Multi-Scale and Nested-Intensity Sampling Techniques for Archaeological Survey

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This paper discusses sampling techniques for archaeological survey that are directed toward evaluating the properties of surface artifact distributions. The sampling techniques we experimented with consist of a multi-scale sampling plot developed in plant ecology and the use of a nested-intensity survey design. We present results from the initial application of these methods. The sampling technique we borrowed from plant ecology is the Modified-Whittaker multi-scale sampling plot, which gathers observations at the spatial scales of 1 sq m, 10 sq m, 100 sq m, and 1000 sq m. Nested-intensity surveys gather observations on the same sample units at multiple resolutions. We compare the results of a closely-spaced walking survey, a crawling survey, and a test excavation to a depth of 10 cm. These techniques were applied to ten 20 × 50 m survey plots distributed over an area of 418 ha near the Hudson-Meng Bison Bonebed in NW *Nebraska. These approaches can significantly improve the accuracy of survey data. Our results show that high-resolution coverage techniques overlook more material than archaeologists have suspected. The combined approaches of multi-scale and nested-intensity sampling provide new tools to improve our ability to investigate the properties of surface records.*

Introduction

Archaeological survey has changed dramatically over the years. While at one time the need to survey had to be justified, the concern with regional patterning has continually developed and today survey is among the most fundamental techniques of archaeological inquiry (Ammerman 1981; Banning 2002; Schiffer, Sullivan, and Klinger 1978). The goals of survey projects and the demands placed on survey data have become more diverse and complicated with time. The observations made by crews walking parallel lines over the landscape must address issues ranging from finding and protecting sites from damage to investigating the nature of past land-use strategies. Because of the diversity of potential applications of survey data and the challenges associated with obtaining and understanding them, multiple concerns may compete for priority in the selection of field techniques. Surveys may need to cover very large areas in little time as well as account for the effects of a variety of taphonomic factors that influence the regional record. Ideally, the data supporting interpretations and management decisions are efficiently gathered but also of sufficient quality to accurately represent the distributional properties of the regional record.

Both management and research perspectives (although these need not be mutually exclusive) can benefit from large spatial samples that reveal associations between ge-

Figure 1. Location of the Oglala National Grassland, Nebraska within the United States.

ography and material culture and a thorough understanding of the processes that influence the distributions that surveys document. Accordingly, the numerous goals of archaeological survey are here grouped into discovery-based and property-based modes of investigation. Discovery-based surveys identify geographical aspects of the surface record by locating and describing clusters of artifacts. A property-based approach focuses on evaluating accuracy of method and technique and formational aspects of the regional record (Ebert and Kohler 1988; Shott 1995; Wandsnider and Camilli 1992). The capacity to analyze and interpret the contexts of discovery could be improved by conducting more detailed analyses of the factors that influence the surface samples that we use to infer spatial relationships. This requires embracing an explicitly experimental approach and integrating property-based investigation as one of several phases in a survey project (Given et al. 1999; Schiffer, Sullivan, and Klinger 1978). Siteless or distributional surveys have made major contributions in this regard (Ebert 1992; Foley 1981; Thomas 1975). By sampling regions as opposed to "sites," these surveys attempt more holistic and accurate interpretations of landscape records.

We present two additions to the conventional survey tool-kit that are aimed at developing property-based investigation. The first is the use of a multi-scale sampling plot developed in plant ecology. The second is a nested-intensity survey design that covers each plot with more-than-one observer resolution. These techniques were applied in an archaeological survey on the Oglala National Grassland (ONG) of NW Nebraska (FIG. 1). A property-based approach is valuable for investigating geomorphologically active and topographically diverse archaeological landscapes like the ONG (FIG. 2), but the basic principles are applicable to many other sampling situations whether landscape-oriented or intra-site.

Figure 2. The Oglala National Grassland landscape.

The technique we borrowed from plant ecology is the Modified-Whittaker multi-scale vegetation sampling plot (FIG. 3). This sampling design was applied to archaeological survey because of the increased accuracy of the plant diversity samples gathered with this method, the experimental control that the plot provides, and because of its multi-scale design. Plants and artifacts share some basic distributional properties, so it follows that a survey design that is highly useful in plant species surveys may also be useful for sampling artifact distributions. "Artifacts share many properties with plants, in having small unit size in relation to a very large spatial context, and also by having a patchy distribution" (Foley 1981: 174). The size of the Modified-Whittaker plot is 1000 sq m, which is a very small area compared to conventional designs. Orton (2000: 88) considers survey units that are 500 to 1000 m on a side as "small" archaeological sample units. Thus, we were initially hesitant to apply the Modified-Whittaker plot directly to archaeological survey. As we became more aware of the improvement in the accuracy and reliability of plant species surveys conducted with this method, however, we decided to test its utility in an archaeological case study.

An additional methodological issue came to light when one of our colleagues in plant ecology wanted to know how archaeologists estimate the number of artifacts they miss, or walk past, when conducting a pedestrian survey. We realized that we had no way to reliably answer this question with conventional techniques (Banning 2002: 62) and thus we elected to conduct a nested-intensity survey to address this issue. A nested-intensity survey consists of covering the same sample units with different resolutions. We covered each of the 10 Modified-Whittaker plots in this study with a fine-grained walking survey, a crawl survey, and then conducted test excavations of the top 10 cm. Comparing the results of the samples obtained by each technique provides a means for investigating the effects of basic decisions on the estimates concerning the overall population. The intensive coverage provides high-resolution samples of limited areas that can be used to evaluate the accuracy of our approach.

