The Status and Potential of Predictive Surveys in New Jersey

by

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Introduction

In this paper, the value and reliability of using survey models to predict archeological site distribution in New Jersey is considered. While the theory is not sufficiently ripe to warrant a "how-to" recipe for predictive surveys, the current volume of literature on the subject provides a fertile field for discussion. Current approaches and assumptions, however, must be understood in their historical context. The fabric of contemporary sampling theory is constructed from antecedents which will be outlined. Such a review of previous work is necessary because many of the assumptions were not so long ago explicit propositions to be questioned and debated. To ignore the origins of modern theory could lead to an unnecessary reiteration of old arguments.

Once sampling theory and its development have been discussed, several recent predictive surveys will be examined as illustrations of the possible range of approaches. The first experiment with developing a predictive survey in New Jersey will be examined as an example of the selection process necessary in order to arrive at a meaningful set of predictive variables for a particular region. This experiment by John Cavallo and others exemplifies a flexible and fluid approach to the development of a research strategy. The preliminary results have provided some important insights into the inadequacy of the data base and into some commonly held biases concerning New Jersey.

Finally, although clearly no right or wrong way can be advised, a consideration of the trials and errors of recent surveys in other regions may prevent similar pitfalls in programs attempted in New Jersey. It is hoped that a discussion of work to date, in its historical and theoretical perspective, will provide some helpful hints and rules of thumb for field archeologists, agency planners, and project reviewers faced with the evaluation of archeological resources through the application of probabilistic regional surveys.

Background

North American archeology is undergoing stressful times. Old assumptions are being reevaluated and new approaches are being developed. Archeologists have been asked recently to provide information about subjects only speculated about within academic circles in the past. Planners and government agencies now expect archeologists to present legally defensible positions regarding

regarding the cultural significance of a region or project area destined for development. The situation is exacerbated by the fact that the archeological community is being asked to communicate with members of other disciplines who are totally unfamiliar with anthropological terminology and assumptions.

This pressure to provide information for purposes beyond pure research could not have come at a worse time for the field. Burdened by a strong feeling of inadequacy compared to sciences such as chemistry or physics, archeology, in the 1960's, began a period of what has been called "frenzied concept borrowing" (Dunnell 1979: 439). The adapted theoretical potpourri included terms such as general systems theory, locational analysis, quantitative techniques, central place theory, stratified sampling, and others. Dunnell points out that besides confounding many students at the time, the massive infusion of new methodologies resulted in "...the decreased readability of Americanist archeological literature in the late 1960s and early 1970s" (ibid.).

It is not clear that this introspective literature on archeological method and theory actually involved much that was truly new in a theoretical sense (Meltzer 1979). David Clarke, the author of Spatial Archaeology (1977) and one of the foremost proponents of the need for a broader regional perspective, cautioned that much, if not most, of the new theory is not only borrowed but is also derived from long-standing traditions of thought in England and Europe. Only their applications to problems of North American archeology are new. Seen from a broad perspective, conceptual approaches such as regional studies, territorial analysis, distribution mapping, density and prehistoric demographic studies, as well as predictive areal surveys are all part of a larger tradition of spatial studies. As Clarke points out, the roots for these research approaches grew from the writings of the Austro-German school of "anthropo-geographers" between 1880 and 1900. Their motivations aside, these turn of the century scholars mapped cultural traits and artifact categories in an attempt to define prehistoric and more recent cultural complexes (Clark 1977: 47).

The European regional approach did influence some 19th century contemporaries but was not widely accepted, especially in America, until much later. The initial concern for regional settlement studies in the United States can be traced back to Lewis Henry Morgan's work on native American village organization (1881) and to Steward's study of the shifting hunting and gathering economy of the Shoshone Indians in the 1930's (Clarke 1977). Despite these early efforts, modern American assumptions and approaches were not formalized on a discipline-wide basis until the 1950's with the impact of Gordon Willey's Viru Valley survey in Peru (1953). While many parallel studies were done in Mexico and North America, it was

Willey's study of changing settlement patterns through time in an arid coastal desert valley that set the form and direction of spatial studies in American archeology for the next two decades (Clarke 1977; Preston 1972).

