SiCL)*	(29)*	65%	10YR 4/1	Very Firm
				common fine prom	7.5YR 5/8	
				20%	10YR 6/1	
Bg	100+	(SiL)*	(25)*	60%	10Y 6/1	Very Firm
				40%	7.5YR 5/8	loses firmness with depth

Additional Notes
~10 m in wet land from Field End
All textures Smooth and Silty, too wet to texture
Textures are from PSA
Bulk Density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric soils indicators: almost F6

Water Table Depth
10/1/2009 41 cm above ground

MDC-R-JL 10/1/2009
Caroline County, MD
Mapped Soil Series: Hammonton-Fallsington-Corsica Complex
Profile B
Description conducted by Daniel Fenstermacher and Phil Z

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	2	-	-			not present on 8/17/10 (dry)
A	23	SiL	(22)		10YR 3/1	
Bg1	46	SiL	(25)	70%	10YR 4/1	no sands
				29%	10YR 6/1	
				few fine dist	10YR 5/6	
Bg2	100+	SiL	(25)		5Y 6/1	
				15%	2.5Y 5/1	
				med, prom, root ch	7.5Yr 4/6+	
				med, prom, root ch	10YR 5/8	total Conc.= 30%

Additional Notes
~20m farther in towards ditch from Profile A
Soil Drainage Class: poorly drained
Hydric soils indicators: A11

Water Table Depth
10/1/2009 34 cm above ground

MDD-N-CF 6/28/2010

Dorchester County, MD

Mapped Soil Series: Hammonton

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
A1	2	LS (SL)*	5 (9)*	2.5Y 2.5/1	30% uncoated SGs sediment from upland
A2	9	SL (LS)*	7 (6)*	2.5Y 2.5/2	10% uncoated SGs sediment from upland
Ab1	19	SL (LS)*	7 (6)*	10YR 2/1	3% uncoated SGs
Ab2	32	SL (LS)*	8 (6)*	10YR 3/1	
BAgb	53	SL (LS)	8 (6)	2.5Y 4.5/2	
Bgb1	89	SL (LS)*	10 (6)*	5Y 5/1.5	
Bgb2	133	LS	8 (6)	2.5Y 5/2	
2BCg	153	SiL	10	5Y 5/1	
3Ab'	178	SL	8 (6)	10YR 2/2	7% gravels
3ABb	185+	LCoS	5	2.5Y 3.5/2	10% gravels

Additional Notes

located center of open area, about 15 m from forest edge.

Open area surrounded by pine trees planted in rows

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: none

Almost indicator A12, but horizon A2 is not chroma 1

Water Table Depth

6/28/2010 160 cm

MDD-N-CF 6/28/2010
Dorchester County, MD
Mapped Soil Series: Hammonton
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A1	6	LS	4		10YR 2/1	lots of OM
A2	51	SL	8		10YR 3/1	
Bg1	94	SL	7		10YR 4/1	
Bw	144	SL	8		5Y 5/2	
				10%	5Y 5/1	
				8%	5Y 6/1	
2CB	165	SiL	10		2.5Y 4.5/1	
3Ab	180	SL	13		10YR 3/2	10% gravels
3Bgb	185+	LS	3		5Y 5/2	10% gravels

Additional Notes
located 10 m from profile A and in open area 5 m from forest edge
Soil Drainage Class: somewhat poorly drained
Hydric soils indicators: none
Water Table Depth
6/28/2010 not reached

MDD-N-CF 6/28/2010
Dorchester County, MD
Mapped Soil Series: Hammonton
Profile C
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A1	4	LS	4		10YR 2/1	organic rich
A2	15	SL	8		10YR 3/1	
AE	21	SL	8		10YR 4/2	
Bhs	34	SL	8		7.5YR 3/2	
Bw	48	SL	9		2.5Y 6/3	
BC	90	SL	7		5Y 6/3	
				medium, 25%	10YR 5/6	
CBg	141	S	2		2.5Y 8/1	
				medium, 3%	2.5Y 7/6	
				medium, 2%	2.5Y 7/4	
CBg	185+	LfS	3		2.5Y 7/1	

Additional Notes
located 10 m from profile B and 5 m into forest
Soil Drainage Class: well drained, wet substratum
Hydric soils indicators: none
Water Table Depth
6/28/2010 not reached

MDD-N-CF 6/28/2010

Dorchester County, MD

Mapped Soil Series: Hammonton

Profile D

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
A	12	SL	9	2.5Y 4/4	
Bt	53	SL	16	10YR 5/6	
BC	97	LS	5	2.5Y 6/4 Coarse, 25% 10YR 5/8	
CBg	152	S	3	5Y 8/1 Coarse, 30% 10YR 5/8	
CBg2	167	LS	5	5Y 6/2	
CB	183+	S	2	2.5Y 6/4	

Additional Notes

located 10 m from profile C and 15 m into forest

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Water Table Depth

6/28/2010 not reached

MDD-PC-BR 9/22/2009

Dorchester County, MD

Mapped Soil Series: Hurlock

Profile A

Description conducted by Daniel Fenstermacher and Michelle Hetu

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	16	L (SL)*	12 (10)*		10YR 4/1	
Bg1	55	L (SL)*	16 (13)*	 prominent, 10% distinct, 15%	2.5Y 5/1 10YR 5/8 10YR 6/6	
Bg2	78	LS	4 (12)		2.5Y 6/2	
Bg3	96	LS (LS)*	6 (12)*	 5% 10% lense at bottom	2.5Y 2/3 10YR 5/6 2.5Y 5/2 10YR 5/8	
Bg4	109	L/SL (SL)*	11 (14)*	 3%	10YR 5/2 10YR 5/6	
Bg5	125	LfS (SL)*	7 (13)*	 5% 3%	2.5Y 4/1 10YR 6/1 10YR 5/4	
2BCg	148	SiL	18	 8% 4%	2.5Y 6/1 10YR 5/8 10YR 6/6	
2CBg	161	SiL	23	 tiger stripes, 12% ring, 1-2%	2.5Y 5/2 2.5Y 6/2 10YR 4/6, 3/6	
3Ab/2CBg	174	SiL	15	 very fine, 1%	2.5Y 3/2 2.5Y 5/2 10YR 4/6	3Ab 2CB
3Ab	200+	SiL	13	 20%	7.5YR 2.5/1 7.5YR 3/2	 more present in top

Additional Notes

5m into low spot

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

9/22/2009 61 cm

MDD-PC-BR 9/22/2009

Dorchester County, MD

Mapped Soil Series: Hurlock

Profile B

Description conducted by Daniel Fenstermacher and Michelle Hetu

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	22	L (SL)	13		2.5Y 4/1	
Bg1	54	SCL	22		10YR 5/1	
				4%	10YR 5/6	
Bg2	75	SCL	32		10YR 4/1	
				10%	7.5YR 4/6	
Bg3	88	SL	12		2.5Y 4/1	
				25%	10YR 4/6	
Cg	94	LS	2		2.5Y 7/1	
C	103	LS	3		7.5YR 5/8	
2Bgb	131	SiL	18		2.5Y 5/1	
				5%	7.5YR 4/6	
				around 7.5YR 10%	10YR 5/6	
				at bottom,1%	5GY 5/1	
2BCg	158	SiL	10		N 6/0	
3Ab	185	SiL	8		2.5Y 3/2	wood and fibrous fragments
				1%	10YR 3/3	.7<N<1
				3%	2.5Y 5/2	more mucky than in Profile A
3Ab/BC	200+	SiL	10	Ab	10YR 2/2	Wood/fibers
				BC	2.5Y 6/2	Colors look like wood grains

Additional Notes

10m farther up low spot, perpendicular to nearest ditch

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

9/22/2009 72 cm

MDD-PC-Kp 6/17/2010
Dorchester County, MD
Mapped Soil Series: Pone
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	30	L (SL)	16		10YR 3/1	
A	72	L (SL)	16		10YR 3.5/1	
Btg	110	SCL	21		2.5Y 7/2	
		(SL)	(18)	fine, 15%	2.5Y 7/6	
				fine, 1%	7.5R 7/6	
BC	150	SL	12		7.5YR 5/8	
				medium, 25%	2.5Y7/2	
CBg	195+	LS	6		2.5Y 7/2	

Additional Notes
Soil Drainage Class: very poorly drained
Hydric soils indicators: F13
Water Table Depth
6/17/2010 184 cm

MDD-PC-Kp 6/17/2010
Dorchester County, MD
Mapped Soil Series: Pone
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	33	L (SL)*	16 (15)*		2.5Y 3/1	
ABg	60	L	16		2.5Y 5/2	
		(SL)*	(17)	medium, 3%	2.5Y 5/6	
BEg	135	SL	17		2.5Y 6/2	
		(SL)*	(12)*	fine, 10%	10YR 6/8	
Btg	192+	SCL	21		2.5Y 6/3	
		(SL)	(17)	Medium-Fine, 25%	7.5YR 5/8	
				medium, 15%	2.5Y 7/2	

Additional Notes
Bulk Density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric Soils indicators: F13
Water Table Depth
6/17/2010 not reached

MDD-R-Ck 6/28/2010

Dorchester County, MD

Mapped Soil Series: Pone

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
AB	5	SL	8		2.5Y 5/4	
		(LS)	(4)		10YR 6/8	
Bg	34	SL	6		10Y 6/1	
		(LS)	(3)	Coarse, 25%	10YR 6/8	
				Med-fine, 5%	7.5YR 5/8	
BCg	60	LS	3		5Y 7/1	
				medium, 5%	2.5Y 7/6	
2CBg	89	vcoS	2		2.5Y 6/2	
2Cg1	98	coS	2		2.5Y 7/2	
				med-coarse, 38%	10YR 6/8	
3Cg2	152+	grcoS	2		10Y 8/1	18% Gravels

Additional Notes

Upper part of soil removed

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

6/28/2010 150 cm

MDD-R-Ck 6/28/2010

Dorchester County, MD

Mapped Soil Series: Pone

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
AB	11	SL (LS)*	7 (3)*		2.5Y 4/1	
Bg	39	LS (LS)*	5 (1)*		2.5Y 5/2	
BCg	66	SL (SL)*	10 (9)		10YR 5/1	
				medium, 15%	10YR 6/8	
				fine, 3%	7.5YR 6/8	
Cg1	118	grLvcosS	4		10YR 4/1	16% gravels
Cg2	160	S	2		10YR 5/2	
				medium, 5%	10YR 6/6	
Cg3	180+	S	2		5Y 6/2	
				25%	5Y 6.5/1	

