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USING BLACK EARTH AND REMOTE SENSING OF INDICATOR PLANTS FOR IDENTIFICATION OF PREHISTORIC ARCHAEOLOGICAL SENSITIVITY AND POTENTIAL SITE INTEGRITY IN THE EASTERN WOODLANDS:

Summary and Analysis of Black Earth and Indicator Species Tools as Indicators of Archaeological Site Presence and Integrity

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Table of Contents

Introduction

Department of Defense Legacy Resource Management Program (Legacy) Project #10-416, "Using Black Earth and Remote Sensing of Indicator Plants for Identification of Prehistoric Archeological Sensitivity and Potential Site Integrity in the Eastern Woodlands" has progressed from field data collection to data analysis and recommendations stages. This technical report will provide a summary of soils data collected at four installations (Fort Drum Army Installation, NY; Marine Corps Base Quantico, VA; Cheatham Annex owned by Naval Weapons Station Yorktown, VA; Dare County Bombing Range owned by Seymour Johnson Air Force Base, NC) to explore the efficacy of Black Earth as an indicator of Native American activity on the landscape. Also included in an appendix (Appendix A) is vegetation and soil charcoal data obtained from seven additional sites surveyed in 2010 on Ft. Drum (Sites: FDP 1161, FDP 1268, FDP 1267, "Earthworks," FDP 1272, "General's Loop Road," and "ASOS Sites").

This technical report is the first of five products delivered to the Department of Defense (DoD) Legacy Resource Management Program relating the findings and management recommendations obtained from this project. This technical report provides detail of data collected, analysis, and major conclusions stemming from the analysis. These conclusions were then applied to develop management strategies that can be implemented across a wide range of DoD holdings in the eastern United States. The second delivered product is a technical analysis of the ways in which DoD cultural resources management personnel can apply what we have found. The technical analysis provides recommended applications of the management strategies. Two protocols (in PowerPoint slideshow format) are also provided that include detailed supporting information about the methodologies discussed in the technical analysis. These protocols are described in step-by-step format and designed to be readily accessible and usable by DoD cultural resources management personnel.

Study Sites

Fort Drum, NY:

Fort Drum is an Army installation in upstate New York, in Jefferson, Lewis, and St. Lawrence Counties. This area of New York was inhabited by Iroquoian peoples that formed semi-sedentary family groups of up to about 200 individuals during the Late Woodland Time

Period (AD 500 to 1000, and extending to Contact in many areas of the northeast US). These groups utilized many plant species for food, medicinal purposes, and building materials. Some of these species were very heavily utilized, and actually purposefully propagated to supply a continual and ready supply for the natives of the area (Day 1953). Species such as oaks, hickories, blueberry, and pine were especially valued as food (mast or berries) and materials sources. Land use practices employed by the Iroquois, such as periodic burning, facilitated a supply of these sources and had a legacy effect on the landscape (Black and Abrams 2001). Hunting wild game, such as deer, bear and small mammals, was also an important source of food; land use practices that ensured a continual supply of food sources also benefited populations of these game species (Abrams and Nowacki 2008).

After 700 AD, maize-based agriculture reached the Fort Drum area, and natives conducted raised-bed gardening, cultivating the "three sisters:" maize, beans, and squash (Trigger 1978, Smith 1989). To supplement horticultural crop production, hunting and gathering occurred from sites known as "resource camps." These camps were inhabited for months at a time, and are identified by artifacts such as lithic scatters from tool-making, hearths, and projectile points (Fort Drum Cultural Resources Management). Soil samples were taken at Fort Drum both on the site of a St. Lawrence Iroquois village, and several outlying resource camps. The village was inhabited by about 200-500 people for about 15 years, with agricultural activity and midden creation taking place during that inhabitation.

MCB Quantico, VA:

Marine Corp Base Quantico (MCBQ) is located in Stafford, Faquier and Prince William Counties in Virginia, along the Potomac River. Tribal groups present in this region in the Late Woodland up to the time of Contact (1608) were the Pamacocack as well as the Pomunkey, who moved to Virginia side of Potomac after Contact. They were Algonquian speakers, like many of the groups inhabiting the eastern coast. The land use practices of these groups were documented by the early European settlers, who indicate that freshwater food resources were very important (also indicated by the concentration of settlements along waterways which were important for transportation as well), as well as wild gathering of plants for food and medicinal plants. Mast species such as white and black oaks, hickory, and chestnut were very important in the diet, and

periodic understory burning propagated these disturbance-adapted tree species (Day 1953). Pickerel weed and arrow arum (or tuckahoe) were important herbaceous sources of food, and can be found in abundance along the many slow-moving freshwater channels in this area.

At the time of contact, maize-based agriculture was very important as a reliable food source for the natives of eastern Virginia and Maryland. Captain John Smith's reports from the exploration of the Chesapeake Bay area reference native "hilltop agriculture," which is the opposite of what would be expected due to the difference in soil quality in the lowlands versus the narrow, sandy, and erodible hilltops. However, positions of settlements were usually on hilltops for defense purposes so agricultural fields may have been located there simply for convenience. Hamlet settlements along the north side of Chopawamsic Creek would have been home to a family group and would have had horticultural gardens associated with them (John Haynes, personal communication). Pamacocack, also the name of the people who inhabited the area in the Late Woodland, was a settlement along the west side of the Potomac River between Quantico and Chopawamsic Creeks. This area has been developed and the site destroyed.

Cheatham Annex, VA:

The Cheatham Annex (CAX) is owned by the Naval Weapons Station at Yorktown, and lies completely within York County, VA. This area was inhabited by Algonquian-speaking peoples of the Powhatan Confederacy during the Late Woodland Time Period. Resources utilized by these groups of people were dominated by marine resources such as shellfish harvested from brackish waterways that flow through the Tidewater Zone of coastal Virginia. Hunting and gathering of wild foods and medicinals was also important. Maize-based agriculture was introduced in AD 700, and was an important steady food supply. In addition, the gathering of wild resources (including marine resources) was also significant, as evidenced by huge areas of shell middens throughout settlement. Shell middens are very diagnostic, and easily recognizable, and are used as indicators in our "hierarchy model" for efficient identification of culturally significant areas. This hierarchy model includes shell middens as the top tier, followed by indicator plant species, Black Earth and soil charcoal presence in the soil. Topographic position, e.g., high, well-drained bluffs overlooking brackish waterways and near freshwater

creeks, were also used in our hierarchy model, as an indicator of the most desirable settlement areas.

Soil sampling on the CAX was limited to a grid along the south bank of Queen Creek, in an area known as the Wilderness Area because of the lack of development. The area is used for hiking and fishing access to a small human-created lake in the eastern section of the area. As archaeological testing of the Wilderness Area has not been completed, exact uses and boundaries for any cultural sites located therein are unknown. For this reason, no controls were available for testing to compare with archaeological sites. The presence of shell midden evidence along the bluff to the south of Queen Creek, especially where the road was cut into the side of the bluff, has led us to believe that there was abundant Native American activity all along the bank of the creek. These sites may have been settlement areas with associated agricultural fields, or resource-gathering camps along the creek. It is possible that activity along the creek was limited to shell fishing, hunting, and gathering of wild resources, because of the amount of resources available in this area. Other evidence that this area contained only resource gathering camps comes from the earliest map of the area, created by Captain John Smith, which notes Indian settlements throughout the area; none are located in the area of the CAX. A blanket grid method of soil sampling may help us to elucidate this issue.

Dare County Bombing Range, NC:

Dare County, NC is a very swampy, peat laden area bisected by many waterways. Native Americans in this area were small Algonquian-speaking groups such as the Croatans, Matamuskeets, and Hattaras groups. They utilized both land and sea resources, making winter camps on the coast and summer camps further inland when insect populations became numerous in low-lying coastal areas. The landscape in this area is waterlogged, and not very useful for agriculture. Most agriculture was conducted inland, and the maize, squash, tobacco, and beans were then preserved or stored, and transported to the coastal habitation areas. When groups inhabited coastal areas the sea resources were abundant. They would fish with weirs along the shallow coastal waterways, and collect oysters and catch turtles for meat. Deer and bear were also hunted.

No soil samples were taken for Black Earth analysis on the Dare County Bombing Range because of the muck and hydric soils and high organic matter or peat mats that cover much of the swampy area. Soil samples were difficult to obtain at the vegetation plots that were established, and even if samples could be obtained, samples for Black Earth testing were not possible because archaeological testing revealed no cultural resources on the Range. While this may or may not be indicative of the amount of Native American activity that was occurring in the area, we have no cultural sites or control sites to compare to one another, and thus no available data for human effects on the soils of pre-European settlement coastal North Carolina.

Black Earth

Introduction:

Terra Preta (or Black Earth) is an anthropogenic soil of enhanced fertility, with high levels of soil organic matter and nutrients embedded in a landscape of infertile soils (Mann 2000, Lehmann et al. 2003). Terra Preta soils created over 2000 years ago have been reported in the Brazilian Amazon basin and other areas, and were created by human amendments to inherently infertile tropical soils over hundreds of years. An important amendment to the soil was created through smothered burning of agricultural and human waste, as well as plant biomass (low or no oxygen prevents combustion). This creates a substance that has been termed "biochar." Biochar and charcoal, human refuse, kitchen waste, etc. were used as amendments (Hecht 2004). These human-related activities increase the amount of calcium, carbon, phosphorous, and nitrogen occurring in soil strata (Skinner 1986). Native groups of highland Mesoamerica also practiced agricultural amendment, in the form of raised fields to which additional nutrient-rich muck and other organic material was added. This practice was a component of the chinampa system (Jácome 1993). The Native Americans inhabiting eastern North America may also have amended soils, especially in areas of inherently low soil fertility.

Maize-based agriculture was introduced in the northeastern U.S. around AD 700-1000. However, hunting and gathering remained important, and the subsistence methods that typified the Late Woodland Period (a combination of maize-based agriculture and hunting and gathering) extended up until the time of first Contact in many more northern areas of the eastern U.S. (Fritz 1990). Prior to the introduction of maize, several plants were brought under human cultivation;

maygrass, lambs quarters, knotweed, sunflowers, and marsh elder, however these plants were more typical of the mid- to southeastern U.S. (sites in Virginia and North Carolina), while the most notable in the northeast was lambs quarters (New York; Day 1953). Agricultural systems were not advanced, however, until the introduction of maize and techniques associated with "three sisters" cultivation. This introduction and the following societal shifts were so profound as to mark the beginning of the Late Woodland Time Period.