At about the same time, developments in biology helped to bring about a shift in how American archeologists viewed human relationships to the environment. With his work Fundamentals of Ecology, published in 1953, Eugene Odum introduced the concept of "ecosystem" into American archeology (Willey and Sabloff 1974). This concept, derived from biology, views human activities within the total environment--animals, plants, and non-living things--each element a part of the whole, each responding to many other elements.

In addition to the ecological approach, during the 1950's and early 1960's, archeologists began to incorporate two basic mathematical concepts into their research plans: 1) quantification; and 2) randomization. The utility of counting and weighing different artifact categories gained general acceptance as a result of the early attempts, especially in California, to estimate prehistoric population levels by quantifying available food resources. Shell mounds were sampled and quantified (Heizer and Cook 1960; Cook 1946); acorn yields were estimated (Baumhoff 1963). Inspired by these early studies, other archeologists began using numerical parameters to define spatial and temporal differences within and between sites. Today, quantification is considered the essential means for deriving and presenting verifiable information and results.

Random sampling emerged in response to the need to avoid bias when choosing locations for excavation units within a site (Vescelius 1960). Archeologists had previously placed their excavation units within what they assumed were "rich" or high yield areas. This biased sampling approach to a site often led to the loss of critical kinds of functional and spatial information. Randomly spaced units began to be used on a wide scale in order to gain a broader and less biased sample of the range of data from a site.

The problem of bias is also critical at the regional level. David Thomas has commented recently that "...capricious sampling techniques can lead the archaeologist astray in assessing the relative importance of various hunting/gathering sites. The best scientific way to insure unbiased results in this situation is through the judicious use of random sampling theory" (1974: 35-36). Despite its virtues, random sampling has sometimes been mindlessly applied while ignoring concrete leads and, as discussed below, does not automatically result in the most significant results.

Also in the 1960's, archeologists began to shift from single site investigations to regional studies. Efforts were made to define seasonal camp sites or specialized work and living areas (tool using, nut cracking, fishing stations, etc.) as diversified aspects of a single economic or settlement system (Thomas 1974, 1978). Taking off from Willey's work in the 1950's, the definition of settlement system rather than just settlement pattern became the problem orientation of much archeological work (Winters 1969; Streuver 1968; Binford 1964). Out of these parallel developments and diverse traditions in both this country and Europe came the realization that archeological information involved more than the study of things, artifacts, or individual sites, but also the relationships between these elements within a larger context of other sites over a large area covering a diversity of natural resources and environments (Clarke 1977: 5).

It was during this period that a network of new federal laws put pressure on the archeological community to produce reliable results as a basis for project planning. Historic Preservation legislation required that all federally funded programs and federally owned lands be surveyed and evaluated for significant cultural resources which were defined as those that met the criteria for inclusion in the National Register of Historic Places. These new programs not only put pressure on the professional community to produce accurate information but they also forced many archeologists to work in little-studied areas under quite unfamiliar conditions.

American archeology is still in its adolescence in terms of learning to cope with the new demands of regionally-oriented government programs but new expectations have also been put on nonarcheologists. Ill-equipped agencies, planners, engineers, and the corporate sector are expected to evaluate the written descriptions of archeological work, its technique and jargon, all of which are more often than not totally foreign to the non-professional reader.

Predictive Survey Models

The enumerated theoretical advances in archeology, the trend toward ecological-settlement system studies and quantitative sampling techniques, and the planning needs of federal and state agencies have combined to make the development of predictive survey models both feasible and desirable. Ideally, a predictive survey makes it possible to inspect only a fraction of the actual area of concern and, in the context of good background research, to extrapolate to the entire area (King 1978: 74). Keeping in mind the difference between the ideal and actual, King and others have warned against reading too much into the term "predictive." It is dangerous, especially under fiscal and legal pressures, to accept the results of a "predictive survey" as an iron-clad argument for the presence or absence of cultural resources. It could have particularly damaging effects on dwindlng cultural resources if non-archeologists take survey information to imply more than it does or should about the depth and scope of information on any particular region. As it will be seen from examples in New Jersey and other areas, this procedure is still in its developing stages as a planning tool.