Additional Notes

Located by pond

Upper part of soil removed

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: none

Water Table Depth

6/28/2010 114 cm

MDD-R-Wn 9/24/2009

Dorchester County, MD

Mapped Soil Series: Hurlock

Profile A

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	5	L	8		2.5Y 4/2	
Ap	14	L	10		2.5Y 4.5/2	
				fine, root ch, 2%	7.5YR 4/4	
				in lower part, 3%	2.5Y 4/1	
Bg1	50	SL/L	9		2.5Y 6/1	4% gravels
				medium, 30%	10YR 5/6	
				fine, 4%	5YR 4/6	
Bg2	73	VGrSL	8		2.5Y 6/1.5	very gravelly 50%
				1%	7.5YR 5/6	
Bg3	121	fSL	7		2.5Y 6/1	
				20%	10YR 5/6	
				stripes, 5%	5YR 5/8	
BCg	156	LfS	6		10YR 6/1	
				5%	10YR 6/6	
				2%	7.5YR 5/6	
CBg	198+	LfS	5		2.5Y 5/1	
				medium, 4%	7.5YR 6/8	dec. with depth

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

9/24/2009 43 cm

MDD-R-Wn 9/24/2009

Dorchester County, MD

Mapped Soil Series: Woodstown

Profile B

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	5	L	10		2.5Y 4/2	uncoated sand
		(SL)*	(9)*	fine, 2%	7.5YR 5/6	grains
Ap	24	L	10		2.5Y 4/2	
		(SL)*	(11)*	root ch, 2%	7.5YR 4/4	
				3%	2.5Y 5/2	
BEg	62	LS	7		2.5Y 6/1.5	
		(SL)*	(7)*	medium, 5%	10YR 5/6	gravel lense at
				fine, 2%	7.5YR 4/6	bottom of horizon
Bg	115	LfS	6	51%	2.5Y 6/1	
				2%	7.5YR 5/8	
				18%	10YR 6/6	
				29%	2.5Y 6/4	
BCg	178+	LfS	5		5Y 6/1	
				favors top, 1%	7.5YR 5/6	
				3%	2.5YR 6/4	Auger Refusal

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

9/24/2009 51 cm

MDQA-N-AF 6/30/2010

Queen Anne’s County, MD

Mapped Soil Series: Corsica

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	-	-		7.5YR 2.5/2	
A	17	SiL	13		10YR 3/1	
		(SiL)*	(19)*	med, distinct, 10%	10YR 5/1	
Btg1	64	SiL	20		10YR 4/1	
		(SiL)*	(24)*	med, distinct, 25%	10YR 6/1.5	
				med-f, distinct, 4%	7.5YR 7/8	
Btg2	97	SiCL	35		10Y 6/1	
		(SiCL)*	(32)*	med, prom, 20%	2.5Y 6/4	
				med, prom, 10%	5YR 4/6	
BC	146	SiL	20		7.5YR 4/6	
				med, prom, 15%	N 6/0	
				med, prom, 10%	10Y 6/1	
CBg	185+	SiL	12		5Y 5/1	
				f, prom, root ch, 3%	10YR 4/6	
				med, distinct, 7%	2.5Y 6/4	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A11

Water Table Depth

6/30/2010 not reached

MDQA-N-AF 6/30/2010
Queen Anne's County, MD
Mapped Soil Series: Corsica
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	5	-	-		5YR 3/3	
A	25	SiL	12		10YR 3/1	
			(19)	Medium-fine, 10%	10YR 5/1	
Btg	64	SiL	18		10YR 5/1	
			(24)	med, prom, 5%	10YR 5/6	
				med, distinct, 20%	10YR 6/1	
Bt	103	SiCL	36		7.5YR 5/8	
			(32)	medium, 10%	10Y 6/1	
				medium, 10%	5YR 5/8	
BCg	128	SiL	25	35%	5GY 5/1	
				25%	10Y 6/1	
				medium, 38%	7.5YR 5/8	
				fine, root pores, 2%	5YR 4/6	
C	185+	SiL	10		5Y 5.5/1	with sand lenses
				prominent, 5%	10YR 5/6	→not in sandy material
				sand lenses	2.5Y 5/2	3cm thick at 166cm

Additional Notes
Soil Drainage Class: very poorly drained
Hydric soils indicators: A11
Water Table Depth
6/30/2010 166 cm

MDQA-N-AF 6/30/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Profile C

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	9	-	-		2.5YR 2.5/1	
A1	35	L	12		5YR 2.5/1	
A2	50	L	14		7.5YR 2.5/1	15% Uncoated SGs
Btg1	91	SCL	24		2.5Y 7/1	
				med, prom, 8%	10YR 5/8	
Btg2	105	SL	16		5Y 6/1	
BCg1	121	LS	3		5Y 7/1	
BCg2	136	LS	3		5Y 7/2	
				medium, 3%	10YR 6/6	in finer pockets
BCg3	167	LS	3		2.5Y 7/2	
				medium, 15%	10YR 6/6	
CBg	185+	LS	3		5Y 7/2	ilmenite bands

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A11

Water Table Depth

6/30/2010 not reached

MDQA-N-AF 6/30/2010

Queen Anne's County, MD

Mapped Soil Series: Corsica

Profile D

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	8	-	-		2.5YR 2.5/1	
A	42	L	10		10YR 3/1	
AEg	58	SL	10		2.5Y 5/2	
EBg	75	SCL	20		2.5Y 6/2	
				med, prom, 5%	10YR 5/8	
Btg	113	SL	7		5Y 7/2	
				medium, 22%	10YR 5/6	
BCg	154	LS	3		5Y 6/1	
				medium, 24%	2.5Y 6/6	
CBg	169	LS	3		5Y 7/2	
				medium, 5%	2.5Y 7/4	
Cg1	185	LS	3		2.5Y 6/6	
Cg2	185+	S	1		5Y 8/1	

Additional Notes

Soil Drainage Class: Moderately well drained

Hydric soils indicators: A11

Water Table Depth

6/30/2010 not reached

MDQA-N-AF 6/30/2010

Queen Anne's County, MD

Mapped Soil Series: Ingleside

Profile E

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3	-	-		5YR 2.5/2	
A	13	L	9		10YR 3/2	
AE	37	SL	6		2.5Y 5/4	
E	65	LS	3		2.5Y 5/4	
Bw1	84	LS	4		10YR 5/6	
Bw2	105	LS	5		7.5YR 5/8	
				depletions	10YR 6/4	
Bg1	140	SL	7		5Y 8/1	
				25%	10YR 6/8	assoc w/ finer pockets
Bg2	165	SCL	23		10Y 7/1	
				15%	10YR 5/8	
BCg	185+	LS	3		2.5Y 7/2	ilmenite bands
				med-coarse, 23%	10YR 6/6	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Water Table Depth

6/30/2010 not reached

MDQA-PC-SS 9/24/2009

Queen Anne’s County, MD

Mapped Soil Series: Ingleside

Profile A

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	5	L	10		10YR 4/3	
				1%	10YR 5/2	
				<1%	7.5YR 5/6	
Ap	36	L	10		2.5Y 5/3	
				fine, RP, 8%	7.5YR 4/4	Mn 5% 10YR 2/1 RP
				3%	2.5y 5/2	& ped faces
A`	66	L	10		2.5Y 5/3	
		sandier		8%	7.5YR 4/4	
				3%	2.5Y 6/2	
2Bg	86	SiL	10		2.5Y 6/1	
				fine, 5%	7.5YR 5/6	favors bottom
2Bg2	114	SiL	16		2.5Y 6/1	
				medium, 20%	10YR 6/8	
2Bg3	155	SiL	18		5Y 6/1	
				medium, 40%	7.5YR 5/8	
				5%	2.5YR 4/1	favors bottom
2BCg	200+	SiL	26	top	5GY 5/1	
				transitions to	10Y 6/1	
				2% at top	10YR 6/6	

Additional Notes

20m from woods

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

9/24/2009 51 cm

MDQA-PC-SS 9/24/2009

Queen Anne's County, MD

Mapped Soil Series: Hammonton

Profile B

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	5	L (L)*	10 (10)*		10YR 3/3	
Ap	36	L (SL)*	12 (7)*	 fine, RP, 8% 2%	2.5Y 5/3 7.5YR 4/4 2.5Y 5/2	Mn 3% 7.5YR 2.5/1
A`	66	L (SL)*	10 (9)*	 8% 3% 3%	2.5Y 5/3 7.5YR 4/4 2.5Y 5/2 7.5YR 2.5/1	
Bg1	103	SiL (L)*	15 (18)*	 medium, 20%	2.5Y 7/1 7.5YR 5/8	Gravels at bottom 3%
Bg2	123	L	9 (16)	 medium, 35%	2.5Y 7/1 7.5YR 5/8	
Bg3	136	LS (SL)*	3 (15)*	 medium, 40%	2.5Y 7/2 10YR 5/8	
BC	157	fSL	11	 stratified, 4%	7.5YR 5/8 7.5YR 4.5/6 5Y 6/1	firm
Cg	181+	LfS	4	 stratified, 4%	2.5Y 7/1 10YR 5/8	

Additional Notes

10m up the valley from Profile A

Bulk Density collected in association with this profile

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Crab claw at 132cm

Water Table Depth

9/24/2009 80 cm

MDQA-R-En 7/27/2010

Queen Anne's County, MD

Mapped Soil Series: Hurlock

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	26	SiL	15		10YR 2/1	
		(SiL)*	(23)*	f, dist, RP, 8%	7.5YR 5/6	
Bg	56	CL	33		10YR 5/1	
		(L)*	(26)*	med, prom, 10%	10YR 5/6	
2Bg2	71	SCL	23		2.5Y 6/1	
				med, prom, 15%	2.5Y 6/6	
2Bg3	84	SL (SL)*	8 (8)*		10Y 6/1	
2Bg4	102	CoSL	14		10YR 4/2	
				med, prom, 35%	10YR 5/6	
				med, prom, 15%	N 7/0	
2Bg5	119	SCL	24		10Y 7/1	
				med, dist, 5%	2.5Y 6/6	
2Bg6	136	LS	5		10YR 5/1	
2Bg7	152	LS	5		2.5Y 7/1	
					10YR 5/6	
2BC	169	LS	4		2.5Y 6/6	
				co, dist, 40%	10YR 5/6	
2C	194+	Gr	3		2.5Y 7/3	18% Gravels
		LCoS			5R 4/2	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