Agricultural systems during this time were thought to be typified by slash and burn techniques. The intended agricultural site would be burned, after which the charcoal produced by the burn would have been left on the field as an amendment (Delcourt 1987). Agricultural fields were typically labor-intensive to create, requiring girdling of the trees on a site and clearing of all vegetation. For this reason, it would have been in the best interest of the Iroquoian groups to increase the useful life of the fields through soil amendments with charcoal, human waste, and organic refuse. Over time, these amendments would have created a signal in the soil, possibly visible in the landscape today in the form of increased fertility in soils of Native American agricultural fields. Alternatively, soils would have received little attention beyond application of the charcoal from initial burning, and would have been depleted of nutrients in 7-15 years. Then, the depleted field would have been allowed to lie fallow in a swidden agricultural system, and another area would be prepared. This type of system would be described as extensive rather than intensive, as the agricultural systems which produced Terra Preta would have been, and may have been more prevalent in areas of higher baseline soil fertility. Another way Black Earth could have been indirectly created was through the formation of middens, or refuse piles that would inevitably form through build-up of waste from a settlement in one spot for an extended period of time.

There is historical evidence that some Native groups in the eastern U.S. were using agricultural amendments at the time of Contact with European explorers and settlers (Mrozowski 1994). The people of the Waumpanoag group in the coastal northeast are said to have applied fish remains to agricultural fields as an amendment (Ceci 1975). Organic remains were also applied to the raised mounds in which the maize was planted. In the rocky coastal soils, this practice would have increased the productivity of the fields. However, determining the cumulative effect of Native Americans on soils has been elusive.

A general hypothesis is that in areas of low soil fertility (e.g., sandy glacial outwash or coastal plains), amendments would have been necessary simply to initiate the growing of horticultural plants. In these areas, the nutrient status and color of the soils on agricultural fields would have been raised through the addition of charcoal and well as human and animal waste. The present nutrient status and color of these soils may still show the signal of these amendments. However, in areas of higher soil fertility where amendments would not have been necessary to initiate crop production, the baseline fertility level of the soil may have been decreased in over-used agricultural fields, and these areas today would show less fertility than the surrounding areas.

Methods:

Soil samples were taken at the depth of occupation (~20 cm at Fort Drum and ~30 cm at MCB Quantico and Cheatham Annex, top 10 cm and organic layer removed). Samples were extracted from the ground using a soil corer with a 25 centimeter diameter tube for minimal disturbance to cultural resources present on the sites. At resource camp locations on Fort Drum and MCB Quantico, samples were obtained in conjunction with surveyed vegetation plots. Depending on the size of the cultural site, anywhere from three to six plots were used for the study. An equal number of paired control plots were set off the archaeological sites, controlling for geomorphology and topography. Soil samples were sifted for organic materials and dried as soon as possible, then sealed in plastic bags for transport back to Penn State University, where they were analyzed for pH, phosphorous, potassium, magnesium, calcium, acidity, cation exchange capacity, and total nitrogen at the Agriculture Analytical Services Lab on Penn State's campus. Soil color was determined in the field prior to sifting and drying, using the Munsell 10YR system of color coding (Figure 1).
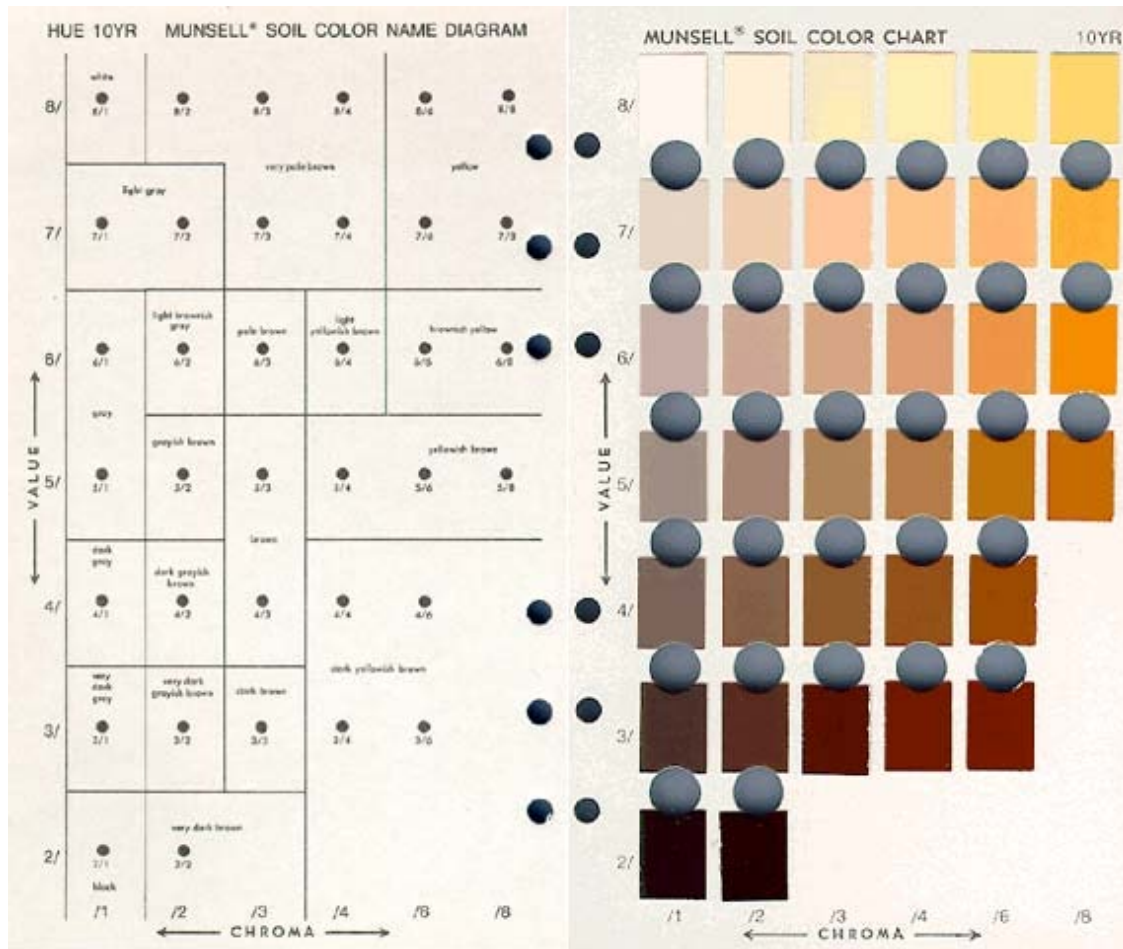
Figure 1. Munsell 10YR system of assigning color to soil samples. On the left are color names, and on the right are color plates for comparison in the field.

At archaeological sites identified as Native American habitation areas, a grid of soil samples was taken to identify inclusions of higher fertility soils. Global Positioning Systems (GPS) waypoints were taken at each sample. The grid was placed to cover the entire archaeological site as well as the surrounding areas. At Fort Drum in upstate New York, a grid was placed on and surrounding an Iroquois palisaded village known as Camp Drum 1. At MCB Quantico in Virginia, a grid was placed on and surrounding several hamlet sites identified along the north bank of Chopawamsic Creek; the entirety of the north bank that had not been developed was surveyed in this way. At the Cheatham Annex along the southwest side of the York River in Virginia, a grid of soil samples was placed adjacent to the south bank of Queen Creek and extending south, including the area of one identified Late Woodland archaeological

site, and surrounding untested areas (shell middens were in evidence in some of the untested area).

Soil data from the resource camp sites at Fort Drum and Quantico was analyzed using 2-sample t-tests in the statistical program R to compare mean values of phosphorous, potassium, magnesium, calcium, nitrogen, and color between samples taken on cultural sites and samples taken on adjacent control sites where no cultural significance was discovered. Nutrient levels were compared in parts per million, and color was compared using a system of continuous coding of Munsell 10YR values (Table 1). This coding system relies on a scaling from darkest soil to lightest soil, with allowances for the fact that colors of black and brown are more representative of soil organic matter content than colors of gray or yellow.

Table 1. Munsell 10YR soil color code and corresponding analysis code for statistical analysis.

Munsell Value	Analysis Code
2/1	1
2/2	2
3/1	3
3/2	4
3/3	5
3/ 4 and 3/ 6	6
4/4 and 4/6	7
4/3	8
4/2	9
4/1	10
5/3	11
5/4 to 5/8	12
5/2	13
5/1	14

Grid samples from Fort Drum, MCB Quantico, and the Cheatham Annex were analyzed using a spatial interpolation method in ArcGIS, a program developed by the Environmental Systems Research Institute (ESRI) for the storage, analysis, and manipulation of geographic data. Waypoints taken at each sample site were uploaded and converted to shapefiles using MN DNR Garmin (software developed by the Minnesota Department of Natural Resources to allow data taken by Garmin handheld GPS units to be uploaded to a desktop), and a "site boundary"

was identified using either heads-up digitizing in ArcMap or through obtaining archaeological site boundary shapefiles from participating installations. Soil sample data returned from Penn State's Agricultural Analytical Services Lab were used to create an index value of soil fertility for each sample. Measurements of sample phosphorous, potassium, magnesium, and calcium were added together for each individual sample to create an "index" value of combined soil fertility at each point a sample was taken. This index value was assigned to each corresponding sample in the attribute table of the waypoint shapefile. Soils information from the Natural Resources Conservation Service (NRCS) was used to ascertain soil types underlying each sample grid for baseline soil fertility (Soil Survey Geographic (SSURGO) Database). If quantitative data on the specific soil types underlying the sites could not be obtained, control soil samples from areas on the same soil type were used to determine the average baseline fertility. A soil fertility index value was assigned to the overall site based on the baseline soil characteristics. The baseline soil fertility index values were subtracted from the individual grid sample soil fertility index values to obtain a value of soil fertility that would indicate whether or not individual sample fertility was higher or lower than the surrounding soils.