Examples of Predictive Surveys

Predictive surveys have been used for research purposes and as regional planning tools for state and federal agencies throughout the country. For obvious fiscal reasons, they have been applied primarily to the definition of culturally sensitive areas within large regions. The structure of these surveys varies due to a number of factors: the proposed scope of work; the size and environmental diversity of the region under investigation; the research interests of the investigator; economic constraints; and the quality of information on the distribution of known archeological sites in the study area.

The following examples share three major design principles. They are based on randomization, discussed above, and they also reflect systematization and stratification. Combinations of these three principles form the common core of most current sampling techniques. As defined by Plog, "systematization involves locating units at equal distances from each other. This technique is useful for many sorts of mapping projects where an even distribution of data points over a study area is needed" (1978: 402). Evenly spaced subsurface probes along a datum line are a familiar example; the dispersion of possible excavation units throughout a grid system at equal distances would be another. The concept of stratification is aimed at establishing relatively even coverage of an area which takes into account the full range of spatial or environmental variation within the region.

Schiffer and House (1977) conducted a predictive survey in the 2,000 square mile Cache River Basin in northeastern Arkansas for the U.S. Army Corps of Engineers. The purpose of this survey was to assess the direct and indirect impacts of stream channelization on the distribution of prehistoric archeological sites in the project area. The investigators obtained data on the distribution of known sites with respect to environmental factors such as soils and landforms. Because of a number of factors, their predictions and recommendations were based on intuitive interpretations which were not formalized into models of differential densities of site types (base camps vs. limited resource stations, etc.).

Using available data on site distributions, university files, and local collectors, Dincauze and Meyer (1977) predicted areas of archeological sensitivity for eastern New England (King 1978: 123). This project was sponsored by Interagency Archeological Services, National Park Service, Washington, D.C.

In 1978, the Illinois State Historic Preservation Office requested proposals from individuals and institutions for the development and testing of predictive survey approaches as part of its comprehensive survey and planning program (Brown 1978). The proposed surveys were based primarily upon the synthesis of existing site data. These data and other strategies were combined in order to facilitate the development of testable models of site prediction. This was the first attempt at using such an approach for assessing prehistoric resources on a statewide versus a local or restricted regional level.

David Hurst Thomas (1973) conducted what has become a classic example of a predictive survey within the framework of pure research (i.e. non-planning purposes). His study was undertaken in order to test a hypothetical pattern of settlement proposed, in the 1930s, by the anthropologist Julian Steward for the Shoshone Indians in the Great Basin. In particular, Thomas was interested in the winter camps found at consistent elevations in the foothills of the central Nevada mountains. Using Steward's ethnohistoric economic patterns and his own familiarity with the study area, Thomas experimented with projecting the presence or absence of winter camps in areas he had not surveyed previously.

In order to determine why his intuitive predictions worked so well and to further quantify their accuracy, Thomas devised a systematic method of testing and analyzing his predictions. His first step consisted of listing all the environmental factors related to winter camp settings. Ultimately, he isolated seven environmental factors or variables as the least number required in order to predict the presence or absence of known Shoshone winter camps within his study area. Subsequent field testing of his predictions of sites in unsurveyed areas yielded results of approximately 85% accuracy.

The use of predictive surveys in the Middle Atlantic region (New Jersey, Maryland, Delaware, Virginia, Pennsylvania, and North Carolina) has not been widespread. One notable exception is a preliminary predictive model developed and currently being tested by William Gardner of Catholic University, Washington, D.C. (1978). The theoretical basis of his model treats archeological site distributions in terms of their relationships to environmental settings, technology, settlement, and food acquisition strategies (1978: 6).

Gardner concerned himself with the distribution of sites within a temporal span of 6500 B.C. to 1000 B.C. (the Archaic Period). His study area consisted of idealized transects (rectangles) which extended across four physiographic provinces: Ridge and Valley; Blue Ridge; Piedmont; and Coastal Plain (1978:1). A number of combinations of environmental variables were isolated. These allowed for the prediction of specific types of sites (in terms of their relative age and function) in both gross environmental and microenvironmental settings.