Before discussing the survey in greater detail, we should emphasize that the techniques of multi-scale and nested sampling are strategies for systematic sub-sampling that can be used to augment traditional survey practice. These

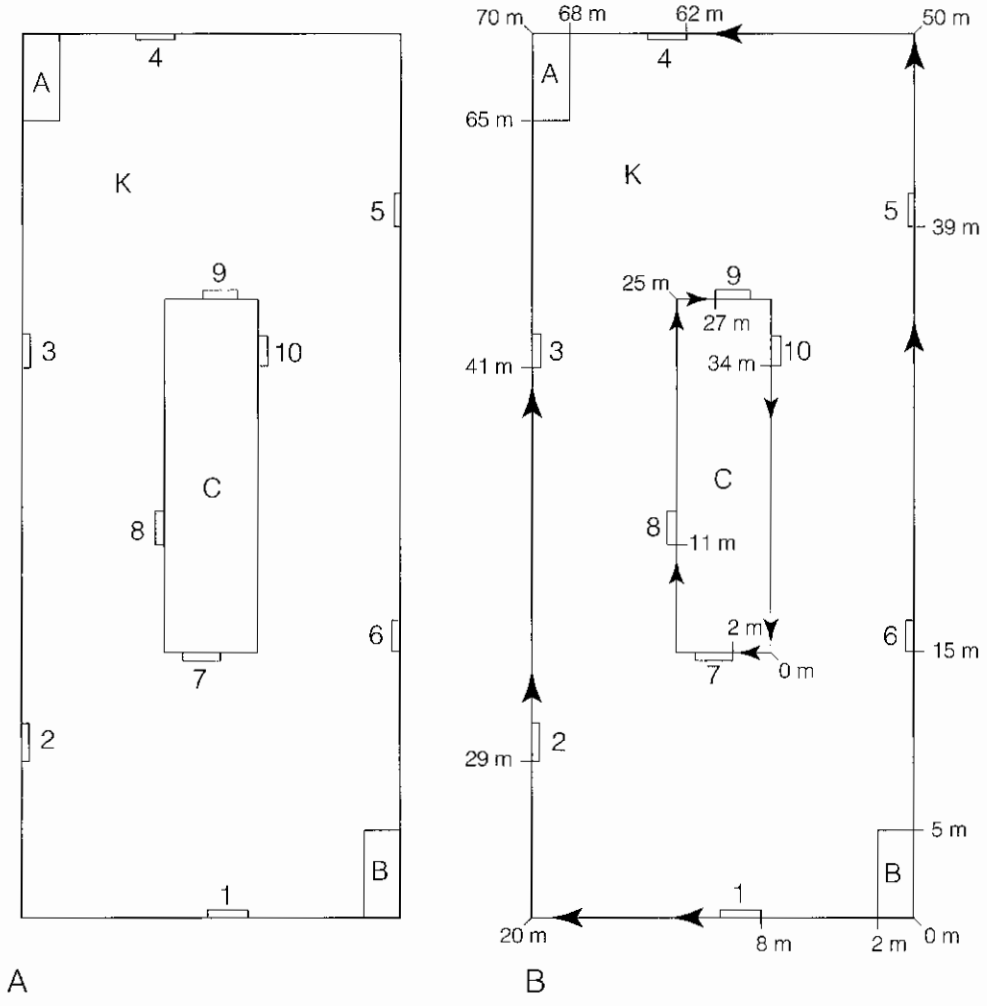

Figure 3. The Modified-Whittaker multi-scale sampling plot. A) The layout of the 20 × 50 m plot. The numbered plots (1 to 10) are 0.5 × 2 m, the A and B plots are 2 × 5 m, and the C plot is 5 × 20 m; B) Plot layout with guides for arranging subplots. The location of each subplot is indicated as a distance in meters from the anchor corner, marked by a 0 m in the lower right corners of the K plot and subplot C.

are not considered replacements for conventional techniques that gather coarser-grained samples of larger spatial extent. Certain aspects of survey certainly require large coarse-grained samples. The small area covered by this approach could not be used on its own to achieve an understanding of a regional record but this small-scale sampling plot is ideal as an experimental framework for property-based investigations. The nature and significance of the items found by discovery-based surveys could be placed into more informative contexts if they were complemented with high-resolution samples aimed at evaluating the properties of the record itself. The techniques we present are intended to enhance discovery by focusing on the evaluative goals of survey which are often not given as much emphasis in the design of regional sampling schemes.

The Modified-Whittaker Plot and Multi-Scale Sampling

The Modified-Whittaker multi-scale sampling plot is an improvement over conventional rangeland techniques for studying plant diversity (Stohlgren, Falkner, and Schell 1995; Stohlgren, Bull, and Otsuki 1998). In comparative studies, the Modified-Whittaker plot outperformed traditional plant sampling designs by documenting more plant species, capturing more rare species, and more accurately representing the relative abundances of species in the community. The traditional techniques that typify plant species-richness surveys are analogous to those in archaeology. Conventional plant survey methods involve documenting species within quadrats placed along a transect, whereas archaeological surveys consist of long linear transects walked