ArcToolbox Spatial Interpolation Tools in ArcMap (ArcGIS by ESRI software package) were used to develop a surface to interpolate the soil fertility index across the entirety of the area encompassed by the grid of soil samples at each site. Spatial interpolation is the process of assigning values to unknown points by using values from a set of known points. Inverse Distance Weighting (IDW) was the spatial interpolation technique used. With IDW, unknown points are assigned a value equal to the weighted average of nearby sampled points, where the weight given each point is an inverse proportion to the distance to the unknown point. The interpolation is run using the soil fertility index difference field in the attribute table of the shapefile containing the information about the location of each individual grid sample. The model outputs a raster grid file with an interpolated soil fertility index value assigned to each individual pixel in the grid. The model parameters for the analysis conducted at Ft. Drum and MCB Quantico were an output cell size of 1.5 meters, a variable search radius using the 12 nearest points to interpolate the value of the unknown point, and a power parameter of 2. The power parameter is the exponential value that weight will decrease as distance increases; in this case moving one unit of distance will cause the weight to decrease by an exponent of 2. This

parameter controls how much surrounding points influence the interpolated value. The model parameters were modified for the analysis conducted at the Cheatham Annex because of the larger size of the area sampled and the relatively low number of sample points (output cell size of 3 meters, interpolation used nearest 5 points, with a power parameter of 3). The interpolated surfaces were used to locate and interpret patterns and trends in the data, and relate them to potentially causative Native American activities. Specifically, catchment analysis will be conducted with these results to identify particular areas where data reveal a concentration of higher fertility soil samples that may be indicative of a large area amended for agricultural use.

Results

Fort Drum, NY:

Spatial interpolation analysis at Ft. Drum was conducted at the site of a Late Woodland St. Lawrence Iroquoian palisaded village now known as Camp Drum 1 (Figure 2). Output grid cell size was 1.5 m x 1.5 m and soil fertility classes are based on equal breaks, with 230 soil index units encompassed by each class. Soil fertility (addition of parts per million measurements of phosphorous, potassium, magnesium, and calcium for each sample) of the samples ranged from 225 to 3676 soil index units. The average baseline soil fertility of the Plainfield (represented mostly by PoB) series was 839.7 index units. After calculation of the Soil Fertility Index (subtraction of sample soil fertility values from the baseline value), the values ranged from -612.6 to 2835.4 index units. About 18% of the range of resulting values was composed of negative values (first 2.5 classes represented by colors of dark to light green). These negative values indicate that soil fertility of the samples was lower than that of the average baseline Plainfield series. Over the rest of the range (82%) of soil fertility values, the fertility was higher than the baseline. There are three areas of significantly higher soil fertility associated with the village site; two small inclusions within the boundary of site itself (roughly within the palisade), and one larger area to the south of the site outside the boundary. The highest fertility values are found in this larger area to the south of the site (lighter pink area).
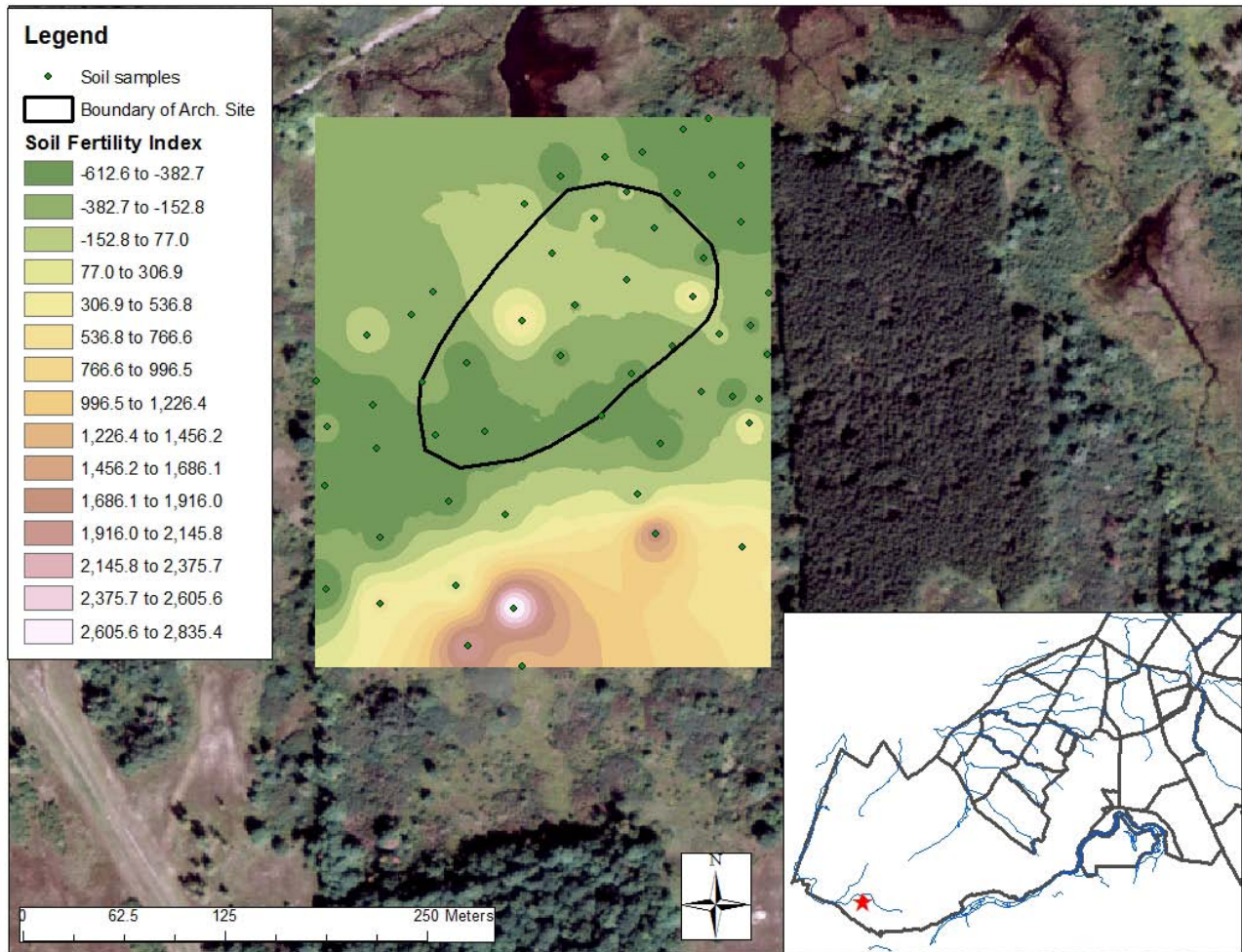
Figure 2. Spatial interpolation of soil fertility using Black Earth grid samples at Camp Drum 1, the site of a Late Woodland St. Lawrence Iroquois palisaded village (inset displays the location of the archaeological site [red star] within the boundary of the military base).

Comparison of mean values of phorphorous, potassium, magnesium, calcium, nitrogen and color between cultural and control soil samples taken at resource camp sites on Ft. Drum reveals that cultural sites have higher mean values of essential nutrients, and darker color (Table 2 and Figure 3). Two-sample t-tests of the means, however, indicate that of these variables of interest, only color displays a significantly different value between cultural and control samples (alpha level of $p < 0.05$). Color of cultural site soil is significantly darker (i.e., more black and brown) than control site soil (p=0.022). Potassium and phosphorous display differences in mean values between cultural and control sites that are indicative of a possible trend (p=0.068 and

0.95, respectively). Phosphorous is potentially a very useful indicator of human activity, thus this trend is notable.

Table 2. Soil data (mean ± standard error) from cultural and control sites on Ft. Drum (soil nutrients are in parts per million).

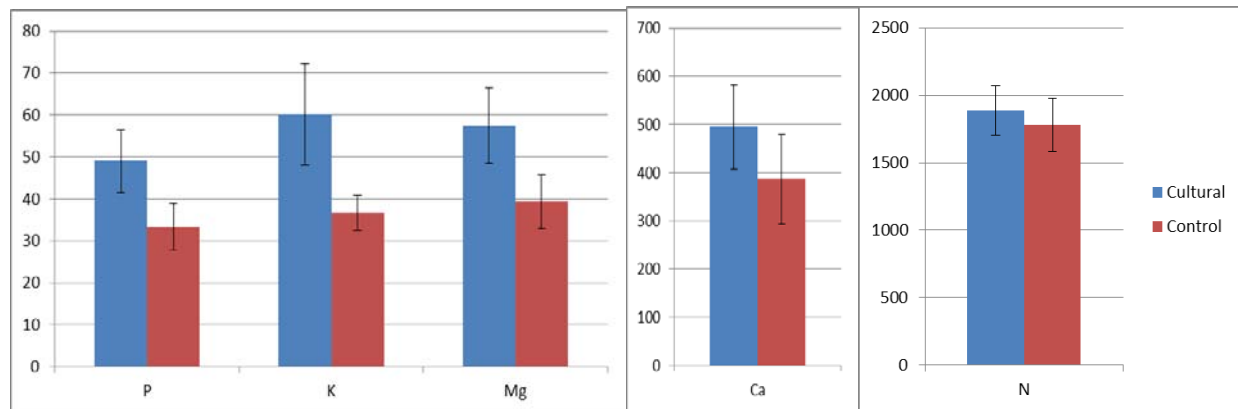| Soil (ppm) Parameter	Cultural	Control
pH	5.23 ± 0.12	5.12 ± 0.15
Phosphorous	48.97 ± 7.42	33.36 ± 5.46
Potassium	60.24 ± 12.01	36.71 ± 4.10
Magnesium	57.50 ± 9.06	39.36 ± 6.35
Calcium	494.99 ± 87.26	386.76 ± 93.66
Total Nitrogen	1889.18 ± 182.44	1780.64 ± 199.13
Soil color	very dark brown	yellowish brown

Figure 3. Mean values (± standard error) of soil parameters of particular interest on cultural and control sites on Ft. Drum.