7/27/2010 79 cm

MDQA-R-En 7/27/2010

Queen Anne’s County, MD

Mapped Soil Series: Hurlock

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	26	SiL	13		10YR 4/2	
A	66	SiCL	37		10YR 3/1	
		(SiL)	(27)	med-co, 10%	2.5Y 6/2	more towards bottom
Bw	116	SiCL	31	40%	2.5Y 6/4	
		(SiL)	(25)	med, dist, 30%	2.5Y 7/2	
				med, prom, 30%	7.5YR 4/6	
Bw2	168	SiCL	36		7.5YR 4/6	
		(SiL)	(25)	med, prom, 42%	10Y 6/1	
CBg	190+	SiL	18		10GY 6/1	
				med, dist, 2%	5G 5/2	favors top of horizon

Additional Notes

located at foot slope position on field side

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

7/27/2010 185 cm

MDQA-R-SS 10/6/2009

Queen Anne’s County, MD

Mapped Soil Series: Whitemarsh

Profile A

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	2				5Y 5/2	
A	9	SiL?			5Y 5/1	firm
		(SiL)*	(9)*	fine, RP,, 8%	10YR 5/6	
Bg1	31	SiL?			5Y 6/1	firm
		(SiCL)*	(30)*	RP, 10%	10YR 5/6 & 8	
Bg2	153	SiL?			5Y 6/1	firm
		(SiL)*	(24)*	medium, 12%	10YR 5/6	
2BC	180	SiL?			2.5Y 5/3	
		sandier		favors top, 20%	2.5Y 6/2	
		(SL)*	(8)*	medium, 3%	2.5Y 6/2 & 1	
				medium, 8%	10YR 5/6	favors bottom
3Cg	200+	SiL?			5Y 6/1	
		(SiL)*	(13)*	fine, 2%	10YR 5/6	

Additional Notes

Bulk density collected in association with this profile

~10 m in wet land from eastern end

most textures Smooth and Silty, nearly no sand, too wet to texture

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

10/6/2009 32 cm above ground

MDQA-R-SS 10/6/2009

Queen Anne's County, MD

Mapped Soil Series: Whitemarsh

Profile B

Description conducted by Daniel Fenstermacher and Rosyland Orr

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oi	4				2.5Y 4/3	
A	14	SiL?	(9)		2.5Y 5/2	
				fine root ch 5%	10YR 5/6	
Bg	96	SiC?			5Y 7/1	
			(30)	med 10%	10YR 5/6	
2BCg	192+	LS		Top	2.5Y 6/2	Matrix gradually changes
		(SL)	(8)	Bottom	5Y 6/1	Si lenses 100, 119, 140, 175 cm
				dec w/ depth 5%	10YR 5/6	Sand coarser w/ depth (M->Co)

Additional Notes

~20m farther down from profile A too wet to texture

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

10/6/2009 28 cm above ground

MDQA-R-Ws 10/8/2009

Queen Anne's County, MD

Mapped Soil Series: Othello

Profile A

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	9	SiL/L	12		2.5Y 5/3	
				f, root ch, 5%	7.5YR 5/8	
Bw	28	SiL/L	12		2.5Y 6/4	platy structure
				med-coarse, 10%	7.5YR 5/6	
				10%	5Y 7/2	
Bg1	60	SiL	8		5Y 8/1	
		fluffy		med, prom, 10%	2.5Y 5/6	
Bg2	80	SiL	12		5Y 8/1	
		fluffy		med-coarse, 45%	10YR 4/6	
2BC	86	SC	42	30%	5Y 7/1	top
		(SCL)	(25)	transition to 70%	2.5Y 4/1	
3CBg	160	SiC	44		2.5Y 7/2	
		(CL)	(33)	fine-med, 35%	7.5YR 6/8	go along plates
3Cg	200+	SiL [Si?]	8		2.5Y 7/2	no sand
				fine-med, 15%	7.5YR 6/8	

Additional Notes

site very ditched and diked

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

10/8/2009 129 cm

MDQA-R-Ws 10/8/2009

Queen Anne's County, MD

Mapped Soil Series: Othello

Profile B

Description conducted by Daniel Fenstermacher and Phil Zurheide

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	14	SiL (SiL)*	10 (7)*	 fine root ch 4%	2.5Y 5/2 10YR 5/8	
Btg1	38	SiL	25 (15)	 8% 5%	5Y 5/1 10YR 4/6 & 6/8 5Y 7/1	
Btg2	63	CL (SiL)*	30 (20)*	 few fine	2.5Y 5/1 10YR 6/8 2.5Y 7/2	prismatic structure N 4/0 clay film
2BCg	98	GrSiL	14	 fine-med	2.5Y 4/1 10YR 4/6	
3CBg	115	SiL	11	 2%	5Y 6/2 10YR 6/8	
4C	140	SC (SCL)*	37 (24)*	 few	2.5Y 3/1 2.5Y 2.5/4 7.5YR 3/3	
5Cg1	152	CoS			2.5Y 7/1	
5Cg2	173+	LS			2.5Y 6/2	

Additional Notes

Across ditch and away from road, ~ 15m away from profile A

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

Not recorded

MDT-N-SD 6/22/2010

Talbot County, MD

Mapped Soil Series: Elkton

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	5	-	-		2.5YR 2.5/1	
A	22	SiCL	36		10YR 4/1	
		(SiC)*	(46)*	medium, 18%	10YR 5/6	
Bg1	70	SiCL	31		2.5Y 7/1	
		(SiCL)*	(36)	med, pores, 25%	10YR 5/6	
				fine, pores, 8%	7.5YR 4/6	
Bg2	126	SiCL	31		10Y 5.5/1	
				medium, 10%	10YR 5/8	
2Ab	141	CL	32		7.5YR 4.5/1	
2ABb	168	CL	32		7.5YR 4.5/1	
				medium, 10%	7.5YR 5/6	
				medium, 5%	2.5Y 6/2	
2Bgb	185+	SCL	22		7.5YR 6/1	
				8%	10YR 5/6	

Additional Notes

BD collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soil indicators: F3

Water Table Depth

6/22/2010 not reached

MDT-N-SD 6/22/2010

Talbot County, MD

Mapped Soil Series: Crosiadore

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4	-	-		5YR 2.5/1	
A	23	SiL	13		10YR 3/1	
Bg1	59	SiL	23		10YR 5/1	
				medium, 21%	10YR 4/6	
Bg2	141	SiL	18		5Y 6/1	
				medium, 4%	10YR 5/8	
				medium, 8%	10YR 5/6	surrounds 10YR 5/8
2Ab	176	CL	39		7.5YR 4/1	
				fine, root pores, 5%	7.5YR 4/6	
				medium, 3%	2.5Y 6/1	
2Bgb	200+	L	24		10YR 5/1	
				medium, 3%	7.5YR 4/6	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soil indicators: A11

Water Table Depth

6/22/2010 not reached

MDT-N-SD 6/22/2010

Talbot County, MD

Mapped Soil Series: Crosiadore

Profile C

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	3.5	-	-		7.5YR 3/2	
A	8	SiL	11		10YR 3/2	
EB	45	SiL	13		2.5Y 6/4	
				10%	2.5Y 7/2	
				root pores, 1.5%	10YR 5/6	
Bw	77	SiL	14		10YR 6/6	
				medium, 8%	7.5YR 5/6	
				medium, 15%	10YR 7/2	
Bg	120	SiL	16		2.5Y 6/2	
				med, root ch, 12%	7.5YR 5/6	
2ABb	162	CL	33		7.5YR 5/1	
				medium, 3%	7.5YR 5/8	
				medium, 10%	10YR 6/6	
2Bgb	185+	CL	31		10YR 6/1	
				medium, 5%	10YR 6/6	

Additional Notes

Soil drainage class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

6/22/2010 not reached

MDT-N-SD 6/22/2010

Talbot County, MD

Mapped Soil Series: Mattapex

Profile D

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	2	-	-		7.5YR 3/2	
A	10	SiL	10		10YR 3/3	
AE	22	SiL	12		10YR 4.5/4	
EB	47	SiL	13		10YR 6/6	
Bw1	74	SiL	17		10YR 5/6	
Bw2	109	SiL	16		10YR 5/6	
				medium, 15%	2.5Y 6/2	
2Bw3	145	SL	10		10YR 5/6	
				fine-med, 1%	2.5Y 6/2	
2BC	169	S	2		2.5Y 7/3	
				20%	2.5Y 7/4	
2CB	185+	SL	8		7.5YR 5/6	
					10YR 6/4	lamellae?
					2.5Y 7/2	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soil indicators: none

Water Table Depth

6/22/2010 not reached

MDT-R-DF 6/22/2010

Talbot County, MD

Mapped Soil Series: Fallsington

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	3	-	-		5Y 2.5/2	
Ag	13	L (SL)	12 (7)		5Y 4/2	
ABg	28	SL	12		5Y 5/1	
		(L)	(10)	medium, 25%	10YR 5/6	
Bg	61	LS	7		2.5Y 6/2	
				medium, 28%	7.5YR 5/6	
BCg	109	S	3		10YR 7/1	
				medium, 10%	10YR 5/8	
2CB	142	SiL	10		10GY 5/1	
				fine, pore ch, 3%	10YR 5/6	
3Ab	165+	Mucky SiL	14		10YR 2/1	

Additional Notes

Soil drainage class: poorly drained

Hydric soils indicators: F3

Water Table Depth

6/22/2010 not reached

MDT-R-DF 6/22/2010

Talbot County, MD

Mapped Soil Series: Fallsington

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	2	-	-		2.5Y 3/3	
Ag	29	L	12		2.5Y 4/2	
		(SL)*	(7)*	fine, root pores, 3%	10YR 4/6	
Bg	66	SL	10		5Y 6/2	
		(L)*	(9)	medium, 25%	10YR 5/6	
BCg	127	LS	7		2.5Y 6/2	
				medium, 25%	10YR 5/8	
2CB	156	SiL	8		N 5/0	
				fine, root pores, 3%	10YR 5/6	
3Ab	162+	mucky SiL	14		2.5Y 2.5/1	

Additional Notes

BD collected in association with this profile

Soil drainage class: poorly drained

Hydric soils indicators: F3

Water Table Depth

not documented

NC-N-EC 7/15/2010
Tyrrell County, NC
Mapped Soil Series: Ponzer
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	2	-	-	7.5YR 2.5/2	
Oa1	13	-	-	10YR 2-/1	
Oa2	18	-	-	5YR 2.5/1	
Oa3	37	-	-	10YR 2-/1	
Ag	63	SiL	16	10YR 4/2	
Bg	86	SiL	24	2.5Y 4/1	
2Bg	144	L/vfSL	8	2.5Y 5/2	
BCg	165	LS	3	2.5Y 5/2	Ilmenite 5%
Cg	180+	LvfS	3	5GY 4/1	

