Soil Indicators of Post Colonization Land Use Change and Vegetation Patterns at Wormsloe Historic Site, Isle of Hope

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Project Overview:
Human history is written in the soil. Land use activities cause long term alterations to soil properties and these alterations, or legacy effects, can be examined to interpret human and environmental history. At Wormsloe, soil provided a basic resource upon which residents relied for food production, shelter, and fortification. Soils had a major impact on the success or failure of early settlements like Wormsloe. The soils at Wormsloe contain over two centuries of human activity and millennia of environmental change. By investigating this repository beneath our feet, we are uncovering the history of Wormsloe.

Our project combines soil sampling and survey, geophysical survey (EMI and resistivity), and ArcGIS to evaluate the human and environmental history at Wormsloe through its chemical and physical soil properties. Data collection from these techniques has revealed buried artifacts, diverse environmental and geologic history, and differences in soil properties across areas of the landscape where historic human activity occurred. In addition, to educate the public about the importance of natural and human activity on the soils at Wormsloe, environmental education displays and activities will be created. Overall, this project will provide baseline soils data for future research at Wormsloe, will reveal how past land use has a long term effect on the natural environment, and will educate the public on the important role of soils in everyday life.

Project Objectives:
1. Document conditions and variability of Wormsloe soils and investigate the relationship between soil conditions, observed vegetation patterns, and past land use.
2. Evaluate the combined use of EMI, Resistivity, and traditional soil sampling for locating and investigating sites of archaeological significance and for examining spatial variation in the subsurface.
3. Incorporate information on soils and land use history into interpretive and educational displays for Wormsloe Historic Site.

Objective 1
Background
Soils are complex and dynamic ecosystems. Changes in soil organic matter, structure, and chemistry from human and natural occurrences influence subsequent vegetation, soil biota, and hydrology patterns. Agriculture, for example, has a legacy effect on soil properties that can persist from decades to centuries. Plowing and drainage ditches physically alter the soil and nutrient additions like fertilizer and lime chemically alter the soil. At Wormsloe, Native American shell middens, building ruins, residential areas, and old roads, in addition to historic agriculture areas, leave a legacy in the soil. Investigating this legacy

at Wormsloe helps interpret why landscape features like vegetation patterns exist, provides further evidence to the site's history, examines the time frame for legacy effects to return to "natural" levels, and guides natural resource management decisions.

The Isle of Hope, an interior barrier island, contains a diverse, yet relatively unexplored geologic history and Wormsloe contains a multi-century, well documented, land use history. These two aspects make Wormsloe an important site for soil investigation. Data collected for this project will provide baseline soils data to further understanding of the geologic history at Wormsloe for future research projects and Wormsloe's detailed land use history maps are essential for answering our primary research questions on land use legacy.

Objective 1 Hypotheses

- Established soil series (Chipley and Olustee) within Agriculture areas (history of agricultural or residential activity) will exhibit elevated soil chemical (C, N, P, Ca, Mg, K, and pH) and physical (Ap horizon, bulk density) properties than the same soil mapping units in Reference (low disturbance, historically forest only) areas.
- The effect of Wormsloe's land use legacy on soil chemical and physical properties influences current over-story and shrub layer vegetation patterns.

Methods

A soil sampling strategy to investigate soil variability related to anthropogenic and natural influences at Wormsloe was developed in ArcGIS based on previously mapped Wormsloe soils (NRCS, 1968) and historic Wormsloe land use maps ranging from years 1760-2010 (UGA Ctr. for Geospatial Research, 2013) (Figure 1). We targeted soil series that simultaneously contained: (1) areas used for historic agriculture and residential activity after 1760 (referred to as Agriculture), (2) significant acreage across the property (spatial variability), and (3) areas under continuous forest cover since 1760 (referred to as Reference). Agriculture and Reference areas are considered areas of high and low human activity, respectively. From the NRCS and land use history maps, two prevalent soil series (Chipley and Olustee) were combined with historic land use types (Agriculture and Reference) to create four distinct blocks: Chipley-Agriculture, Chipley-Reference, Olustee-Agriculture, and Olustee-Reference Each block contains thirty randomized points (ArcGIS).