MCB Quantico, VA:

Spatial interpolation analysis at MCB Quantico was conducted along the north bank of Chopawamsic Creek, in the eastern portion of the installation (Figure 4). In this area, family groups settled in several locations along the creek bank in a "hamlet-style" occupation pattern during the Late Woodland Period. Soil sampling was conducted all along the bank in the area of four different archaeological sites, and spatial interpolation using the inverse distance weighting technique was used to elucidate patterns in soil fertility. Output grid cell size was 1.5 m x 1.5 m and soil fertility classes were based on equal breaks, with 268 soil index units encompassed by

each class. Soil fertility (addition of parts per million measurements of phosphorous, potassium, magnesium, and calcium for each sample) of the samples ranged from 157 to 2588 soil index units. The average baseline soil fertility of the soils present along the creek bank was 536 index units. After calculation of the Soil Fertility Index, the values ranged from -378.3 to 2040.1 index units. About 16% of the range of these values was composed of negative values (first 1.5 classes represented by colors of dark and lighter green). These negative values indicate that soil fertility of the samples was lower than that of the average baseline series. Over the rest of the range (84%) of soil fertility values, the fertility was higher than the baseline. There are areas of significantly higher soil fertility associated with three of the hamlet sites. One occurs to the south of the second site (from the left), one occurs within the third site, and the last occurs within the fourth site. The highest fertility values are found within the fourth site, however only one soil sample represents the highest class of fertility values (represented by the lighter pink color).
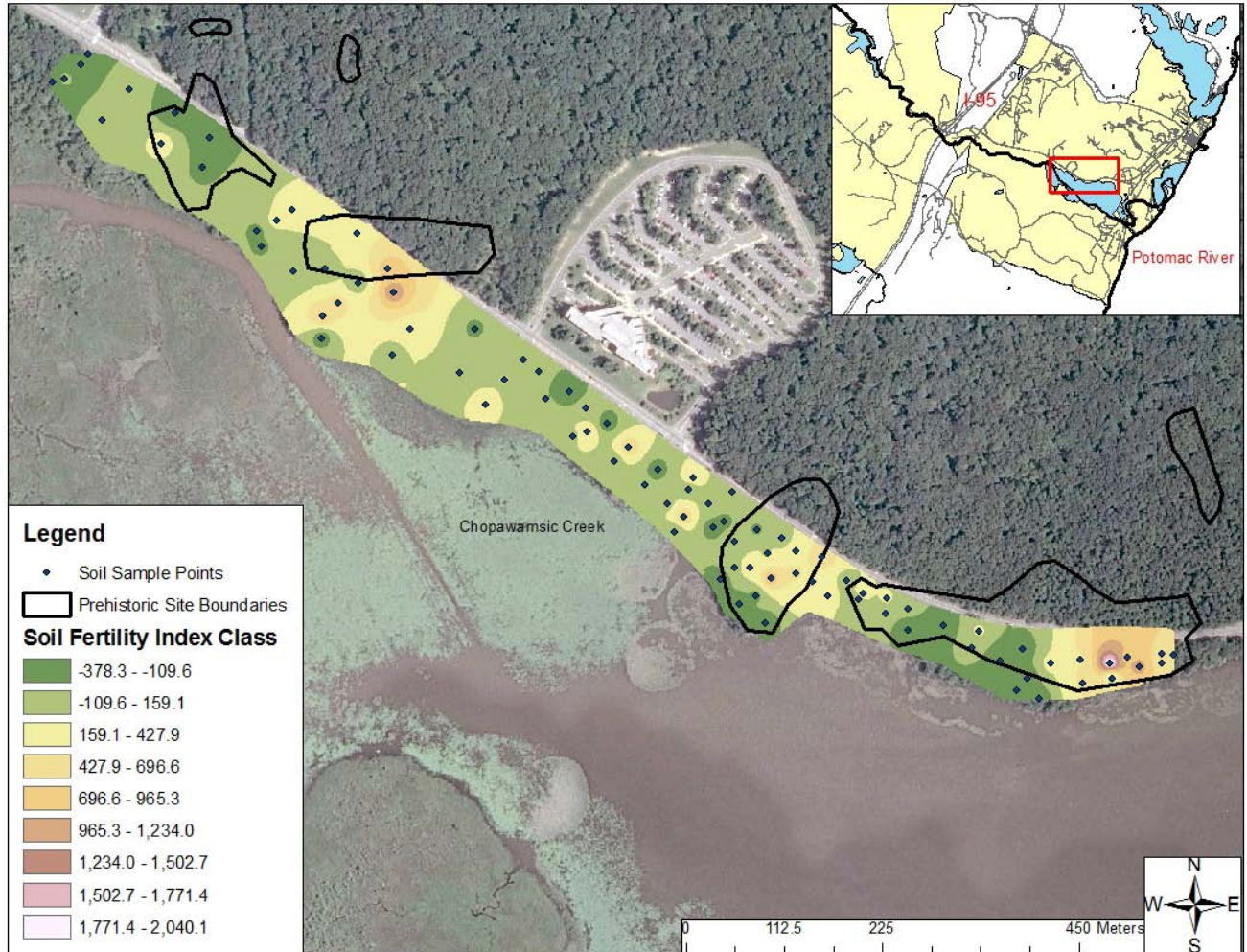
Figure 4. Spatial interpolation of soil fertility using Black Earth grid samples along the north bank of Chopawamsic Creek where four Late Woodland "hamlet-style" settlement archaeological sites are located (inset shows the location of the stretch of creek bank [red rectangle] within the boundary of MCB Quantico and relative to the Potomac River and Interstate 95).

Differences in mean parts per million values of soil fertility parameters of interest do not indicate that cultural sites have inherently higher soil fertility than control sites (Table 3 and Figure 5). Phosphorous, potassium, and nitrogen are lower on cultural sites than controls, however these differences are not statistically significant (p=0.12, 0.85, and 0.45, respectively). Magnesium and calcium are higher on cultural sites, and cultural site soils are darker than control soils. However, none of these differences are statistically significant either (p=0.23, 0.35, and 0.45, respectively). Cultural site soils do seem to have a component of gray color, which is less indicative of high fertility and organic matter than colors of black and brown. This data may

suggest more of a nutrient depletion signal on cultural sites versus controls. Reasons for this are discussed in the Discussion Section of this document (page 18).

Table 3. Soil data from cultural and control sites on MCB Quantico (in parts per million ± standard error).

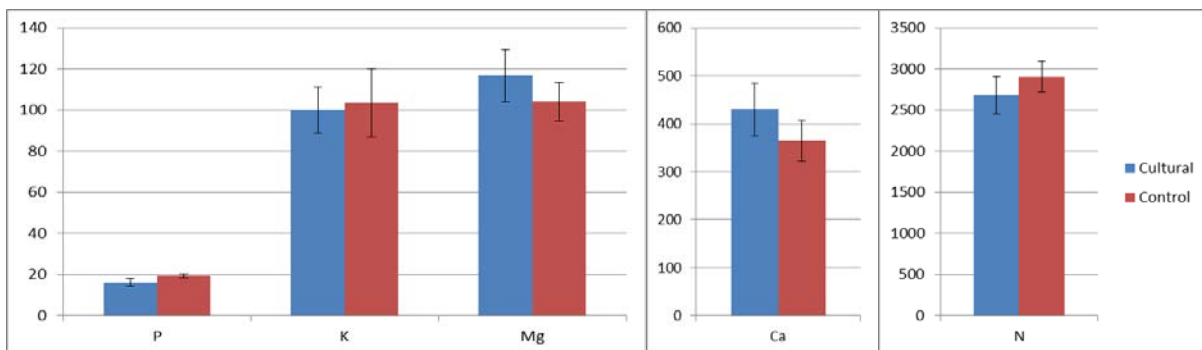| Soil (ppm) Parameter	Cultural	Control
pH	4.87 ± 0.11	4.77 ± 0.11
Phosphorous	16.07 ± 1.80	19.25 ± 0.94
Potassium	99.93 ± 11.17	103.40 ± 16.78
Magnesium	116.79 ± 12.78	104.05 ± 9.25
Calcium	430.30 ± 54.28	364.88 ± 42.90
Total Nitrogen	2678.21 ± 227.50	2904.44 ± 187.82
Soil color	very dark grayish brown	dark brown

Figure 5. Mean values (± standard error) of soil parameters of particular interest on cultural and control sites on MCB Quantico.

Cheatham Annex, VA:

Spatial interpolation analysis at the Cheatham Annex was conducted along the south bank of Queen Creek, in the Wilderness Area portion of the CAX (Figure 6). In this area, there is evidence of three archaeological sites (blue points) that have been identified with traditional testing. There are also several sites where shell midden evidence is present and apparent in the soil (green points), indicating resource-gathering use during the Late Woodland. Spatial interpolation using the inverse distance weighting technique was used to elucidate patterns in soil fertility. Output grid cell size was 3 m x 3 m, and the nearest five sampled points were used to interpolate soil fertility values (the power parameter was set at a value of three to decrease the