Additional Notes
Soil Drainage Class: very poorly drained
Hydric soils indicators: A2
Histic epipedon
Water Table Depth
7/15/2010 59 cm

NC-N-EC 7/15/2010
Tyrrell County, NC
Mapped Soil Series: Ponzer
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	3	-	-	2.5YR 2.5/1	
Oa1	28	-	-	10YR 2/1	charcoal chunks present
Oa2	69	-	-	7.5YR 2.5/1	soft fluffy granules
BA	95	SiL (SiL)*	10 (14)*	2.5Y 5/3 10% 2.5Y 4/2	
Bg	117	SiL (SiCL)*	18 (27)*	2.5Y 4/1	
2Bg2	168	fSL	6	10YR 4/2	
2BCg	185+	fSL	6	2.5Y 3/1 Coarse, 40% 2.5Y 4/2	

Additional Notes
Bulk density collected in association with this profile
Soil Drainage Class: very poorly drained
Hydric soils indicators: A1
Soil taxonomy: Terric Haplosaprist
Water Table Depth
7/15/2010 not recorded

NC-N-PLR1 7/13/2010

Hyde County, NC

Mapped Soil Series: Scuppernong

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	6	-	-		7.5YR 2.5/2	
BC	13	LvfS	2		2.5Y 8/4	eolian?
				Medium, 2%	10YR 6/8	
Oe`	17				7.5YR 2.5/1	
A	46	SiL Mucky (L)	14 (21)		10YR 3/1	
Bg	74	fSL	8		10YR 4/2	
				med, root ch, 3%	7.5YR 5/6	
BCg	112	LfS	6		5Y 6/1.5	
				m, d, root ch, 1.5%	7.5YR 5/6	
Ab	137	vfSL mucky	8		5Y 4/1.5	
Bgb	161	LS	2		2.5Y 6/2	
Ab`	185+	LS	3		2.5Y 3/1	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Water Table Depth

7/13/2010 171 cm

NC-N-PLR1 7/13/2010

Hyde County, NC

Mapped Soil Series: Scuppernong

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	8	-	-		7.5YR 2.5/2	
BC	16	LvfS	3		10YR 7/6	eolian?
		(SL)*	(3)*	medium 8%	10YR 5/6	
A	51	SiL (L)*	14 (21)*		10YR 3/1	
Bg	80	fSL	7		10YR 4/2	
		(SL)*	(12)*	10%	2.5Y 7/1	pocket
Bg2	106	L	8		10YR 4/1	
		w/ vf	(10)	m, p, root ch, 10%	7.5YR 4/6	
		sands		m, p, root ch, 5%	10YR 6/6	
BCg	130	fSL	8		2.5Y 6.5/1	
Ab	142	vfSL mucky	8		2.5Y 3/1	
Bgb	176	LS	4		10YR 6/2	
Ab`	185+	LS	4		2.5Y 3/1	

Additional Notes

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: none

Water Table Depth

7/13/2010 178 cm

NC-N-PLR2 7/13/2010

Hyde County, NC

Mapped Soil Series: Belhaven

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oa/e	18	-	-	5YR 2.5/1	intermittent charcoal 17-20 cm
Oa	41	-	-	5YR 3/1	
Oa	63	-	-	10YR 3/2	N > 1
Oa	115	-	-	10YR 3/1	N > 1
A	124	LfS mucky	1	10YR 3/2	
AC	140	LfS (S)	1	10YR 4/2	
Cg	190+	LvfS (S)	3	5GY 4/1	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Soil Taxonomy: Terric haplosaprist

Water Table Depth

7/13/2010 At surface

NC-N-PLR2 7/13/2010

Hyde County, NC

Mapped Soil Series: Belhaven

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oa1	13	-	-	N 2/5/0	charcoal chunks
Oa2	29	-	-	7.5YR 2.5/1	
Oa3	58	-	-	10YR 2/2	N >1
Oa4	118	-	-	10YR 3/2	N>1
AC	142	LfS Mucky (LS)*	2 (7)*	10YR 3/1	
C/A	190+	C=LS	2	2.5Y 5/2	
		A=LfS Mucky (S)*	2 (3)*	coarse 25% 10YR 2/1	

Additional Notes

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A11

Soil Taxonomy: Terric Haplosaprist

Water Table Depth

7/13/2010 49 cm

NC-PC-EC 7/14/2010

Tyrrell County, NC

Mapped Soil Series: Ponzer

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oap	13	-	-	10YR 2-/1	
Oa	35	-	-	5YR 2.5/1	
Ag	57	SiL (CL)*	12 (30)*	10YR 4/2	
Bg	125	SiC (SiCL)*	43 (38)*	10YR 5/2 co-m, p, root ch, 22% 7.5YR 4/6	
CBg	161	vfSL	8	5G 6/1 distinct, 30% 5G 5/1 f, prom, root ch, 1% 10YR 4/6	pockets
Cg	190+	LfS	4	5G 4/1 coarse, 40% 10GY 5/1	

Additional Notes

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Water Table Depth

7/14/2010 179 cm

NC-PC-EC 7/14/2010

Tyrrell County, NC

Mapped Soil Series: Ponzer

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap	14	-	-		N 2.5/0	
Oa	37	-	-		7.5YR 2.5/1	
Ag	61	CL	34		10YR 4/2	
					7.5YR 4/6	
Bg	109	C	44		10YR 5/2	
				med, prom, 18%	5YR 4/6	
BC	134	SiCL	29		5Y 6/3	
				med-co, prom, 15%	7.5YR 4/6	
				med, p, root ch, 5%	5YR 3/2	
				med distinct, 23%	5Y 7/1	
CBg	163	vfSL	8		10GY 5/1	
					5G 5/1	
				f, prom, root ch, 1%	7.5YR 4/6	
Cg	190+	LfS	4		5G 5/1	
				med, distinct, 10%	5G 4/1	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Histic epipedon

Water Table Depth

7/14/2010 167 cm

NC-PC-KY 8/11/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap1	14	-	-		10YR 2/1	all visible sand grains are uncoated
Oap2	33	-	-		5YR 2.5-/2	
A	53	SL (LS)*	8 (4)*		7.5YR 3/3	
BA	80	L	18	Coarse, 65%	10YR 3/2	
		(SL)*	(10)*	35%	10YR 4/3	
BC	100	SL	7		10YR 3/1.5	
					10YR 5/3	sandier pockets
Cg1	146	LS	5		10Y 4/1	pockets of finer material 5%
Cg2	165+	LS	5		5GY 4/1	

Additional Notes

low spot within 20m of both roads

Bulk density collected in association with this profile

Sand in surface could be from roads

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Histic epipedon

Water Table Depth

8/11/2010 102 cm

NC-PC-KY 8/11/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oap1	20	-	-	10YR 2/1	all sand grains are uncoated
Oap2	30	-	-	10YR 2/2	
Oa	44	-	-	5YR 2.5-/2	
AB	57	SL (LS)	6	7.5YR 3/2	
Bw	71	SL	15	10YR 4/3	
Bw2	104	L	12	10YR 3/1	
BC	120	SL	5	10YR 3/1.5	
Cg1	152	L	13	5GY 4/1	
Cg2	166+	LS	3	10GY 5/1	

Additional Notes

located 35 m from road, tried to avoid surface sand

slightly higher elevation than profile A

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Water Table Depth

8/11/2010 103 cm

NC-PC-MT 8/12/2010

Tyrrell County, NC

Mapped Soil Series: Roper

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap	22	-	-		10YR 2/1	really black!
				or	N 2.5/0	
Oa1	47	-	-		7.5YR 2.5-/2	
Oa2	87	-	-		10YR 3/2	
Ag	110	L	8		2.5Y 5/2	
		(SL)*	(4)*	coarse, 15%	10YR 4/2	
BCg	134	L	26		2.5Y 7/1	
		(L)*	(17)*		10GY 6/1	
				prominent, 15%	10YR 5/6	assoc with 2.5Y 7/1
				prominent, 8%	7.5YR 5/6	assoc with 10GY 6/1
Cg	185+	CL (L)	36 (26)		5GY 5/1	

Additional Notes

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Soil Taxonomy: Terric Haplosaprist

Water Table Depth

8/12/2010 81 cm

NC-PC-MT 8/12/2010

Tyrrell County, NC

Mapped Soil Series: Roper

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap	14	-	-		10YR 2/1	Really Black!
				or	N 2.5/1	
Oa1	30	-	-		7.5YR 2.5-/1	firm chunks
Oa2	52	-	-		7.5YR 2.5-/1	
Ag	86	SiL	8		10YR 4/2	
		mucky				
Bg	130+	L	8		2.5Y 5/2	
				35%	10YR 4/2	

Additional Notes

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Soil Taxonomy: Terric Haplosaprist

Water Table Depth

8/12/2010 113 cm

NC-R-EC 7/14/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap	12	-	-		10YR 2/1	
Oa	40	-	-		10YR 2/1	
				mineral pocket 5%	10YR 3/3	
Ag	59	SiL Mucky (SiCL)*	10 (30)*		10YR 4/2	
Bg	75	CL	37		10YR 4/1	
		(SiCL)*	(35)*	med, root ch, 28%	10YR 4/6	
Cg1	125	LvfS	3		10GY 5/1	
Cg2	190+	fSL	5		10GY 5/1	
				med, distinct, 10%	5G 5/1	

Additional Notes

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Soil taxonomy: Terric Haplosaprist

Water Table Depth

7/14/2010 118 cm

NC-R-EC 7/14/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oap	2	-	-		10YR 2/1	
Cg?	9	SiL	7		2.5Y 7/2	
				fine, prom, 35%	7.5YR 6/6	
?	14	-	-		N 2/0	entire horizon is Charcoal
Oa	56	-	-		7.5YR 2.5/1	
Ag	104	SiL (SiCL)	10 (30)		10YR 4/2	
Bg	129	CL	33		5Y 5/2	
		(SiCL)	(35)	m, p, root ch, 23%	7.5YR 4/6	
Cg	175	fSL	4		5G 6/1	
Cg2	190+	fSL	6		10GY 5/1	

Additional Notes

Located ~30 m from pond at a higher elevation, between drainage ditches

Two feet next to auger boring, 20cm higher with no charcoal and 20cm more Oa on top.