Developing a Predictive Model for New Jersey

In New Jersey, there was no tradition of regional or predictive surveys. In 1979, however, a project was undertaken by John Cavallo and Alan Mounier to develop and test a predictive model for the Pinelands of southern New Jersey. Efforts to date have focused on the definition of regionally appropriate and statistically relevant sampling units. A brief description of this project will illustrate the significance of flexibility and constant feedback during the formulation of a sampling strategy. Field investigations have not begun but the results of the background study revealed biases and limitations in the available data base which necessarily influence the construction of a predictive model. In addition to defining the gaps in the existing data, the ongoing process of developing a probabilistic sampling strategy for the coastal plain of New Jersey illustrates the need for constant reanalysis and selection of variables for field testing.

In this and other regions, the identification of environmental factors which might have influenced the distribution of prehistoric Indian sites has formed the basis for most recent predictive surveys. Ray et al. (1976) claimed that slope gradient, distance from water, and site altitude were the most important variables for site prediction. Lee (1976) considered the distance to water (up to 300 meters), land form, and soil type to be the significant variables. Schneider and Frantz (1977) listed ten variables in their study: landform; source of materials; soil moisture; slopes; modifiers such as prevailing winds, defense, etc.; aspect (orientation); elevation; vegetation; stream distance; and stream order. Swigart (1976: 61) emphasized the proximity of water in western Connecticut. He specifically suggested that there was a strong prehistoric preference "toward the lee shores adjacent to potable water, particularly on lakes and streams where sites are most often located at the confluence of a small stream."

The predictive survey program for the New Jersey Pinelands emanated from an experiment conducted by two graduate students during the 1978 Monmouth College Archeological Field School under the direction of John Cavallo. Sandra Hartzog and Daniel Sorkowitz were provided with locational and cultural information on fourteen prehistoric sites. The majority of these sites were located in the oak-pine fringe area of the Pinelands. Each of them had yielded diagnostic artifacts of Paleo-Indian and/or Early Archaic through Late Woodland occupations.

Using U.S.G.S. topographic quadrangles, U.S.D.A. soil maps, and aerial photographs, the students were asked to examine the sites for the numbers and kinds of environmental variables they exhibited. They then compared the sites to each other and came up with a list of variables shared by the majority of sites in the sample: elevation; slope at site; slope in contiguous areas; aspect (orientation); distance to stream; elevation above stream; water resources beyond immediate stream; stream order; relation of site to stream confluence; drainage at site; and drainage in contiguous areas. Through further analysis of a larger number of Coastal Plain sites and data from the research of Gardner, Bonfiglio, Cresson, and others, some of the variables were combined and others were deleted or added.

The building of a predictive model involves more than the definition of environmental variables. It is important that the variables be observable without going into the field, i.e. that all information is available in either map or tabular form. The environmental variables chosen must also be sufficiently common within the study area to have some predictive value. For instance, springs may be unfailing predictors of sites but if there are few known springs, the variable will not be very helpful. Variables should exhibit significant spatial variation. In the case of the Pinelands, which are largely flat, topographic characteristics or site orientation would be fairly useless for predictive purposes. This would likewise hold true for any other natural or cultural trait which is constant over a study region.

For the Pinelands, after numerous additions and deletions, Cavallo et al. selected eleven variables which appear to approach the requirements for utility and relevance to the area:

1. Present land use;
2. Proximity to fresh water;
3. Proximity to salt water;
4. Number of hydrological types in grid area;
5. Altitude;
6. Altitude: lowest elevation in meters;
7. Soil type: percentage of grid area suitable for Woodland;
8. Soil type: percentage of grid area suitable for Openland;
9. Soil type: percentage of grid area suitable for Wetland;
10. Percentage of grid area exhibiting soils with 0-5% slope; and
11. Ratio of eroded to deposited soils.

During the initial phases of this project involving both the selection of testable environmental variables and a thorough review of available background information to date, two factors of universal concern were brought into focus: 1) the common thinness and gaps in existing background information; and 2) the impact of lay and professional biases on available information. Unfortunately, these factors are not unique to the region but they must be taken into account in this and other study areas.