amount of influence that further sampled points had on each interpolated point). Soil fertility classes were based on equal breaks, with 379 soil index units encompassed by each class. Soil fertility (addition of parts per million measurements of phosphorous, potassium, magnesium, and calcium for each sample) of the samples ranged from 332 to 3745 soil index units. Baseline measurements of soil fertility were not obtained because we cannot be assured that archaeological resources weren't present all along the entirety of the creek bank (due to incomplete testing), therefore soil samples unaffected by Native Americans were not available. The top 56% of the range of soil fertility values was considered significantly increased fertility (> 1848.9 soil index units, represented by colors of orange to light pink). One area of increased soil fertility occurs in association with the most eastern of the established archaeological sites. Higher fertility in general occurs here surrounding the two most eastern of the three sites that have been located with traditional testing. The northernmost samples of the two easternmost transects have very high calcium measurements, which drive up the soil fertility index values in these areas.
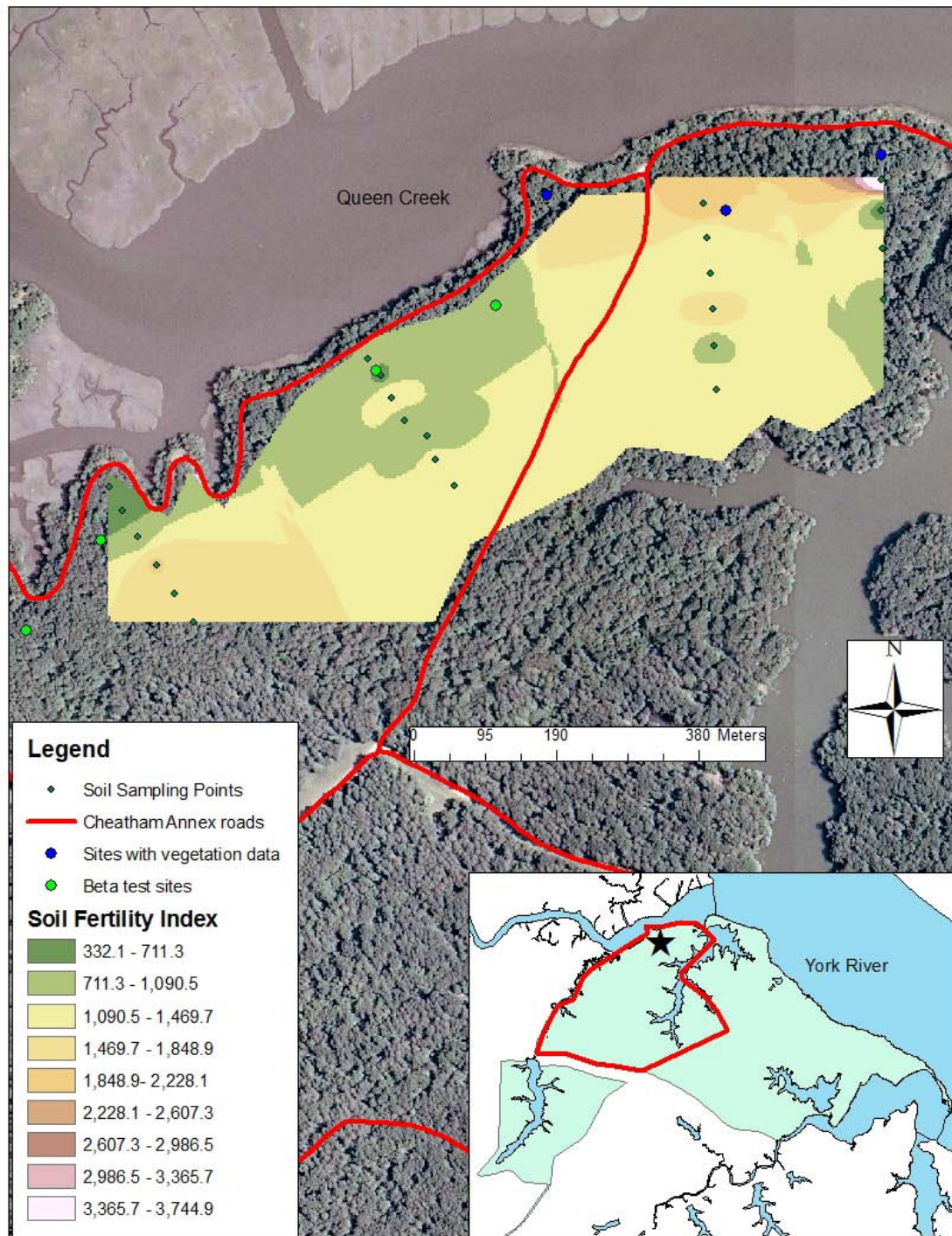
Figure 6. Spatial interpolation of soil fertility using Black Earth grid samples along the south bank of Queen Creek, located in the area of several identified beta test sites/shell middens and three identified Late Woodland archaeological sites (inset map shows the location of the soil samples [black star] within the boundary of the Wilderness Area [red outline] on Cheatham Annex).

Discussion

The results of these analyses suggest that patterns are region-specific. The landscape, lifeways, and resources utilized by a specific group of people will affect how these methods should be applied across the eastern US. What the diet of the natives of the Late Woodland Time Period consisted of will be crucial in understanding what the landscape was used for and how it was used. For example, groups may put more emphasis on resources gained from waterways in some areas, such as at MCB Quantico and the Cheatham Annex. In other areas, such as northern New York (where Ft. Drum is located), these types of resources may be less relied on, and more emphasis put on hunting terrestrial game. Results of spatial interpolation and resource camp soil tests reveal patterns that can be associated with the types of usage each site experienced during the Late Woodland Period. We expect that Black Earth (purposely amended soils) is most indicative of Native American agricultural fields in areas with inherently low fertility (such as sandy glacial outwash at Fort Drum). However, other Native American activities can also cause alterations in soil color and fertility in areas used for purposes other than agriculture (e.g., temporary hunting and camping sites).

Soil analysis on Ft. Drum reveals a trend in resource camp data of higher fertility on archaeological sites. Even though this trend is not statistically significant (alpha level 0.05), this could indicate that any area occupied or used for up to a month or two at a time on a yearly basis could become amended through the addition of human and animal waste and "kitchen waste;" in effect the creation of a "broadcast midden" area. Spatial interpolation using the grid of soil samples taken at the Iroquoian palisaded village site showed three separate areas of higher fertility. While it's not certain that the larger area of highest fertility to the south of the site is indicative of agricultural fields, we believe it is likely. We also believe that the two smaller inclusions within the palisade could be the site of small middens associated with day to day living within the palisade walls, and could lead to discovery of what the diet of this group consisted of. This in turn would provide more clues into the types of land use that would have been important, based on the composition of the diet and the relative importance of each component.

Patterns of soil fertility at MCB Quantico may be the result of different usage of the landscape in this area where natives depended largely on resources from the waterways of the Potomac River and tributaries (such as Chopawamsic and Quantico Creeks). Agriculture may not have been as important, or may have been conducted in areas other than along waterways. The three inclusions of higher fertility that are present among the four 'hamlet' sites along Chopawamsic Creek all are in association with sites, but not all of the recorded archaeological sites have higher fertility areas associated with them (the westernmost site is relatively uniform in showing mid-level fertility). These results may indicate that if agriculture was conducted in this area, amendments to soil were not required for initial planting of fields, and thus after use by Native Americans, fields were deplete of key nutrients. Another explanation might be that agriculture was not conducted here, but the amount of resources pulled from the waterway stimulated the creation of large midden areas of fish and shellfish waste. This may be indicated by the seemingly random pattern of increased fertility along the bank of the creek. MCB Quantico resource camp data indicates no trend whatsoever; a few of the measured nutrients are lower in archaeological sites, while other variables show higher levels in archaeological sites. Phosphorous and color are possibly two key indicators, phosphorous is lower in archaeological sites, while color is only slightly darker. With color it is also notable that there is a higher component of gray in the soils of archaeological sites, which is less indicative of elevated organic matter. These trends, taken together, may indicate that where the main resources utilized are from waterways, soils may only reflect Native American usage in the areas of middens.

On the Cheatham Annex, unlike at MCB Quantico and Ft. Drum, there is no evidence of long-term habitation by Native Americans. Thus, soils would have been affected through midden creation only in this area. In this area, the main occupation of the Native Americans was collecting shellfish and fish from Queen Creek. Thus, we would not expect signals in soil related to agriculture. However, we may expect signals from inadvertent amendment, such as with midden creation. Shell middens may return much higher calcium than control soils. In the analysis conducted here, the northernmost samples of the easternmost transects have very high calcium measurements, which drive up the soil fertility index values and result in higher interpolated values in this area. These samples may have been taken in an area significantly affected by shellfish midden creation, which would be indicative of Native American activity.

22

Spatial interpolation using individual soil samples as analysis grid points may be useful for locating agricultural fields in association with village sites, and smaller inclusions of higher fertility where middens may have been located. Using soil analysis to locate potential midden sites would be more useful for initial discovery of archaeological sites, while the discovery of agricultural fields in association with known village sites may help to elucidate subsistence patterns among groups of Native Americans. If baseline fertility of non-cultural soils can be ascertained, areas of increased fertility can be clearly identified.

Catchment analysis of soils data lends itself very well to predictive modeling using Geographic Information Systems (GIS). This technique will make up of both soils and vegetation data in predictive models across a landscape, taking into account soil type, soil fertility, and vegetation present. With this type of analysis, grid sampling is more useful than on (versus off) site resource camp data because catchments or inclusions of increased soil fertility would be evident using spatial interpolation. In this way also, the boundaries of the archaeological site do not constrict the available data. Spatial interpolation with a grid of soil samples is useful in judging, based on comparisons between sites, if Native Americans would have been conducting certain land uses practices such as amending soils or broadcast burning of vegetation. Baseline or example characteristics for this type of predictive analysis can be based on what is found at known sites.

Major Outcomes

1. Patterns of soil fertility on archaeological sites are region-specific and related to the primary resources utilized by the different groups of Native Americans.

2. Black Earth (purposely amended soils) may be present only in agricultural areas of inherently low soil fertility.

3. Determining baseline fertility of non-cultural soils is crucial in identification of patterns.

4. Catchment analysis of soils data, coupled with plant indicator species and other evidence such as shell middens, are very useful for predictive modeling of archaeological potential using GIS techniques.

Transferable recommendations are detailed in the Technical Analysis, and methodologies are described more fully, with figures and examples, in the two protocols.

Literature Cited

Abrams, M.D., and Nowacki, G.J. 2008. Native Americans as active and passive
    promoters of mast and fruit trees in the eastern USA. *The Holocene* 18: 1123-1137.

Black, B.A., and Abrams, M.D. 2001. Influences of Native Americans and surveyor
    biases on metes and bounds witness-tree distribution. *Ecology* 82: 2574-2586.

Ceci, L. 1975. Fish fertilizer: A native North American practice? *Science* 4: 26-30.

Day, G.M. 1953. The Indian as an ecological factor in the northeastern forest. *Ecology*
    34: 329-346.

Delcourt, H.R. 1987. The impact of prehistoric agriculture and land occupation on natural
    vegetation. *TREE* 2: 39-44.

Fritz, G.J. 1990. Multiple pathways to farming in precontact eastern North America. *Journal of*
    World Prehistory 4: 387-435.

Haynes, John. 2010. Personal communication. Head of Cultural Resources Management, MCB
    Quantico, VA.

Hecht, S.B. 2004. Indigenous soil management and the creation of Amazonian dark
    earths: Implications of Kayapó practices. In *Amazonian Dark Earths: Origin, Properties,*
    Management. Lehmann, J., Kern, D.C., Glaser, B., and Woods, W.I. (editors). Kluwer
    Academic Publishers; New York, New York. Pgs 355-372.

Jácome, A.G. 1993. Management of land, water and vegetation in traditional agro-ecosystems
    in Central Mexico. *Landscape and Urban Planning* 27: 141-150.

Lehmann, J., Pereira da Silva Jr., J., Steiner, C., Nehls, T., Zech, W., and Glaser, B.
    2003. Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of
    the Central Amazon basin: Fertilizer, manure and charcoal amendments. *Plant and Soil*
    249: 343-357.