Soil drainage class: very poorly drained

Hydric soils indicators: A1

Water Table Depth

7/14/2010 158 cm

NC-R-KY 8/11/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile A

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oap	12	-	-	10YR 2/1	
Oa	33	-	-	7.5YR 2.5/2	
A	46	L (SL)*	11 (12)*	10YR 3/3	
Bg	59	L (SL)*	8 (14)*	10YR 4/2	
Ab	100	SL	16	2.5Y 3/1 10YR 3/1 2.5Y 5/2	
BCg	115	S	2	2.5Y 4/1	
Cg1	147	LfS	4	10GY 4/1	
Cg2	160+	LS	4	5GY 4/1	

Additional Notes

At end of big ditch, right next to it

Bulk density collected in association with this profile

Soil Drainage Class: very poorly drained

Hydric soils indicators: A2

Histic epipedon

Water Table Depth

8/11/2010 <54 cm

NC-R-KY 8/11/2010

Tyrrell County, NC

Mapped Soil Series: Belhaven

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oap	18	-	-	10YR 2/2	firm
Oa1	46	-	-	10YR 2/2	soft
Oa2	70	-	-	7.5YR 2.5/2	
Oa3	95	-	-	5YR 2.5/2	
Cg	100	SL	6	2.5Y 5/3	
Ab	116	L	14	2.5Y 2.5/2	
Ab2	174	fSL	2	2/5Y 3/1 2.5Y 4/2	
Cg	190+	fSL	2	10Y 4/1	

Additional Notes

Up on original surface, about 50 cm higher than profile A

Soil Drainage Class: very poorly drained

Hydric soils indicators: A1

Soil Taxonomy: Terric Haplosaprist

Water Table Depth

8/11/2010 113 cm

NC-R-MT 7/16/2010
Tyrrell County, NC
Mapped Soil Series: Scuppernong
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	10	-	-	10YR 2-/1	had small hard OM pellets
Oa1	44	-	-	10YR 2-/1	
Oa2	86	-	-	7.5YR 2.5/1	
Oa3	137	-	-	10YR 2/2	
AC	163	mucky fSL (vfSL)*	8 (14)*	10YR 3/2 20% 2.5Y 6/3	
Cg	189	LfS (LvfS)*	5 (5)*	2.5Y 4/2	

Additional Notes

Bulk density collected in association with this profile
Soil Drainage Class: very poorly drained
Hydric soils indicators: A1
Soil Taxonomy: Terric Haplosaprist

Water Table Depth

7/16/2010 70 cm

NC-R-MT 7/16/2010
Tyrrell County, NC
Mapped Soil Series: Scuppernong
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color	Notes
Oe	10	-	-	10YR 2-/1	small hard OM pellets
Oa1	36	-	-	7.5YR 2.5-/1	
Oa2	92	-	-	7.5YR 2.5/2	
Oa4	129	-	-	10YR 2.5/2	
ACg	176	fSL	9	10YR 4/2	
Cg	190+	LfS	4	2.5Y 4/2 8% 10Y 5/1	

Additional Notes

Soil Drainage Class: very poorly drained
Hydric soils indicators: A1
Soil Taxonomy: Terric Haplosaprist

Water Table Depth

7/16/2010 68 cm

VASH-PC-Bks 7/8/2010

Southampton County, VA

Mapped Soil Series: Bojac

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	24	LfS	6		10YR 4/2	
		(fS)*	(2)*	bottom of Ap, 3%	10YR 6/6	
BE	42	LfS	5		2.5Y 7/3	
		(LfS)*	(5)*	fine-med, dist, 3%	10YR 6/6	
Bw1	95	fSL	6		2.5Y 7/6	
		(LfS)*	(7)*	medi, prom, 15%	7.5YR 5/8	
				med, prom, 8%	2.5Y 7/3	
Bw2	121	LfS	4		10YR 6/6	Ilmenite
		(fS)*	(2)*	prom, 10%	10YR 5/8+	
BC	143	LfS	3		2.5Y 7/3	ilmenite
		(fS)	(2)	med, distinct, 4%	10YR 6/6	
CB	186	S	1		2.5Y 7/5	ilmenite
				med, dist, 1.5%	10YR 6/6	
CBg	190+	fS	1		2.5Y 7/2	very little ilmenite
				med-coarse, 5%	10YR 7/6	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: None

Water Table Depth

7/8/2010 181 cm

VASH-PC-Bks 7/8/2010

Southampton County, VA

Mapped Soil Series: Bojac

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	22	LfS (fS)	6 (2)		10YR 4/3	
BE	48	LfS	3		2.5Y 6/4	
			(7)	fine, distinct, 1%	10YR 6/8	
Bw1	90	LfS	5		2.5Y 6/6	
		(S)	(2)	med, distinct, 2%	10YR 6/8	
Bw2	118	LfS	4		2.5Y 6/6	
		(S)	(2)	med, distinct, 4%	10YR 6/8	
Bw3	142	LfS	4		10YR 7/6	15% ilmenite
		(S)	(2)	med, distinct, 8%	10YR 6/8	
BC	169	LfS	3		2.5Y 7/3	10% ilmenite
		(S)	(2)	coarse, 20%	10YR 6/6	
CB	178	LS	4		7.5YR 5/8	
		(S)	(3)	medium, 1%	7.5YR 2.5/2	Mn

Additional Notes

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: None

Water Table Depth

7/8/2010 180 cm

VASH-PC-BN 7/6/2010

Southampton County, VA

Mapped Soil Series: Slagle

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	20	L (SiL)*	13 (14)*		2.5Y 5/2	
A	45	L (SiL)*	16 (14)*	med-f, dist, 10%	2.5Y 5/2 10YR 4/6	
Bt	91	CL (L)*	29 (22)*	med, dist, 15%	2.5Y 5/4 2.5Y 5/2	
BCg	143	fSL	17	med, prom, 40%	2.5Y 6/1 10YR 7/6	
Cg1	162	LfS	3	m-co, prom, 5%	2.5Y 7/1 2.5Y 7/6	
Cg2	188+	LfS	3	med, dist, 35%	2.5Y 7/1 2.5Y 6/4	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: somewhat poorly drained

Hydric soils indicators: none

Water Table Depth

Did not reach water table

VASH-PC-BN 7/6/2010

Southampton County, VA

Mapped Soil Series: Slagle

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	22	L (SiL)	12		2.5Y 5/2	
A	48	L	13		2.5Y 5/2	
		(SiL)		fine, distinct, 8%	7.5YR 5/6	
Bt	90	L	27		2.5Y 6/4	
			(22)	fine-m, dist, 15%	10YR 5/6	
Btg1	118	L	25		10YR 6/2	
				m-f, prom, 4%	10YR 5/8	
				m-co, dist, 23%	10YR 6/6	
Btg2	142	SCL	24		2.5Y 6.5/1	
				med, prom, 15%	10YR 5/8	
				m-co., prom, 10%	2.5Y 6/6	
Btg3	169	L	18		2.5Y 7/1	
				med, prom, 10%	10YR 6/6	
BCg	178	LfS	3		2.5Y 8/1	
CBg2	190+	LfS	3		10YR 7/2	
				med, prom, 5%	7.5YR 6/8	
				co, prom, 20%	10YR 6/6	

Additional Notes

Soil Drainage Class: moderately well drained

Hydric soils indicators: none

Water Table Depth

Did not reach

VASH-R-Bks 7/8/2010

Southampton County, VA

Mapped Soil Series: Roanoke

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	23	L (SCL)	12 (20)		10YR 2/1	
Ag	56	L	18		10YR 4/1	
		(SCL)	(25)	f, dist, root ch, 5%	10YR 5/6	
Bg	81	fSL	12		10YR 5/1	
				fine, prom, 1%	10YR 6/6	
Bg2	109	fSL	12		10YR 5.5/2	
				med, prom, 5%	10YR 5/8	
				medium, 5%	10YR 4/1	Ilmenite
BCg	190+	L	10		2.5Y 7/1	
		w/ vfs		med, prom, 10%	10YR 5/8	
				nodules, 10%	10YR 5/8	dominant at bottom

Additional Notes

Location for lowland sample for Cs-137 analysis

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

7/8/2010 not reached

VASH-R-Bks 7/8/2010

Southampton County, VA

Mapped Soil Series: Roanoke

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	22	L (SCL)*	14 (21)*		10YR 2/1	
Ag	45	L	18		10YR 4/1	
		(SCL)	(25)*	fine, distinct, 5%	10YR 5/6	
Bg	78	fSL	16		10YR 5/2	
				faint, medium, 8%	10YR 5/1	
Bg2	107	SCL	28		10YR 6/2	
		(SCL)*	(25)*	fine, root ch, 3%	5YR 4/6	
				med-fine, dist, 6%	10YR 5/6	
BCg	190+	L/fSL	10		2.5Y 7/2	
				25%	10YR 5/8	
				nodules, 10%	10YR 5/8	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

7/8/2010 not reached

VASH-R-BN 7/6/2010

Southampton County, VA

Mapped Soil Series: Slagle

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	6	LfS	6		2.5Y 4/3	
Ap1	15	LS	6		2.5Y 5/3	
				fine, faint, 5%	10YR 6/6	
Ap2	30	LfS	6		2.5Y 4/3	
EB	57	SL	16		2.5Y 6/6	
BE	79	SL	18		10YR-2.5Y 5/6	10% gravels
Bt1	110	L	24		10YR 6/6	
				med-co, dist, 45%	7.5YR 5/8	
Bt2	144	L	25		7.5YR 5/8	
				med, prom, 8%	2.5Y 7/2	
Bt3	185+	L	25		7.5YR 5/8	
				med, prom, 27%	2.5Y 7/2	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Water Table Depth

Did not reach water table

VASH-R-BN 7/6/2010

Southampton County, VA

Mapped Soil Series: Slagle

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	25	fSL (SL)*	9 (4)*		2.5Y 4.5/3	10% gravels
BE	64	fSL (SL)*	12 (11)*		2.5Y 6/4	
Bt1	116	L	22		7.5YR 5/8	
				medium, dist, 5%	2.5Y 7/4	
Bt2	165	CL	32		10YR 5/8	
				med, prom, 30%	10YR 7/1	
Btg	185+	CL	28		10YR 7/1	
				Med, prom, 40%	10YR 5/8	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Water Table Depth

