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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:

Recommendations for Applying Results to DoD Modeling Initiatives

SARAH JOHNSON, MARC ABRAMS, AND LAURIE RUSH

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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 to the recommendations stage. This technical analysis reports the management recommendations of the project for Department of Defense (DoD) installations throughout the eastern U.S. (eastern Woodlands) based on data and results obtained for the four participating installations: Ft. Drum, NY, MCB Quantico, VA, Cheatham Annex, VA, and the Dare County Bombing Range, NC. Included in this report are recommendations for applying the results of this project as well as another Legacy project (#08-416) to Department of Defense archaeological site identification and possible evaluation, using an integration of indicator species tools, Black Earth soil sampling, and remote sensing of vegetation. Project #08-416 reported on "The Use of Vegetative Indicator Species in Assessing Archaeological Site Integrity" and included recommendations concerning the identification of vegetative indicator species and application to DoD archaeological modeling initiatives. We believe that the integration of a variety of available tools is a more robust approach. This is why we have reported recommendations in this technical analysis that include vegetative indicator species tools along with the Black Earth and remote sensing tools.

Management Recommendations

Legacy Projects #10-416 and #08-416 have been conducted with the purpose of developing tools for the efficient identification and protection of cultural resources on military lands. The tools developed have been based on the impact of prehistoric Native American land uses on present-day vegetation composition and soils. Following is a detailed summary of recommendations concerning each individual tool that was developed, as well as an integration of the tools. Final management recommendations are then made as a general step by step guide for the application of these tools to Cultural Resources Management initiatives on DoD land holdings throughout the eastern U.S.

Vegetative Indicator Species

Ethnobotanical studies suggest that Native American cultural and land-use practices have significantly altered forest vegetation in the eastern woodlands; these changes persist to the present-day. Agricultural activity, forest management, including planting, the use of fire, and fuelwood cutting of forests by Native Americans may have facilitated the establishment of early successional tree species including a large number of dietary mast and fruit trees. Mast-bearing species such as oak, hickory, American chestnut, or black walnut may also have been cultivated or favored by Native Americans, increasing their importance in present-day forests. Gathering of plant species for food may have resulted in concentrations of seed and new plants in the immediate vicinities of occupation areas (such as *Chenopodium*). In addition, Native Americans used fire to improve browse for game, to encourage growth of berries, mast, and important pine species, and to clear underbrush to maintain agricultural fields or facilitate hunting. These activities resulted in significant alteration of vegetation composition and structure in intensively occupied areas. Identifying plant species promoted by Native American activity to such an extent as to be indicative of cultural significance on the present-day landscape can be termed "vegetative indicator species." Study of indicator species is based on the idea that the presence and number of certain plant species, including trees, shrubs, and herbs, are an indicator of a specific site quality, habitat type, soil type, microclimate and successional stage.

Species of particular importance to Native American populations in any given area would have been preferentially propagated or cultivated. These vegetative indicator species can be identified through ethnobotanical literature review. Surveying vegetation in and around known archaeological sites, and comparing the species composition to areas where cultural resources appear to be absent can also inform the identification of indicator species of particular note in any given area. Vegetation surveys can be conducted through fixed-area circular plot sampling (per methodologies outlined in the Progress Report for Legacy Project #08-416, submitted on 9-30-2008) or through simple reconnaissance of the vegetation on sites, noting presence/absence of plant species. Once vegetative indicator species are identified for a given installation area, noting their presence on the landscape, especially where they make up a high percentage of the tree canopy, shrub, or herbaceous layer, can indicate Native American influence, and thus archaeological potential.

Black Earth Soil Sampling

Black Earth soil testing methods can be useful to archaeological site evaluations, particularly on long term habitation sites. Both agricultural fields and middens would have been located at long-term habitation sites in the eastern woodlands, and impacted soil characteristics. Using elevated soil nutrient status or soil color to identify patterns on the landscape that could be indicative of Native American influence in the soil is a simple and cost-effective way to narrow the area where more time-consuming and expensive shovel testing needs to be conducted. Also, if cultural resources are known to be present, soil nutrient status and color can help identify the layout of a site and potential locations of agricultural fields and middens. Locating middens is especially important because their contents contain a wealth of information about prehistoric diets and lifestyles.

The impact of Native American activities on soils can be evaluated through testing of soil nutrient status and examination of soil color using the Munsell system (detailed method for using Munsell system included in the Technical Report for this project). Both soil color and soil nutrient status require soil samples to be taken in areas of known or suspected Native American habitation. In areas where habitation is suspected or yet to be determined, obtaining soil samples in a grid format throughout the area can allow DoD cultural resources managers to evaluate the potential for Native American impacts in the soil. A grid pattern of sample points can be placed on the landscape, using transects that cover the site of suspected habitation. Transects and samples along each transect can be of varying distances apart; from intensive sampling at 5 foot spacing, to a more general sampling with up to 20 foot sampling. We suggest using a soil corer to obtain samples, as soil color is much easier to inspect and should be recorded immediately following removal of the soil core from the ground.

Spatial interpolation with the grid samples, the method employed with this project (results shown in the Technical Report, and methodology detailed in the Black Earth Protocol slideshow), is useful here because there are technically no “control” areas to compare with soil test results and many times baseline soils information is hard to come by in general soil surveys. However, a control may be possible if directly adjacent areas have previously been tested and found to be lacking in cultural resources. Also, viewing the patterns in soil nutrient status across a landscape may provide clues to spatial distribution of cultural resources in relation to topographic changes, water resources, defensible areas, etc. As soil testing in a laboratory can be

somewhat costly and time-consuming (although less so when compared with many traditional archaeological methods), soil color analysis can be used to approximate soil nutrient status. Spatial interpolation can be employed in the same way as with nutrient status to note patterns across a landscape, potentially indicating areas of either directly (agriculture) or indirectly (midden) amended soils.