Mann, C.C. 2000. The good earth: Did people improve the Amazon Basin? *Science* 4:
    788-790.

Mrozowski, S.A. 1994. The discovery of a Native American cornfield on Cape Cod.
    Archaeology of Eastern North America 22: 47-62.

Skinner, S.M. 1986. Phosphorous as an anthrosol indicator. *Midcontinental Journal of*
    Archaeology 11: 51-78.

Smith, B.D. 1989. Origins of agriculture in eastern North America. *Science* 246: 1566-
1571.

Trigger, B.G. 1978. Handbook of North American Indians - Northeast. Volume 15.
William C. Sturtevant, General Editor. Washington, D.C.: Smithsonian Institution.

Appendix A. New sites surveyed (archaeological sites and controls, with soil color and soil charcoal results) summer 2010 at Fort Drum Army Installation, NY (overstory is listed as species and diameter at breast height in inches; saplings and seedlings are listed as species and count; and shrub and herbaceous species are listed as species and cover percentage range).

FDP 1161 (Training Area 5D)

FDP 1161 Archaeological
-plots set NE of shovel test pit site
Plot 1
Overstory
Red maple 3.0
Northern red oak 4.7
Red maple 3.6
White oak 3.4
Northern red oak 16.3
Red maple 5.0 (stump sprout)
Red maple 4.9 (stump sprout)
White oak 3.4
Northern red oak 5.8
Northern red oak 8.5
Saplings
Serviceberry 6
White oak 1
Seedlings
Serviceberry 17
Red maple 25
Northern red oak 19
White oak 10
Shrub/herb
Partridgeberry 0-4
Canada mayflower 0-4
Blueberry species 5-25
Bracken fern 5-25
Grass species 5-25
Soil color 2/2

Plot 2
Overstory
Northern red oak 8.2
Northern red oak 9.6
White oak 6.6
White oak 7.5
Northern red oak 4.2
Northern red oak 9.6

Northern red oak 8.3
Northern red oak 8.5
Northern red oak 9.3
Saplings
Serviceberry 9
Northern red oak 2
White oak 3
Seedlings
Northern red oak 13
Red maple 2
White oak 5
Serviceberry 4
Shrub/herb
Partridgeberry 0-4
Blueberry species 25-50
Bracken fern 5-25
Canada mayflower 0-4
Grass species 0-4
Black huckleberry 0-4
Soil color 3/1

Plot 3:
Overstory
Northern red oak 3.7
White pine 4.4
Red pine 5.1
White pine 3.4
White oak 3.9
Red pine 3.8
White pine 4.9
White pine 3.9
White pine 4.2
Northern red oak 3.7
Red pine 9.7
Northern red oak 7.3
Northern red oak 17.6
White pine 3.7
Saplings
Red maple 1
White pine 8
Serviceberry 2
Northern red oak 1
Red pine 1
Seedlings
Red maple 5

Serviceberry 20
Northern red oak 20
White oak 4
Black cherry 1
Shrub/herb
Canada mayflower 0-4
Blueberry species 5-25
Bracken fern 5-25
Partridgeberry 0-4
Soil color 3/3

Plot 4
Overstory
White oak 5.8
White oak 9.8
Red pine 16.9
White oak 9.8
White oak 15.4 (stump sprout)
White oak 12.5 (stump sprout)
White oak 15.1 (stump sprout)
White oak 9.8
White pine 3.0
White oak 7.2
White pine 3.2
White oak 5.3
Saplings
White pine 6
Red maple 8
Serviceberry 12
Seedlings
Black cherry 5
Serviceberry 11
White oak 7
Red maple 25
Northern red oak 10
White pine 1
Shrub/herb
Blueberry species 25-50
Witch hazel 0-4
Canada mayflower 0-4
Grass species 0-4
Bracken fern 5-25
Partridgeberry 0-4
Soil color 3/3

Plot 5
Overstory
Northern red oak 9.8
White oak 5.0
White oak 5.0
White oak 3.6
Sugar maple 3.5
Northern red oak 5.1
White oak 15.2
Saplings
Red pine 2
Serviceberry 5
White oak 2
Northern red oak 2
Red maple 1
Sugar maple 3
Seedlings
Black cherry 1
Red maple 10
White oak 17
Northern red oak 10
Serviceberry 4
Shrub/herb
Partridgeberry 5-25
Bracken fern 0-4
Blueberry species 5-25
Witch hazel 25-50
Black huckleberry 25-50
Soil color 4/1

FDP 1161 Control
Plot 1
Overstory
Northern red oak 5.2
Red maple 5.1
White oak 3.7
Red pine 5.8
Red pine 5.0
Red pine 3.7
Northern red oak 20.8
Saplings
Red maple 1
Seedlings
Northern red oak 23
Red maple 6

White oak 1
Serviceberry 1
Shrub/herb
Bracken fern 5-25
Canada mayflower 0-4
Blueberry species 25-50
Grass species 0-4
Partridgeberry 0-4
Soil color 3/3

Plot 2
Overstory
Sugar maple 5.1
White oak 10.8
Northern red oak 7.9
White oak 12.1
White pine 6.6
Northern red oak 7.6
Northern red oak 12.9
Serviceberry 3.3
White pine 3.5
White pine 3.3
Red pine 18.2
Saplings
Serviceberry 3
White pine 1
Red maple 6
Sugar maple 4
Seedlings
Black cherry 1
Sugar maple 1
Serviceberry 1
Northern red oak 20
Red maple 2
White pine 1
Shrub/herb
Black huckleberry 25-50
Blueberry species 5-25
Bracken fern 5-25
Canada mayflower 0-4
Grass species 0-4
Soil color 4/2

Plot 3
Overstory

Northern red oak 8.5
Scarlet oak 14.9
Scarlet oak 16.2
White pine 5.7
White pine 4.1
White pine 3.8
Red maple 10.9
Red maple 10.6
Saplings
Red maple 7
Sugar maple 1
White oak 1
Serviceberry 2
Seedlings
Northern red oak 24
Red maple 16
Serviceberry 11
Sugar maple 3
White oak 1
Shrub/herb
Black huckleberry 25-50
Bracken fern 5-25
Blueberry species 5-25
Grass species 0-4
Soil color 4/3

Plot 4
Overstory
Scarlet oak 10.6
Scarlet oak 4.7
White pine 6.1
Red maple 5.2
Scarlet oak 8.3
Saplings
White oak 2
Seedlings
Red maple 10
Serviceberry 5
White oak 22
Northern red oak/Scarlet oak 16
Sugar maple 3
Shrub/herb
Partridgeberry 0-4
Canada mayflower 0-4
Blueberry species 25-50

Bracken fern 0-4
Grass species 5-25
Bedstraw 0-4
Soil color 3/2

FDP 1268 (Training Area 8B)

FDP 1268 Archaeological
Plot 1
Overstory
Black cherry 11.9
Black cherry 12.0
Black cherry 12.6
Black cherry 13.7
Black cherry 13.1
Red maple 10.0
Black cherry 11.4
Black cherry 10.4
Red maple 5.1
Red maple 9.3
Black cherry 10.5
Black cherry 11.4
Saplings
Serviceberry 1
Red maple 6
European buckthorn 1
Seedlings
Northern red oak 14
Red maple 30
Flowering dogwood 1
Black cherry 10
European buckthorn 5
Shrub/herb
Tick trefoil 5-25
Canada mayflower 5-25
Swamp dewberry 0-4
Blueberry species 5-25
Teaberry 0-4
Black cohosh 0-4
Cow vetch 0-4
Soil color 3/4

Plot 2: dead birch stem across plot ~8" dbh
Overstory
Black cherry 10.9
Red maple 11.3
White oak 7.7
Black cherry 3.9
White pine 18.0
Saplings
Red maple 18
Seedlings
Black cherry 5
Red maple 111 (most are first year seedlings and will not survive)
Northern red oak 4
Serviceberry 5
Flowering dogwood 5
Shrub/herb
Starflower 0-4
Arrowwood viburnum 0-4
Canada mayflower 5-25
Tick trefoil 5-25
Blackhaw 0-4
Cow vetch 0-4
Soil color 3/4

FDP 1268 Control
-directly West of archaeological site, beyond boundary of harvest
Plot 1
Overstory
Red maple 7.1
Red maple 6.0
Black cherry 4.5
Red maple 11.4
Red maple 4.0
Black cherry 4.1
Red maple 3.1
Red maple 3.3
Red maple 6.2
Red maple 12.8
Red maple 5.5
Saplings
Red maple 3
Seedlings
American hophornbeam 3
Northern red oak 3

Red maple 6
Serviceberry 3
White pine 2
Flowering dogwood 3
Shrub/herb
Forsythia 5-25
Cinquefoil 25-50
Trillium species 0-4
Swamp dewberry 5-25
Tick trefoil 0-4
Starflower 0-4
Hayscented fern 0-4
Soil color 4/6

<u>Plot 2</u>
Overstory
Sugar maple 13.5
Paper birch 6.2
Black cherry 7.7
Sugar maple 8.3
Sugar maple 10.0
Sugar maple 10.9
Sugar maple 5.0
Sugar maple 5.2
Sugar maple 3.5
Saplings
Black cherry 1
White oak 2
Speckled alder 4
Seedlings
Red maple 7
Sugar maple 36
Serviceberry 8
Black cherry 1
Flowering dogwood 17
White pine 1
Northern red oak 1
Shrub/herb
Solidago (goldenrod) 0-4
Sensitive fern 0-4
Forsythia 5-25
Starflower 0-4
Swamp dewberry 5-25
Cow vetch 0-4
Black cohosh 0-4

Greenbriar 0-4
Canada mayflower 0-4
Arrowwood viburnum 0-4
Soil color 4/6

Plot 3
Overstory
Red maple 3.2
Red maple 7.2
Red maple 4.0
Red maple 4.1
Black cherry 11.9
Black cherry 13.5
Black cherry 11.8
Black cherry 9.5
Red maple 14.8
Saplings
Red maple 3
Sweet cherry 1
Seedlings
Black cherry 7
Northern red oak 1
Serviceberry 26
Flowering dogwood 2
Red maple 144 (most are first year seedlings and will not survive)
European buckthorn 7
White pine 2
Shrub/herb
Black cohosh 5-25
Sensitive fern 5-25
Swamp dewberry 0-4
Teaberry 5-25
Starflower 0-4
Greenbriar 0-4
Arrowwood viburnum 0-4
Soil color 4/4