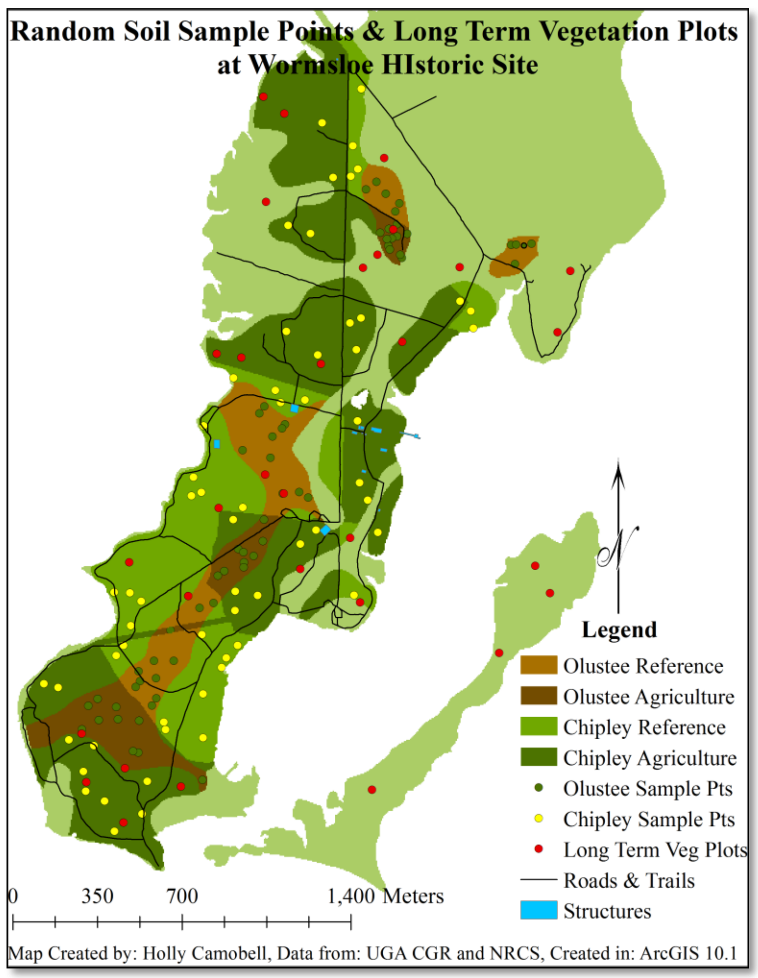

Figure 1: Map of 60 Olustee and 60 Chipley randomized soil sample points in Reference and Agriculture areas and 33 Long Term Vegetation Plot soil sample points.

Additional soil samples were collected in an ongoing research project at Wormsloe Long Term Vegetation Plots (Figure 1) providing further soil variability data across the site. All thirty-three vegetation plots were sampled.

At each random point and vegetation plot in the field, the soil profile was documented, dominant vegetation and landscape features were recorded, and soil samples were collected. All soil samples are currently being analyzed in the lab for: C, N, P, Ca, Mg, K, and pH, with a subset of samples being analyzed for heavy metals, particle size analysis, sand grain size analysis, and mineralogy.

Preliminary Results

Preliminary results indicate differences in surface soil chemistry between Reference and Agriculture areas and more diverse soil series than have been mapped at the property (see profile diversity in pictures below the title of our project at the beginning of this report). Results will be used in ArcGIS to generate a new soil map for Wormsloe and analyze spatial patterns of soil properties in relationship to historic land use and vegetation patterns. Data will also be used to describe soil genesis at Wormsloe.

Objective 2

Background

According to historic land use maps, several areas at Wormsloe have experienced prolonged human use. These areas are not limited to, but usually include sites of long term residential and agricultural activity and are of potential archaeological significance. Investigating soil properties at these sensitive sites is best approached by use of techniques that minimize site disruption. Shallow geophysical survey is a non-invasive way to investigate sites of archaeological significance. Geophysical instruments map subsurface conditions without disrupting the soil and can investigate large areas that would otherwise be costly and disruptive to excavate[1]. These maps can be used to target soil sampling, reveal artifacts, guide future excavations, and map natural, soil variation.

Our project uses two geophysical instruments, EMI and resistivity, for mapping soil conditions. EMI measures the conductivity of an electric current through the subsurface terrain and detects the geometry and depth of conductive, subsurface materials[1]. One primary advantage of EMI over resistivity is that it does not require being in contact with the ground, so is easily transported over large or challenging sites. EMI is useful for detecting subsurface metal and moisture-holding substances, revealing artifacts and natural soil patterns. Resistivity measures the resistance of an electric current across the subsurface matrix. Resistivity surveys detect subsurface features that do not contain water or conduct electricity, such as rock, buried foundations, old roads, hearths, shells, and rubble[2,3].

Objective 2 Hypotheses

- EMI and resistivity survey data will accurately locate anomaly features, as verified by soil sampling, making use of the data collected from these instruments as well as the instruments, themselves, useful for future archaeological surveys at Wormsloe.
- Soil samples collected within archaeologically sensitive sites will exhibit elevated soil chemical properties as compared to Reference soils elsewhere on the property.

Methods

Three survey sites were selected based on historic land use maps and prior soil and EMI data we collected (Figure 2). The first site, Dairy, experienced multiple land use activities (rice mill, dairy, pasture, buried refuse, burn piles). The second site, Cabin, experienced long term residential activity, including the historic location of slave residences. And finally, the third site, Forest Charcoal, though not indicated in land use maps as experiencing sustained human activity, revealed a 55cm deep charcoal layer (C dated to 810 yearsold) when sampled for an Objective 1 random sample point. At the Forest Charcoal site, we wanted to investigate if prehistoric human activity occurred.