Remote Sensing of Indicator Vegetation

Remote sensing techniques are widely used in the field of archaeology to locate recognizable landscape features potentially created or impacted by humans, such as mounds, levees, walls, and other features distinguishable from the natural topography primarily by their regularity. Here we have successfully used photointerpretation of aerial imagery to identify prominent indicator vegetation types (inclusions within a broader vegetation matrix) associated with known archaeological sites across a landscape. We strongly recommend aerial photography over satellite imagery for this method, as high resolution of the imagery is very beneficial to the strength of the analysis and results. We suggest the National Agricultural Imagery Program (NAIP) aerial photographs, when high-resolution aerial photography is not already available for an installation. These are publicly available, one meter resolution images. For this project, the NAIP images used for analysis (images shown and methodology detailed in the Remote Sensing Protocol slideshow for this Legacy Project) were obtained from the United States Geologic Survey (USGS) Seamless Data Warehouse website (http://seamless.usgs.gov/) for publicly available geospatial data downloads.

Areas of the landscape not previously surveyed for cultural resources can be viewed with NAIP aerial imagery in natural color rendering and color infrared rendering to locate areas that contain the vegetative indicator species or types that have been found to be associated with archaeological sites. Vegetation types can be differentiated by noting tone and texture qualities. Tone and texture, as well as other qualities of different vegetation in aerial imagery, vary between natural color rendered and color infrared rendered images. Both types of renderings can be useful in differentiating vegetation types. Tone and texture of indicator vegetation types can be ascertained by ground surveys of areas located on aerial images. These specific tones and textures can be identified across a broad landscape to pinpoint potential cultural resources (detailed methodology available in the Remote Sensing Protocol slideshow). Other significant

aspects that can be noted are patterns in vegetation across the landscape that can be related to specific soil characteristics or other attributes such as proximity to water or defensible position. The specific methodology in the use of aerial imagery to evaluate indicator vegetation types on known archaeological sites is detailed in the Remote Sensing Protocol slideshow. This methodology can be applied very widely, on Department of Defense land holdings throughout the entire United States.

Integration of the Tools

The combined usage of vegetation, soils, and remote sensing tools would be able to predict cultural significance better than any one method independently. For example, where certain indicator species are present, a simple soil test can be used to corroborate the expectation of cultural resources. However in some areas, a small soil core to determine soil color could be enough to corroborate the other lines of evidence. Remotely sensed data, such as aerial photography, can be incorporated to determine where areas of significant indicator vegetation are located, allowing areas of cultural significance to be narrowed quickly and effectively. A general hierarchical method to follow would be using indicators like earthworks, shell middens, and other physical evidence first, then vegetative indicator species (narrowed most effectively with the use of remote sensing), then soils. This is also the order in which identification of sites is most efficient, as physical evidence can be identified rather easily with the naked eye, while vegetation may require surveying for quantification of trends, and soil samples would potentially require testing. Following are step by step recommendations for the integration of tools developed with this project that can be applied beyond the four participating installations to any DoD land holding in the eastern U.S.

Conclusion and Final Recommendations

We recommend the application of indicator species tools, Black Earth soil sampling, and the use of remotely sensed data products to predictive models that are already used by cultural resources management personnel on DoD land holdings. A general order of procedures that can be applied across DoD land holdings in the eastern U.S. is as follows:

1 – Perform an ethnobotanical review for potential indicator species and vegetation types that can be found on any given DoD installation in eastern CONUS (This requires a knowledge of Native American lifeways and important plant species that CRM personnel would already have; these methods are detailed in Legacy project #08-416).

2 – Perform ground vegetation surveys and reconnaissance for local or regional indicator species. This should be coupled with a spatially distributed soil color analysis while in the field to identify areas of higher nutrient status and/or soil charcoal (or middens) indicated by darker color.

3 – Perform an analysis of remote sensing data (photointerpretation of aerial imagery) of known sites in the area of interest to identify prominent indicator vegetation. Determine tone and textural qualities of this indicator vegetation.

4 – Use aerial imagery to locate unsurveyed areas where indicator vegetation can be identified by evaluation of tone and texture.

5 – When these areas are located on aerial imagery, perform ground vegetation survey (can be with vegetation sampling plots or simple recording of presence/absence of vegetative indicators) and Black Earth soil sampling.

These steps may not all be necessary to identify areas of potential cultural significance. If, for example, photointerpretation of aerial imagery indicates clear areas of vegetative indicator species on an installation, DoD Cultural Resources Management personnel can bypass further and more intensive steps such as ground vegetation surveys or laboratory testing of soil samples. CRM personnel need only perform the steps necessary to determine cultural significance, thus the expenditure of time and money versus knowledge gained is maximized.

Literature Cited

Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42: 346-353.

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.

Clark, J.S., and Royall, P.D. 1995. Transformation of a northern hardwood forest by aboriginal (Iroquois) fire: Charcoal evidence from Crawford Lake, Ontario, Canada. *The Holocene* 5: 1-9.

Delcourt, H.R., and Delcourt, P.A. 1997. Pre-Columbian Native American use of fire on southern Appalachian landscapes. *Conservation Biology* 11: 1010-1014.

Smith, B.D. 1984. *Chenopodium* as a prehistoric domesticate in eastern North America: Evidence from Russell Cave, Alabama. *Science* 12: 165-167.