FDP 1267 (Training Area 6B)

FDP 1267 Archaeological
Plot 1
Overstory
White oak 9.2
Northern red oak 7.1
Northern red oak 3.8
Northern red oak 6.9
Northern red oak 8.2
Northern red oak 7.9
Saplings
Black cherry 1
Serviceberry 1
Paper birch 7
Seedlings
Serviceberry 4
Northern red oak 1
Red maple 6
Black cherry 3

Shrub/herb
Rubus species 25-50
Blueberry species50-75
Bedstraw 0-4
Soil color 3/2

Plot 2
Overstory
Northern red oak 8.0
Northern red oak 9.7
Northern red oak 9.3
Northern red oak 9.5
Northern red oak 11.6
Northern red oak 9.4
Saplings
Serviceberry 1
Seedlings
Northern red oak 4
Red maple 22
Serviceberry 2
Black cherry 2
Shrub/herb
Rubus species 0-4
Blueberry species 0-4

Bedstraw 0-4
Solidago (goldenrod) 0-4
Soil color 3/3

Plot 3
Overstory
White oak 9.1
White oak 10.0
Northern red oak 10.4
Northern red oak 9.3
Northern red oak 8.9
Northern red oak 7.4
Northern red oak 10.4
White oak 8.1
White oak 6.1
Saplings
Red maple 1
Seedlings
White oak 1
Northern red oak 7
Serviceberry 6
Black cherry 5
Red maple 8
Shrub/herb
Bedstraw 0-4
Blueberry species 5-25
Plaintain species 0-4
Twistedstalk 0-4
Soil color 3/1

FDP 1267 Control
-set to north of archaeological site
Plot 1
Overstory
White oak 7.2
White oak 8.3
Northern red oak 3.9
Northern red oak 6.5
Northern red oak 8.1
White oak 4.6
White oak 4.6
Northern red oak 7.4
Northern red oak 3.2
Northern red oak 5.7
Saplings

None
Seedlings
Northern red oak 2
Serviceberry 3
Shrub/herb
Bedstraw 0-4
Blueberry species 25-50
Unknown 5-25
Soil color 3/2

Plot 2
Overstory
Northern red oak 5.9
White oak 7.5
White oak 8.6
White oak 6.2
Northern red oak 6.1
Northern red oak 10.9
Northern red oak 6.8
Northern red oak 6.8
Northern red oak 11.4
Northern red oak 6.6
Northern red oak 10.2
Saplings
None
Seedlings
Black cherry 1
White oak 3
Shrub/herb
Blueberry species 5-25
Bedstraw 0-4
Unknown 0-4
Grass species 75-95
Soil color 3/4

Plot 3
Overstory
White oak 6.7
White oak 6.2
White oak 4.1
White oak 3.6
White oak 7.8
White oak 5.9
White oak 8.8
White oak 4.5

Northern red oak 4.6
Northern red oak 10.6
Northern red oak 6.3
White oak 10.3
White oak 4.4
Northern red oak 6.5
Northern red oak 7.5
Northern red oak 7.8
Saplings
None
Seedlings
Northern red oak 6
Serviceberry 1
Shrub/herb
Blueberry species 50-75
Bedstraw 0-4
Soil color 3/2

FDP 1210 (Earthworks Prehistoric) Archaeological Site (Cantonment)
-a linear mound that is cut through by a historic road to a nearby mill; heavy post-European settlement traffic
-Earthworks are usually associated with a village site, although shovel testing on and around the mound hasn't uncovered artifacts
-*no control possible here* because it is unclear what the area surrounding the mound was actually use for prehistorically, and there has been much post-European settlement disturbance

Earthworks Archaeological
Plot 1
Overstory
Sugar maple 7.2
Sugar maple 5.3
Black cherry 10.6
American hophornbeam 3.5
Sugar maple 13.3
Sugar maple 6.3
Sugar maple 7.4
Saplings
Sugar maple 1
Seedlings
Mockernut hickory 1

European buckthorn 3
American hophornbeam 2
Shrub/herb
Mayapple 5-25
Jewelweed 0-4
Solidago (goldenrod) 0-4
Honeysuckle species 0-4
Soil color 5/4

Plot 2
Overstory
Sugar maple 5.5
Sugar maple 3.0
Sugar maple 5.7
Sugar maple 8.9
American hophornbeam 4.7
Sugar maple 8.4
Sugar maple 12.0
Sugar maple 6.2
Sugar maple 19.3
Sugar maple 22.0
Sugar maple 7.0
Sugar maple 5.3
Sugar maple 8.0
Saplings
None
Seedlings
European buckthorn 31
Mockernut hickory 1
Shrub/herb
Garlic mustard 5-25
Wild geranium 0-4
Bloodroot 0-4
Soil color 4/4

Plot 3: large dead stem in plot inhibiting growth
Overstory
Black cherry 3.5
Black cherry 7.5
Black cherry 6.7
Sugar maple 20.6
Black cherry 7.3
Sugar maple 9.2
Saplings
Black cherry 1

Seedlings
European buckthorn 1
Shrub/herb
Garlic mustard 5-25
Virginia creeper 0-4
Soil color 4/3

Plot 4
Overstory
Sugar maple 5.5
Sugar maple 23.9
Sugar maple 9.5
Sugar maple 9.8
Mockernut hickory 10.9
Mockernut hickory 7.2
Sugar maple 3.5
Sugar maple 3.1
Saplings
European buckthorn 1
Seedlings
Black cherry 1
American hophornbeam 4
European buckthorn 5
Shrub/herb
Garlic mustard 25-50
Jewelweed 0-4
Wild geranium 0-4
Soil color 5/4

Plot 5
Overstory
American hophornbeam 5.3
European buckthorn 3.7
Sugar maple 4.5
Sugar maple 9.7
Sugar maple 8.1
Sugar maple 33.0
Mockernut hickory 3.2
American hophornbeam 4.7
Sugar maple 30.3
Saplings
European buckthorn 3
American hophornbeam 3
Seedlings
European buckthorn 52

Sugar maple 2
American hophornbeam 1
Serviceberry 1
Shrub/herb
Jewelweed 0-4
Bedstraw 0-4
Honeysuckle species 0-4
Grape species 0-4
Soil color 5/4

FDP 1266 (General's Loop Road) Archaeological Site (Cantonment)
-post molds were found here, which indicates a structure and potential long-term habitation

FDP 1266 (General's Loop Road) Archaeological
Plot 1
Overstory
Red maple 11.6
Red maple 10.9
Red maple 8.4
Black cherry 5.9
Black cherry 4.7
Black cherry 3.3
Black cherry 3.1
White pine 13.8
Red maple 22.3
Saplings
White ash 2
Black cherry 1
Seedlings
Black cherry 31
Red maple 123 (many are first year seedlings and will not survive)
White ash 5
Shrub/herb
Rubus species 5-25
Horsetail 0-4
Wood sorrel 0-4
Arrowwood viburnum 0-4
Wild strawberry 0-4
Veronica species 0-4
Garlic mustard 0-4
Soil color 3/4

Plot 2
Overstory
Silver maple 15.9
Silver maple 16.0
Silver maple 12.5
Silver maple 6.0
White pine 7.9
Sugar maple 8.6
White pine 21.8
Serviceberry 4.8
Serviceberry 3.4
Serviceberry 4.0
Sugar maple 6.6
Saplings
Striped maple 1
Serviceberry 1
White ash 1
Seedlings
Black cherry 8
Sugar maple 76
White ash 8
Striped maple 5
American hophornbeam 1
Shrub/herb
Bedstraw 0-4
False nettle 5-25
Wood sorrel 5-25
Rubus species 0-4
Jewelweed 0-4
Canada mayflower 0-4
Veronica species 5-25
Hayscented fern 0-4
Soil color 2/2

FDP 1266 (General's Loop Road) Control
-set to southwest of site
Plot 1
Overstory
Sugar maple 24.0
White pine 16.0
Northern red oak 8.7
Red maple 5.1
Quaking aspen 12.2
Northern red oak 7.3

Red maple 4.2
Quaking aspen 11.3
Saplings
White ash 1
Sugar maple 1
Seedlings
White ash 8
Black cherry 15
Northern red oak 3
Red maple 21
Mockernut hickory 1
Shrub/herb
Bedstraw 0-4
Horsetail 0-4
Garlic mustard 0-4
Soil color 3/6

Plot 2
Overstory
Red maple 3.0
Paper birch 13.0
Northern red oak 9.8
Paper birch 16.3
Red maple 3.5
Sugar maple 3.9
White oak 3.5
Red maple 5.0
Red maple 3.2
Red maple 4.2

Saplings
Sugar maple 2
Seedlings
White ash 2
Red maple 7
Striped maple 2
Black cherry 1
American hophornbeam 1
Shrub/herb
Canada mayflower 0-4
Soil color 3/6

Plot 3
Overstory
Black cherry 20.1

American beech 5.0
Sugar maple 13.7
Sugar maple 12.1
Black cherry 13.4
Black cherry 9.5
Sugar maple 5.9
Saplings
American beech 2
Sugar maple 1
Seedlings
Northern red oak 6
Black cherry 66
American hophornbeam 1
Red maple 75
Sugar maple 21
White pine 1
Shrub/herb
Bedstraw 5-25
Swamp dewberry 0-4
Lycopodium species (ground pine) 0-4
Canada mayflower 0-4
Rubus species 0-4
Soil color 5/8

FDP 1272 (LeRay) Archaeological Site (Cantonment)

FDP 1272 (LeRay) Archaeological
Plot 1
Overstory
Eastern hemlock 3.4
Eastern hemlock 5.0
American beech 3.5
Northern red oak 17.5
White pine 16.1
Red maple 3.3
Eastern hemlock 5.9
Eastern hemlock 4.9
Eastern hemlock 6.0
Northern red oak 16.8
White pine 18.7

Saplings
None
Seedlings
Northern red oak 10
Serviceberry 53
American beech 1
Red maple 2
Shrub/herb
Tick trefoil 5-25
Bracken fern 0-4
Canada mayflower 0-4
Partridgeberry 0-4
Starflower 0-4
Teaberry 0-4
Soil color 3/3