At each of the three sites, a grid was established to conduct EMI and resistivity surveys. Data generated from the geophysical surveys were converted into visual formats that created subsurface "maps". These maps displayed patterns of soil variation and evidence of human activity, indicated anomaly feature location, and directed soil sampling. Three anomaly features were selected at each grid site for soil sampling (Figure 2 inset). One soil sample was taken within each feature and one or more soil samples were taken in close proximity, but outside of the mapped anomaly feature. All soil was screened through a quarter inch mesh (for sifting artifacts), profiled (following the same methods as in Objective 1), and soil samples were analyzed in the lab for C, N, P, Ca, Mg, K, and pH. Artifacts were dated and archived.

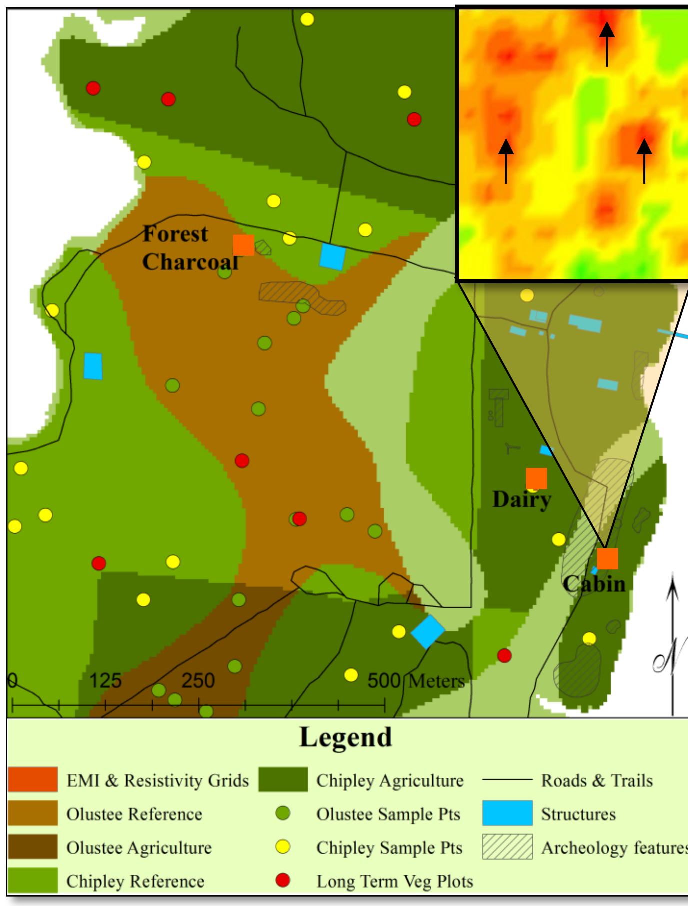

Figure 2: Map of three survey sites: Forest Charcoal, Dairy, and Cabin. Inset shows a resistivity map of the Cabin site. Black arrows indicate anomaly features where soil samples were taken. Natural soil variation does not contain distinct linear features as seen in this resistivity map, thus anomalies likely originate from human activity.

Preliminary Results

Most anomaly features investigated by soil sampling contained abundant evidence of human activity through artifact remains (shells, gravel, charcoal, glass, and pottery) at the Cabin and Dairy sites. The Forest Charcoal site did not reveal prehistoric or modern human activity. The examined anomaly features at this site were inconclusive, the profiles were normal. Soil chemistry results for the Dairy and Cabin sites were elevated for all elements (except C) and pH compared to Reference soil samples taken elsewhere on the property (Figure 3). Forest Charcoal soil chemistry was similar to Reference levels for all elements and pH (Figure 3). Resistivity more accurately identified subsurface anomaly features whereas EMI revealed subsurface soil variation.

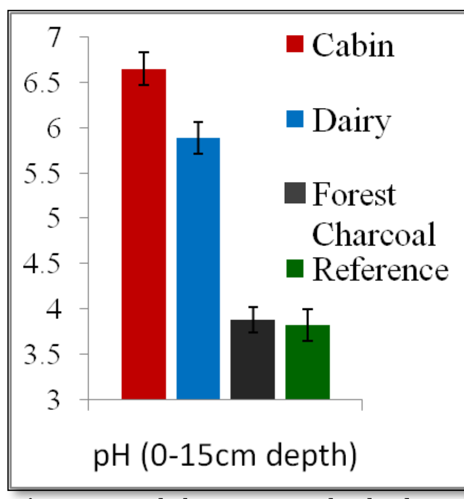

Figure 3: Soil chemistry results displaying differences in soil pH across the three sites and compared to Reference soil samples (taken from random sample points in Reference areas.)

Objective 3

Two soil monoliths, or mounted soil profiles, with interpretive signs, will be created using Wormsloe soils. These will be available for display at the Wormsloe Historic Park visitor center or the Wormsloe library.

[1]Collins, J.M. and Molyneaux, B. L. 2003. Archaeological Survey. Alta Mira Press, Walnut Creek, California.;[2]Gaffney, C. and Gater, J. 2003. Revealing the Buried Past: Geophysics for Archaeologists. Tempus Publishing, Gloucestershire, England.; [3]Garrison, E.G. 2003. Techniques in Archaeological Geology. Springer, Berlin, Germany.