Did not reach

VASK-N-Cd 7/7/2010

Suffolk County, VA

Mapped Soil Series: Lynchburg

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oi	10	-	-		7.5YR 3/4	
A	30	L (SL)*	10 (13)*		10YR 3/2	
Btg1	68	SCL	22		7.5YR 5/1	
		(SL)*	(13)*	med, prom, 5%	10YR 5/6	
Btg2	120	SCL	32		10YR 6/2	
			(22)	co, prom, 40%	10YR 5/6	
Btg3	150	SCL	28		10YR 6/2	
			(22)	med, prom, 10%	10YR 5/6	
				med, prom, 3%	5YR 4/6	
2Ab	167	C	44		10YR 4/2	Charcoal fragments
				med, prom, 10%	7.5YR 5/8	
				med, prom, 10%	7.5YR 4/6	
2Bgb	195+	C	44		10YR 4/1	Charcoal fragments
				med, prom, 15%	7.5YR 6/8	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Water Table Depth

Did not reach

VASK-N-Cd 7/7/2010
Suffolk County, VA
Mapped Soil Series: Lynchburg
Profile B
Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oi	3	-	-		7.5YR 2.5/2	
A	24	L	11		10YR 3/1	
Btg1	62	CL	32		2.5Y 5/2	
		(SCL)	(22)	med, prom, 5%	7.5YR 5/6	
Btg2	108	CL	34		7.5YR 5/6	
		(SCL)	(22)	med, prom, 25%	2.5Y 6/1	
				medium, dist, 5%	5YR 5/6	
Btg3	144	SC	38		7.5YR 4.5/1	
		(SCL)	(30)	med, prom, 25%	10YR 5/6	
2Ab	172	C	42		7.5YR 4/1	
				med, dist, 18%	7.5YR 5/8	
				med, prom, 8%	2.5YR 5/2	
2Bgb	195+	CL	38		10YR 5/1	
				med, dist, 15%	10YR 6/8	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: A11

Water Table Depth

7/7/2010 155 cm

VASK-PC-Cd 7/7/2010

Suffolk County, VA

Mapped Soil Series: Eunola

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	26	SL (SL)*	7 (8)*		10YR 5/3	
BE	45	L (L)*	18 (20)*		10YR5/6	
Bt1	97	SC	38		7.5YR 5/8	
		(SCL)*	(27)*	med, prom, 10%	2.5YR 4/6	
				med, prom, 10%	2.5Y 7/2	
Bt2	132	SCL	27		10YR 6/8	
			(22)	m-co, prom, 35%	2.5YR 4/8	
				med, prom, 15%	10YR 7/2	
Bt3	163	SCL	24		10YR 6/8	
		(SL)	(19)	med, prom, 5%	10YR 7/1	
				med, prom, 20%	2.5YR 4/8	
BC	186+	SL	10		10YR 6/6	
				med, prom, 4%	2.5Y 7/2	
				med, prom, 10%	2.5YR 4/6	

Additional Notes

Bulk Density collected in association with this profile

Soil Drainage Class: Somewhat Poorly drained

Hydric soils indicators: none

Water Table Depth

7/7/2010 not reached

VASK-PC-Cd 7/7/2010

Suffolk County, VA

Mapped Soil Series: Eunola

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap1	18	SL	8		10YR 5/4	
Ap2	30	SL (L)	16		10YR 5/5	
Bt1	61	CL	28		10YR 5/6	
Bt2	102	CL	34		10YR 6/6	
				med, distinct, 5%	2.5Y 7/3	
				med, prom, 10%	2.5YR 4/6	
				fine, prom, 2%	10R 4/6	
Btg	140	CL	38		2.5Y 7/1	
				med, prom, 10%	10YR 6/6	
				med, prom, 15%	10YR 4/6	
				med, prom, 15%	7.5YR 5/8	
BC	173	SL	16		2.5YR 5/8	
				med, prom, 15%	2.5Y 7/2	
				med, prom, 25%	10YR 5/8	
CB	195+	SL	8	34%	10YR 8/1	
				m-co., prom, 32%	10YR 6/8	
				m-co., prom, 34%	2.5YR 4/6	

Additional Notes

Soil Drainage Class: well drained, wet substratum

Hydric soils indicators: none

Water Table Depth

No water table reached

VASK-R-Cd 7/7/2010

Suffolk County, VA

Mapped Soil Series: Rains

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	21	LS	7		10YR 4/1	
2Bg1	67	SC	37		2.5Y7/1	
				med, prom, 5%	7.5YR 4/6	
				med, prom, 25%	10YR 5/6	
3Bg2	101	fSL	16		2.5Y 7/1	
				med, prom, 15%	10YR 5/6	
3Bg3	142	fSL	10		5Y 7/1	
				med, prom, 3%	10YR 5/6	
				med, prom, 2%	10YR 5/8	
3BC	148	fSL	8		10YR 6/8	
4CBg	159	SiL	12		2.5Y 7/1	
				m-co., prom, 25%	10YR 5/6	
5Cg	190+	S	1		2.5Y 7/1	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3

Wet example of site

Water Table Depth

Did not reach

VASK-R-Cd 7/7/2010
Suffolk County, VA
Mapped Soil Series: Rains
Profile B
Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	24	LfS (fSL)*	7 (6)*		10YR 3/1	
BA	43	fSL	8		2.5Y 6/3	
		(fSL)*	(12)*	medium, faint, 5%	2.5Y6/2	
				m-co., prom, 10%	10YR 5/6	
				med, prom, 2%	7.5YR 4/6	
Btg1	78	fSL (fSL)	10 (12)*		2.5Y 6/2	weak clay films
Btg2	105	SCL	25		2.5Y 7/1	Clear clay films
				med, prom, 10%	7.5YR 5/6	
2BCg	151	C	42		2.5Y 7/1	
				fine, prom, 2%	5YR 5/8	
				fine, prom, 10%	7.5YR 5/8	
3CBg	192+	LfS	4		2.5Y 7/1	

Additional Notes

Representative of site
Bulk Density collected in association with this profile
Soil Drainage Class: somewhat poorly drained
Hydric soils indicators: none

Water Table Depth

7/7/2010 155 cm

VASX-N-TNC1 7/9/2010
Sussex County, VA
Mapped Soil Series: Myatt
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	5	-	-		7.5YR 2.5/2	
A	33	SiL	10 (18)		10YR 3/1	
Bg1	57	C (CL)	41 (30)		10YR 5/1	
Bg2	110	C	42		10YR 5/1	
		(CL)	(35)	med, prom, 21%	10YR 5/6	
Bg3	150	C	46		10YR 4/2	
		(CL)	(36)	med, prom, 2%	7.5YR 5/8	
BCg	185+	SC	40		2.5Y 7/1	
			(38)	med, prom, 18%	10YR 6/6	

Additional Notes
Soil Drainage Class: poorly drained
Hydric soils indicators: A11
Water Table Depth
7/9/2010 Not Reached

VASX-N-TNC1 7/9/2010
Sussex County, VA
Mapped Soil Series: Myatt
Profile B
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4	-	-		7.5YR 2.5/2	
A	32	SiL (SiL)*	10 (18)*		10YR 3/1	
Bg1	87	CL	35		10YR 5/2	
		(L)*	(26)*	fine prominent 1%	7.5YR 6/8	
Bg2	145	C	42		10YR 5/1	
		(CL)	(35)	fine prominent 5%	10YR 5/6	
Bg3	175	C	43		10YR 5/2	
		(CL)	(35)	med, prom, 10%	10YR 5/6	
BCg	185+	C	50		10YR 7/1	
			(41)	fine prominent 1%	10YR 5/8	

Additional Notes
Bulk density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric soils indicators: A11
Water Table Depth
7/9/2010 178 cm

VASX-N-TNC1 7/9/2010

Sussex County, VA

Mapped Soil Series: Myatt

Profile C

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oe	4	-	-		7.5YR 3/3	
A	6	L	10		10YR 3/1	
AE	18	L	11		2.5Y 4/3	
E	36	L	13		2.5Y 6/4	
Bt1	79	CL	31		2.5Y 5/4	
				med prominent 20%	10YR 5/6	
Bt2	120+	CL	37		10YR 5/6	
				med prominent 20%	2.5Y 6/1	

Additional Notes

Upland Location, about 20 m up from profile B?

Soil Drainage Class: moderately well drained

Hydric soils indicators: None

Water Table Depth

7/9/2010 not reached

VASX-N-TNC2 8/12/2010
Sussex County, VA
Mapped Soil Series: Yemasee
Profile A
Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	16	SiL (SiL)*	10 (22)*		2.5Y 3/1	
Bg1	46	SiL	14		2.5Y 5/1	
				m-f, prominent, 12%	10YR 5/6	
				10%	10YR 4/1	
Bg2	70	SiC	42		2.5Y 5/1	
		(SiC)*	(43)*	medium, prom, 22%	10YR 5/8	
				10%	10YR 4/1	
Bg3	88	SiCL	33		2.5Y 5/1	
		(CL)		medium, prom, 3%	10YR 5/6	
Bg4	108	SiCL	35		10YR 4/1	
		(CL)*	(35)*	fine, prominent, 3%	10YR 5/8	
Bg5	154	C	42		10YR 6/2	
				med-co, prom, 25%	10YR 5/6	
Bg6	190+	CL	39		10YR 5/2	
				med-co, prom, 25%	10YR 5/6	

Additional Notes

Bulk density collected in association with this profile
Soil Drainage Class: poorly drained
Hydric soils indicators: A11

Water Table Depth

8/12/2010 Not Reached

VASX-N-TNC2 8/12/2011

Sussex County, VA

Mapped Soil Series: Yemasee

Profile B

Description conducted by Daniel Fenstermacher and Phil Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ag	8	SiL	24		10YR 4/1	
				f, p, root ch, 10%	7.5YR 5/8	
Bg1	48	SiCL	33		2.5Y 5/1	
				f, p, root ch, 10%	7.5YR 5/8	
				medium, prom, 25%	10YR 6/6	
Bg2	110	CL	38		2.5Y 6/1	
				fine prominent 5%	7.5YR 5/8	
				medium, prom, 30%	10YR 6/6	
Bg3	151	CL	34		2.5Y 6/1	
				medium, faint, 15%	2.5Y 7/1	
				medium prom 18%	10YR 5/6	
Bg4	190+	CL	38		2.5Y 7/1	
				co, distinct, 10%	2.5Y 4/1	
				medium, prom, 8%	2.5Y 6/1	
				medium, prom, 22%	10YR 6/8	