Plot 2: lots of dead stems and standing White pine snags
Overstory
Northern red oak 4.0
White pine 21.7
Red maple 3.2
White pine 20.0
White pine 17.9
Saplings
Red maple 3
American beech 1
Seedlings
Serviceberry 81
Northern red oak 11
Striped maple 11
Red maple 8
White pine 1
Shrub/herb
Blueberry species 5-25
Canada mayflower 0-4
False solomon's seal 0-4
Teaberry 0-4
Tick trefoil 0-4
Starflower 0-4
Soil color 4/6

FDP 1272 (LeRay) Control
-set to the West and slightly North of the cultural site
Plot 1
Overstory

Red maple 6.9
Eastern hemlock 10.9
Eastern hemlock 3.2
Eastern hemlock 4.3
Red maple 3.4
Northern red oak 15.4
Serviceberry 4.2
Northern red oak 13.1
Eastern hemlock 3.5
Eastern hemlock 3.8
Red maple 3.9
Northern red oak 11.8
Saplings
Eastern hemlock 2
Northern red oak 2
Seedlings
Red maple 14
Serviceberry 4
Northern red oak 2
Shrub/herb
Tick trefoil 0-4
Blueberry species 0-4
Canada mayflower 0-4
Partridgeberry 0-4
Soil color 5/6

Plot 2
Overstory
Eastern hemlock 3.5
Red maple 6.4
Northern red oak 8.8
Eastern hemlock 13.0
Eastern hemlock 12.9
Northern red oak 9.7
Northern red oak 12.5
Northern red oak 14.1
Northern red oak 10.9
Saplings
Serviceberry 1
American beech 4
Seedlings
Northern red oak 18
Red maple 21
Serviceberry 3
American beech 1

Shrub/herb
Blueberry species 5-25
Partridgeberry 0-4
Teaberry 0-4
Canada mayflower 0-4
Soil color 4/6

Plot 3
Overstory
Eastern hemlock 19.9
White oak 7.7
Eastern hemlock 10.0
American beech 14.2
Eastern hemlock 3.5
Northern red oak 11.7
Saplings
Eastern hemlock 2
Serviceberry 2
Seedlings
Red maple 11
Northern red oak 4
Serviceberry 2
Shrub/herb
Partridgeberry 0-4
Witch hazel 0-4
Canada mayflower 0-4
Soil color 5/6

ASOS Sites (Cantonment)
-three separate very small archaeological sites (large enough to contain one circular plot each), as yet not designated with FDP numbers; 2 of the more likely cultural sites surveyed

ASOS 1 Archaeological
Overstory
Black walnut 4.0
Sugar maple 3.9
Mockernut hickory 4.0
American beech 8.7
American beech 6.9
American beech 4.5

American beech 4.1
American beech 7.0
Sugar maple 22.0
Saplings
American beech 1
Mockernut hickory 1
American hophornbeam 2
Seedlings
Mockernut hickory 1
Sugar maple 4
American hophornbeam 9
Basswood 1
Shrub/herb
Rubus species 5-25
Grape species 0-4
Violet 0-4
Honeysuckle 5-25
Wild strawberry 0-4
Veronica species 0-4
Soil color 3/3

ASOS 3 Archaeological
-this small area is the most likely to be designated as a significant cultural site out of the three
Overstory
Sugar maple 4.5
Sugar maple 3.5
Sugar maple 10.8
Sugar maple 4.4
Mockernut hickory 9.8
American hophornbeam 3.4
Mockernut hickory 13.4
American hophornbeam 4.8
American hophornbeam 4.5
Sugar maple 3.3
American hophornbeam 3.0
Sugar maple 7.7
Sugar maple 12.0
Saplings
Sugar maple 4
Seedlings
American hophornbeam 16
Mockernut hickory 1
Sugar maple 1
Shrub/herb
Canada mayflower 0-4

Jack-in-the-pulpit 0-4
Soil color 4/4

ASOS Control
-set to the South of ASOS 1, running from West (S of ASOS 1) to East (past ASOS 2 and still west and south of ASOS 3)
Plot 1
Overstory
Mockernut hickory 6.1
Sugar maple 3.5
Sugar maple 4.0
Sugar maple 4.1
Sugar maple 3.3
Mockernut hickory 4.3
Sugar maple 3.0
American hophornbeam 5.3
Mockernut hickory 3.1
Sugar maple 21.6
Saplings
American hophornbeam 1
Sugar maple 5
White ash 1
American hophornbeam 8 (stump sprouts)
Sugar maple 2 (stump sprouts)
Seedlings
Mockernut hickory 1
Sugar maple 1 (stump sprout)
Shrub/herb
Jack-in-the-pulpit 0-4
False solomon's seal 0-4
Christmas fern 0-4
Soil color 4/6

Plot 2
Overstory
Black walnut 4.0
Sugar maple 20.3
Sugar maple 4.0
Sugar maple 5.5
Sugar maple 4.1
Sugar maple 4.0
Black cherry 3.8
Black cherry 4.1
Sugar maple 3.7
Sugar maple 3.5

American hophornbeam 5.7
American hophornbeam 4.2
Basswood 6.1
Basswood 4.4
American hophornbeam 6.4
Saplings
Sugar maple 15
Black cherry 1
Seedlings
American hophornbeam 1
Sugar maple 1 (stump sprout)
Mockernut hickory 1
Shrub/herb
Jack-in-the-pulpit 0-4
Soil color 3/2

Plot 3
Overstory
American hophornbeam 5.3
American hophornbeam 4.7
Sugar maple 5.8
Sugar maple 7.0
Sugar maple 4.8
Sugar maple 3.5
Sugar maple 4.0
Sugar maple 4.9
Sugar maple 3.8
Sugar maple 4.1
Mockernut hickory 21.7
Saplings
Sugar maple 7
Seedlings
Mockernut hickory 2
American hophornbeam 11
Shrub/herb
Wild strawberry 0-4
Soil color 4/4

Soil Charcoal Analysis, All Sites

FDP 1161 Archaeological
     Plot 1 positive
     Plot 2 negative (fine soil charcoal)
     Plot 3 positive
     Plot 4 positive
     Plot 5 negative (fine soil charcoal)
FDP 1161 Control
     Plot 1 negative (fine soil charcoal; could have blown in from adjacent cultural site)
     Plot 2 positive
     Plot 3 positive
     Plot 4 positive

FDP 1268 Archaeological
     Plot 1 positive
     Plot 2 positive
FDP 1268 Control
     Plot 1 negative (fine soil charcoal, possibly blown in)
     Plot 2 negative (fine soil charcoal; possibly blown in)
     Plot 3 negative (fine soil charcoal; possibly blown in)

FDP 1267 Archaeological
     Plot 1 positive
     Plot 2 positive
     Plot 3 positive
FDP 1267 Control
     Plot 1 positive
     Plot 2 positive
     Plot 3 positive

FDP 1210 (Earthworks Prehistoric) Archaeological
     Plot 1 negative
     Plot 2 negative
     Plot 3 negative
     Plot 4 negative
     Plot 5 negative

FDP 1266 (General's Loop Road) Archaeological
     Plot 1 negative
     Plot 2 negative
FDP 1266 (General's Loop Road) Control
     Plot 1 negative
     Plot 2 negative
     Plot 3 negative

FDP 1272 (LeRay) Archaeological
    Plot 1 positive (large pieces)
    Plot 2 positive (large pieces)
FDP 1272 (LeRay) Control
    Plot 1 positive
    Plot 2 positive
    Plot 3 positive

ASOS Site 1 Archaeological
    Plot 1 negative (fine soil charcoal)
ASOS Site 3 Archaeological
    Plot 1 positive
ASOS Sites Control
    Plot 1 negative
    Plot 2 negative
    Plot 3 positive

Soil Color Comparison, All Sites

FDP 1161 Archaeological
    Plot 1: 2/2 – very dark brown
    Plot 2: 3/1 – very dark gray
    Plot 3: 3/3 – dark brown
    Plot 4: 3/3 – dark brown
    Plot 5: 4/1 – dark gray
FDP 1161 Control
    Plot 1: 3/3 – dark brown
    Plot 2: 4/2 – dark grayish brown
    Plot 3: 4/3 – brown
    Plot 4: 3/2 – very dark grayish brown

FDP 1268 Archaeological
    Plot 1: 3/4 – dark yellowish brown
    Plot 2: 3/4 – dark yellowish brown

FDP 1268 Control
    Plot 1: 4/6 – dark yellowish brown
    Plot 2: 4/6 – dark yellowish brown
    Plot 3: 4/4 – dark yellowish brown

FDP 1267 Archaeological
     Plot 1: 3/2 – very dark grayish brown
     Plot 2: 3/3 – dark brown
     Plot 3: 3/1 – very dark gray
FDP 1267 Control
     Plot 1: 3/2 – very dark grayish brown
     Plot 2: 3/4 – dark yellowish brown
     Plot 3: 3/2 – very dark grayish brown

FDP 1210 (Earthworks Prehistoric) Archaeological
     Plot 1: 5/4 – yellowish brown
     Plot 2: 4/4 – dark yellowish brown
     Plot 3: 4/3 – brown
     Plot 4: 5/4 – yellowish brown
     Plot 5: 5/4 – yellowish brown

FDP 1266 (General's Loop Road) Archaeological
     Plot 1: 3/4 – dark yellowish brown
     Plot 2: 2/2 – very dark brown
FDP 1266 (General's Loop Road) Control
     Plot 1: 3/6 – dark yellowish brown
     Plot 2: 3/6 – dark yellowish brown
     Plot 3: 5/8 – yellowish brown

FDP 1272 (LeRay) Archaeological
     Plot 1: 3/3 – dark brown
     Plot 2: 4/6 – dark yellowish brown
FDP 1272 (LeRay) Control
     Plot 1: 5/6 – yellowish brown
     Plot 2: 4/6 – dark yellowish brown
     Plot 3: 5/6 – yellowish brown

ASOS Site 1 Archaeological
     Plot 1: 3/3 – dark brown
ASOS Site 3 Archaeological
     Plot 1: 4/4 – dark yellowish brown
ASOS Sites Control
     Plot 1: 4/6 – dark yellowish brown
     Plot 2: 3/2 – very dark grayish brown
     Plot 3: 4/4 – dark yellowish brown