Additional Notes

Soil Drainage Class: poorly drained

Hydric soils indicators: F3 and F8

Water Table Depth

8/12/2010 not reached

VASX-PC-Bn 8/10/2010

Sussex County, VA

Mapped Soil Series: Eulonia

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	19	L	16		2.5Y 4/2	
		(SL)	(10)	fine, distinct, 3%	10YR 5/6	
Bw1	57	CL	36		2.5Y 5/4	
		(SCL)	(28)	med, distinct, 8%	7.5YR 5/8	
Bw2	116	CL	32		2.5Y 5/4	
		(SCL)		med, distinct, 15%	2.5Y 6/2	
				med, distinct, 12%	5YR 4/6	
				med, distinct, 15%	7.5YR 5/6	
Bg	153	CL	36		2.5Y6/2	
		(SCL)		med, prom, 22%	7.5YR 5/8	
				med, prom, 13%	5YR 4/6	
BC	177	SCL	23		7.5YR 5/6	
				med, prom, 18%	2.5Y 6/1	
CBg	195+	C	50		10Y 7/1	
				co, prominent, 23%	10YR 6/8	
				co, prominent, 8%	10R 5/4	

Additional Notes

Soil Drainage Class: moderately well drained

possibly somewhat poorly drained due to concentrations to the surface

Hydric soils indicators: none

Water Table Depth

Did not reach

VASX-PC-Bn 8/10/2010

Sussex County, VA

Mapped Soil Series: Eulonia

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Ap	28	SL (SL)*	12 (10)*		2.5Y 4/2	
Bw1	55	CL	28		2.5Y 5/3	
		(SCL)*	(28)*	med, prom, 15%	10YR 5/6	
Bw2	90	CL	38		2.5Y 6/3	
		(SCL)*	(29)*	med, prom, 30%	10YR 6/8	
				medium, faint, <2%	2.5Y 6/2	favors bottom
				med, distinct, 5%	5YR 5/6	
Bw3	108	CL	30		7.5YR 5/8	
		(SCL)		med, prom, 25%	2.5Y 6/2	
				med, distinct, 3%	5YR 4/4	
Bw4	134	CL	33	40%	7.5YR 5/8	
		(SCL)		med, prom, 40%	2.5Y 7/1	
				med, prom, 20%	2.5YR 4/8	
Bg	170	CL	34		2.5Y 7/1	
		(SCL)		med, prom, 30%	7.5YR 5/8	
				med, prom, 15%	5YR 5/6	
BCg	195+	CL	39		2.5Y 8/1	
		(SCL)		med, prom, 8%	10YR 5/6	
				med, prom, 4%	5YR 5/6	

Additional Notes

Soil Drainage Class: moderately well drained

Bulk Density collected in association with this profile

Hydric soils indicators: none

Water Table Depth

no water table reached

VASX-R-Bn 8/10/2010

Sussex County, VA

Mapped Soil Series: Eulonia

Profile A

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
A	2	SL	3		2.5Y 4/2	
1^BC	12	SL	4		2.5Y 6/4	8% gravels
		(LS)		med-fine, prom, 8%	7.5YR 5/8	->root pores
2^C1	32	LS	5		2.5Y 6/3	
		(SL)		med, distinct, 30%	2.5Y 5/2	->favors bottom
3^C2	50	CoS	2		2.5Y6/4	
4Apb	57	SL	9		2.5Y 5/2	
4Bwb	70	SL	14		2.5Y6/4	
				med, prom, 25%	2.5Y 6/6	
				med, prom, 21%	2.5Y 6/1	
5Bgb	130	CL	36		2.5Y 6/1	
				co, prominent, 10%	5YR 4/6	
				co, prominent, 20%	10YR 5/6	
5BCg	163+	CL	31		2.5Y 6/1	
				co, prominent, 20%	10YR 5/6	

Additional Notes

^ indicates human transported material

Soil Drainage Class: poorly drained although not clear due to human disturbance

Hydric soils indicators: none

Water Table Depth

8/10/2010 2cm above surface

VASX-R-Bn 8/10/2010

Sussex County, VA

Mapped Soil Series: Eulonia

Profile B

Description conducted by Daniel Fenstermacher and Philip Clements

Horizonation	Depth (cm)	Texture	% Clay	Color		Notes
Oa	0.5	-	-		2.5Y 4/2	
1^BC	11	S	2		2.5Y 5/4	
		(LS)*	(5)*	f-m, distinct, 15%	7.5YR 5/8	
2^CBg	32	LS	4		2.5Y 5/2	
		(SL)*	(6)*	fine, distinct, 6%	10YR 6/6	
3Bgb	52	CL	34		2.5Y 6/2	
		(SL)	(15)	med, prom, 15%	10YR 5/6	
				med-co, dist, 20%	2.5Y 6/6	
3Bgb2	79	SC	37		10YR 7/1	
		(SL)*	(16)*	coarse, prom, 20%	10YR 5/8	
				medium, prom, 5%	5YR 4/6	
4Bwb	125	SL	15		10YR 5/6	
				medium, prom, 10%	10YR 7/1	
				medium, dist, 5%	5YR 4/6	->favors top
5BCg	162	SC	38		2.5Y 6/1	
				medium, prom, 10%	7.5YR 5/6	
				med-co., prom, 20%	2.5Y 6/6	
5CBg	195+	CL	34		10YR 7/1	
				coarse, prom, 23%	2.5Y 6/6	

Additional Notes

^ indicates human transported material

Bulk Density collected in association with this profile

Soil Drainage Class: poorly drained, although not clear due to human disturbance

Hydric soils indicators: S5

Water Table Depth

no water table reached

although water ponded near surface

effect of wetland construction

Appendix E: Bulk Density and Carbon Data, CEAP

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
DEK-PC-Me	Ap	28	1.54	0.02	1.29	0.09
DEK-PC-Me	Bg	45	1.74	0.01	0.21	0.03
DEK-PC-Me	2Bg2	66	1.68	0.02	0.07	0.01
DEK-PC-Me	2Bg3	108	1.81	0.04	0.03	0.01
DEK-PC-Rs	Ap	24	1.46	0.06	1.43	0.08
DEK-PC-Rs	Bg1	60	1.84	0.11	0.06	0.01
DEK-PC-Rs	Bg2	91	1.85	0.02	0.03	0.01
DEK-PC-Stn	Ap	15	1.05	0.05	3.86	0.31
DEK-PC-Stn	Ap2	27	1.08	0.03	3.56	0.04
DEK-PC-Stn	A	45	1.12	0.12	2.12	0.39
DEK-PC-Stn	Ag	60	1.60	0.04	0.45	0.06
DEK-PC-Stn	Bg	85	1.43	0.08	0.37	0.08
DEK-PC-Stn	BCg	101	1.42	0.05	0.27	0.01
DEK-R-Jr	A	6	1.36	0.12	1.71	0.17
DEK-R-Jr	Ap	24	1.78	0.06	0.17	0.01
DEK-R-Jr	Bg1	54	1.78	0.05	0.06	0.04
DEK-R-Jr	Bg2	77	1.87	0.04	0.03	0.00
DEK-R-Sg	^AC	4	1.78	0.00	0.21	0.12
DEK-R-Sg	A	41	1.81	0.09	0.46	0.01
DEK-R-Sg	Bg	65	1.86	0.06	0.04	0.01
DEK-R-Sg	BCg	116	1.67	0.02	0.03	0.01
DENC-N-BB	Oe	2	0.10	0.01	36.78	16.01
DENC-N-BB	Oa	10	0.31	0.22	35.88	11.45
DENC-N-BB	A1	39	0.56	0.01	8.99	0.69
DENC-N-BB	A2	68	1.23	0.13	3.64	0.06
DENC-N-BB	AB	105	1.55	0.10	3.04	0.41
DENC-R-As	Oa	8	1.51	0.08	0.96	0.08
DENC-R-As	Ap	19	1.54	0.03	0.78	0.06
DENC-R-As	EBg	33	1.62	0.00	0.09	0.00
DENC-R-As	Bw	90	1.56	0.01	0.05	0.00
MDC-N-AB	Oe	9	0.21	0.02	9.13	0.44
MDC-N-AB	Oa	22	0.31	0.09	3.43	0.57
MDC-N-AB	A1	53	0.34	0.03	1.71	0.16
MDC-N-AB	A2	72	1.10	0.19	15.70	1.13
MDC-N-AB	BCg	150	1.21	0.04	56.05	0.39
MDC-N-BC	Oe	5	0.13	0.01	55.92	0.22
MDC-N-BC	Oa	50	0.42	0.19	13.90	3.12
MDC-N-BC	A	70	0.59	0.09	7.67	3.19

Appendix E: Bulk Density and Carbon Data, CEAP, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
MDC-N-BC	Bg	97	1.39	0.06	2.66	0.57
MDC-N-BeW	Oe	8	0.21	0.02	35.67	1.72
MDC-N-BeW	A1	30	1.13	0.13	2.45	0.56
MDC-N-BeW	A2	54	1.13	0.03	1.65	0.22
MDC-N-JL	Oe	4	0.51	0.09	11.51	1.99
MDC-N-JL	A	22	0.86	0.09	4.30	0.25
MDC-N-JL	Bg1	39	1.41	0.07	0.69	0.39
MDC-N-JL	Bg2	84	1.49	0.17	0.26	0.02
MDC-PC- Hs	Ap	19	1.32	0.13	1.93	0.36
MDC-PC- Hs	A	30	1.51	0.05	0.62	0.21
MDC-PC- Hs	AB	49	1.38	0.02	0.40	0.03
MDC-PC- Hs	Bg1	66	1.59	0.08	0.26	0.05
MDC-PC- Hs	Bg2	88	1.83	0.03	0.13	0.05
MDC-PC-BeF	Ap	36	1.26	0.06	2.60	0.05
MDC-PC-BeF	A1	58	0.92	0.00	3.38	0.14
MDC-PC-BeF	A2	89	0.93	0.08	2.73	0.49
MDC-PC-Cr	Ap	40	1.59	0.01	0.81	0.10
MDC-PC-Cr	AB	66	1.66	0.03	0.19	0.02
MDC-PC-Cr	Bg1	102	1.83	0.02	0.09	0.01
MDC-R-Bs	Ap	13	1.52	0.01	1.09	0.08
MDC-R-Bs	2A	47	1.37	0.01	3.16	0.24
MDC-R-Bs	2Btg1	69	1.74	0.03	0.12	0.01
MDC-R-Bs	2Btg2	105	1.79	0.08	0.06	0.00
MDC-R-JL	A1	11	1.38	0.03	1.10	0.06
MDC-R-JL	A2	45	1.43	0.05	1.44	0.05
MDC-R-JL	BAg	63	1.35	0.06	1.12	0.13
MDC-R-JL	Bg	100	1.38	0.03	0.40	0.03
MDD-N-CF	A1	2	0.31	0.02	0.23	0.04
MDD-N-CF	A2	9	1.27	0.03	0.25	0.04
MDD-N-CF	Ab1	19	1.35	0.13	0.12	0.00
MDD-N-CF	Ab2	32	1.37	0.04	9.60	3.31
MDD-N-CF	BAgb	53	1.56	0.00	1.79	0.23
MDD-N-CF	Bgb1	89	1.63	0.02	1.28	0.27
MDD-PC-Br	Ap	16	1.73	0.03	0.79	0.12
MDD-PC-Br	AEg	55	1.88	0.02	0.83	0.13
MDD-PC-Br	Eg	78	1.82	0.07	0.10	0.01
MDD-PC-Kp	Ap	33	1.61	0.08	0.03	0.01
MDD-PC-Kp	ABg	60	1.61	0.06	1.05	0.18
MDD-PC-Kp	BEg	135	1.82	0.02	0.32	0.12

Appendix E: Bulk Density and Carbon Data, CEAP, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	% C St. Dev.
MDD-R-Ck	AB	11	1.78	0.12	0.23	0.13
MDD-R-Ck	Bg	39	1.78	0.07	0.07	0.05
MDD-R-Ck	BCg	66	1.76	0.05	0.06	0.01
MDD-R-Ck	Cg1	118	1.82	0.13	0.04	0.01
MDD-R-Wn	A	5	1.27	0.04	1.35	0.09
MDD-R-Wn	Ap	24	1.60	0.01	0.69	0.04
MDD-R-Wn	Beg	62	1.93	0.06	0.10	0.04
MDD-R-Wn	Bg	115	1.68	0.06	0.05	0.01
MDQA-N-AF	Oe	3	0.33	0.09	20.00	3.10
MDQA-N-AF	A	17	1.19	0.02	2.26	0.21
MDQA-N-AF	Btg1	64	1.39	0.15	0.67	0.23
MDQA-N-AF	Btg2	97	1.33	0.10	0.37	0.04
MDQA-PC-Ss	A	5	1.15	0.12	1.94	0.34
MDQA-PC-Ss	Ap	36	1.59	0.02	0.58	0.12
MDQA-PC-Ss	A`	66	1.63	0.04	0.38	0.03
MDQA-PC-Ss	Bg	103	1.88	0.09	0.07	0.00
MDQA-R-En	Ap	26	1.51	0.05	1.08	0.34
MDQA-R-En	Bg	56	1.60	0.06	0.24	0.04
MDQA-R-En	2Bg2	71	1.63	0.02	0.12	0.00
MDQA-R-En	2Bg3	84	1.80	0.16	0.05	0.03
MDQA-R-Ss	Oe	2	0.74	0.12	0.32	0.03
MDQA-R-Ss	A	9	1.49	0.09	6.32	0.61
MDQA-R-Ss	Bg1	31	1.44	0.01	0.53	0.10
MDQA-R-Ss	Bg2	153	1.59	0.04	0.22	0.02
MDQA-R-Ws	A	14	1.36	0.11	0.05	0.00
MDQA-R-Ws	Btg1	38	1.70	0.01	1.63	0.40
MDQA-R-Ws	Btg2	63	1.75	0.05	0.08	0.00
MDQA-R-Ws	2Bg	98	1.68	0.13	0.07	0.02
MDT-N-SD	Oe	5	0.18	0.08	0.08	0.01
MDT-N-SD	A	22	1.25	0.04	38.46	6.01
MDT-N-SD	Bg1	70	1.39	0.03	1.28	0.08
MDT-N-SD	Bg2	126	1.54	0.03	0.35	0.07
MDT-R-DF	Oa	2	0.57	0.03	0.07	0.00
MDT-R-DF	Ag	29	1.71	0.01	4.68	0.34
MDT-R-DF	Bg	66	1.84	0.00	0.24	0.05
MDT-R-DF	BCg	127	1.92	0.11	0.06	0.01
NC-N-EC	Oe	3	0.13	0.02	0.03	0.02
NC-N-EC	Oa1	28	0.29	0.06	58.87	0.17
NC-N-EC	Oa2	69	0.27	0.03	59.87	1.86

Appendix E: Bulk Density and Carbon Data, CEAP, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	%C St. Dev.
NC-N-EC	BA	95	1.22	0.01	2.16	0.15
NC-N-PLR1	Oe	8	0.20	0.02	33.82	3.53
NC-N-PLR1	BC	16	0.36	0.03	1.96	0.18
NC-N-PLR1	A	51	1.25	0.22	2.84	0.50
NC-N-PLR1	Bg1	80	1.64	0.01	0.37	0.08
NC-N-PLR1	Bg2	106	1.40	0.08	0.74	0.12
NC-N-PLR2	Oa1	13	0.20	0.03	61.92	0.65
NC-N-PLR2	Oa2	29	0.24	0.04	60.22	8.79
NC-N-PLR2	Oa3	58	0.65	0.02	10.12	0.82
NC-N-PLR2	Oa4	118	1.20	0.18	4.77	1.36
NC-PC-EC	Oap	13	0.86	0.02	17.05	0.38
NC-PC-EC	Oa	35	0.55	0.11	29.57	5.40
NC-PC-EC	Ag	57	0.92	0.03	5.10	0.49
NC-PC-EC	Bg	125	1.41	0.03	0.70	0.09
NC-PC-KY	Oap1	14	0.73	0.05	27.35	2.64
NC-PC-KY	Oap2	33	0.46	0.04	42.34	12.45
NC-PC-KY	A	53	1.05	0.06	5.07	0.48
NC-PC-KY	BA	80	1.71	0.01	1.01	0.06
NC-PC-KY	BC	100	1.50	0.12	1.36	0.26
NC-PC-MT	Oap	22	0.86	0.02	13.07	0.47
NC-PC-MT	Oa1	47	0.51	0.05	22.42	4.20
NC-PC-MT	Oa2	87	1.16	0.02	3.35	0.02
NC-PC-MT	Ag	110	1.30	0.05	2.26	0.90
NC-R-EC	Oap	12	0.57	0.03	26.57	3.60
NC-R-EC	Oa	40	0.73	0.03	14.17	0.64
NC-R-EC	Ag	59	1.15	0.02	2.53	0.40
NC-R-EC	Bg	75	1.18	0.02	0.85	0.30
NC-R-EC	Cg1	125	1.34	0.07	0.40	0.33
NC-R-KY	Oap	12	0.37	0.01	70.65	1.48
NC-R-KY	Oa	33	0.29	0.00	70.10	0.43
NC-R-KY	A	46	1.10	0.12	4.50	1.32
NC-R-KY	Bg	59	1.29	0.10	2.52	0.50
NC-R-KY	Ab	100	1.60	0.12	1.06	0.20
NC-R-MT	Oe	10	0.29	0.02	61.42	0.63
NC-R-MT	Oa1	44	0.32	0.01	71.17	0.93
NC-R-MT	Oa2	86	0.55	0.06	37.05	6.04
NC-R-MT	Oa3	137	0.81	0.05	16.49	0.70
VASH-PC-BKS	Ap	24	1.30	0.00	0.72	0.15
VASH-PC-BKS	BE	42	1.60	0.03	0.05	0.01

Appendix E: Bulk Density and Carbon Data, CEAP, continued

Site	Horizon	Bottom Depth (cm)	Bulk Density (g cm^{-3})	Bulk Density St. Dev.	% C	%C St. Dev.
VASH-PC-BKS	Bw1	95	1.55	0.01	0.05	0.00
VASH-R-BKS	Ap	22	1.45	0.07	1.80	0.11
VASH-R-BKS	Ag	45	1.56	0.12	0.54	0.18
VASH-R-BKS	Bg	78	1.57	0.07	0.17	0.05
VASH-R-BKS	Bg2	107	1.53	0.01	0.11	0.02
VASH-PC-Bn	Ap	20	1.50	0.06	0.91	0.03
VASH-PC-Bn	A	45	1.65	0.01	0.43	0.13
VASH-PC-Bn	Bt	91	1.71	0.00	0.07	0.00
VASH-R-Bn	Ap	25	1.71	0.00	0.17	0.02
VASH-R-Bn	BE	64	1.75	0.04	0.10	0.01
VASH-R-Bn	Bt1	116	1.71	0.02	0.07	0.01
VASK-N-CD	Oi	10	0.15	0.02	36.82	5.81
VASK-N-CD	A	30	1.63	0.04	1.16	0.08
VASK-N-CD	Btg1	68	1.66	0.02	0.33	0.07
VASK-N-CD	Btg2	120	1.60	0.06	0.22	0.02
VASK-PC-CD	Ap	26	1.79	0.06	0.29	0.03
VASK-PC-CD	BE	45	1.75	0.03	0.12	0.01
VASK-PC-CD	Bt1	97	1.65	0.07	0.08	0.02
VASK-R-CD	Ap	14	1.51	0.01	0.96	0.06
VASK-R-CD	BA	43	1.67	0.06	0.09	0.06
VASK-R-CD	Btg1	78	1.74	0.04	0.03	0.00
VASX-N-NC1	Oe	4	0.25	0.02	20.21	2.96
VASX-N-NC1	A	32	0.98	0.12	3.79	0.42
VASX-N-NC1	Bg1	87	1.52	0.15	0.44	0.34
VASX-N-TNC2	A	16	1.30	0.05	3.28	0.17
VASX-N-TNC2	Bg1	46	1.55	0.04	0.38	0.18
VASX-N-TNC2	Bg2	70	1.50	0.04	0.36	0.08
VASX-N-TNC2	Bg3	88	1.46	0.01	0.37	0.01
VASX-PC-BN	Ap	28	1.65	0.01	0.74	0.01
VASX-PC-BN	Bw1	55	1.67	0.00	0.17	0.01
VASX-PC-BN	Bw2	90	1.64	0.01	0.07	0.01
VASX-R-BN	Oa	0.5	0.11	0.00	4.27	0.53
VASX-R-BN	1^BC	11	1.79	0.03	0.11	0.01
VASX-R-BN	2^CBg	32	1.98	0.05	0.05	0.00
VASX-R-BN	3Bgb	52	1.85	0.02	0.05	0.00
VASX-R-BN	3Bgb2	79	1.75	0.01	0.04	0.01
VASX-R-BN	4Bwb	125	1.77	0.01	0.03	0.00

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