Initial Insights from the Background Research

The first steps in the Cavallo survey program were to review available published sources on the area, to record museum and agency listings of located sites, and to interview private collectors who might have additional information. Despite the numbers of sources and informants, the resulting site inventory was spatially uneven and problematic on several grounds. As Tom King et al. have cautioned, "predictions derived from background research can be only as reliable as the data upon which they were based" (1977: 150). In other words, the densities of known or reported sites in a particular area may not reflect the total range, number, or distribution of actual sites within it. Instead, they may reflect where people have looked for one reason or another such as road cuts and plowed fields, or where collectors have lived.

Cavallo and Mounier observed exactly this phenomenon in the Pinelands. They noted a dramatic increase in the numbers of sites in areas with the greatest density of roadways and large tracts of cleared farmland. The numbers of sites decreased in areas having fewer roads and large tracts of inaccessible forested land. Sites also appeared to follow river and stream banks, an environmental feature long used by collectors interested in finding artifacts, not in building models. The convenience of identifying prehistoric remains in road cuts, stream cuts, and plowed fields has biased any overview of site distribution in the area.

Other biases have also affected the background data available on the Pinelands. Until very recent times, the Pinelands have been known as the Pine Barrens, a name connoting an unattractive environment desirable for neither prehistoric nor historic habitation. Early travelers and even scientists claimed that the natural resources of the area could not, and did not, support permanent settlements. No comprehensive site surveys or excavations have been done in the area primarily because of the bias against it as a likely living environment. Scientists are just beginning to recognize the food resources such as now extinct riverine fish populations and non-western plant varieties that went unnoticed by the early Europeans.

Collectors have not investigated whole sites or areas but have picked up recognizable, classifiable artifacts, i.e. projectile points and other stone tools. The full range of prehistoric debris including stone debitage, food remains, etc. has been left unnoticed and, by and large, unrecorded.

Were these two basic shortcomings of the background data not taken into account, a predictive model would simply produce a self-fulfilling prophecy; all new sites located would be confined to the few environmental niches that have already been investigated because they were accessible and obvious. Areas obscured by woods, not under cultivation, and not cut by streams or roads would be excluded from the survey. Apparent prehistoric use of the environment would simply be a reflection of historic activity within the area.

In summary, five limitations were noted which affected the development of a model for the Pinelands based upon the relationship of site locations to environmental factors:

1. avoidance of the Pinelands as an area of study;
2. focus of archeological activity on sites predominantly in riverine settings and intensively farmed land;
3. selective artifact collection;
4. adherence to the site rather than the region as the unit of analysis and inference; and
5. lack of systematically recorded archeological information.

Insights and Lessons from Recent Fieldwork

Some of the problems of developing a predictive model for one region of New Jersey have been considered. This paper will now turn to some of the insights that have been gained from work in other regions. Several influential summaries of advances in survey design have been published in the last few years (King et al. 1977; Schiffer and Gumerman 1977; Schiffer et al. 1978; Plog et al. 1978). Though not beyond criticism (Thomas 1978), these summaries include a few key pointers for work in the Northeast.

Probabilistic sampling techniques developed for open and easily accessible parts of the southwest and California are not immediately applicable to the northeastern woodlands. The debate over whether square or linear survey areas are more effective (King 1978; Thomas 1978) takes on a different character when considered in light of the heavily obscured ground surface of the Northeast. The discussion in the literature has made archeologists and planners realize that techniques appropriate in one area may be unworkable in another. Three basic issues have emerged from the literature which are of immediate pertinence to future work in New Jersey: 1) the size and limits of the survey area; 2) the scope and intensity of the sample design; and 3) site definition both in concept and on the ground. It is advisable to recognize the meanings and possible abuses of the jargon and assumptions that are part of the recent archeological literature. If some of these observations represent the state of the art, it must also be realized that the art is at a finger painting stage of development.

The Problem of Environmental Change

Under federal programs, survey areas are limited by the funding agencies, patterns of modern landownership, and project development needs. These spatial limitations do not always conform well with the anthropological assumptions underlying regional survey. By and large, archeological surveys are being conducted within government owned tracts of land and along corridors or pockets of land that are being altered by federally-funded construction projects. At the same time, the theoretical basis for regional survey is that prehistoric peoples lived in different areas according to a seasonal round by which some sites were occupied permanently and others were occupied seasonally for the exploitation of a wide range of resources. The range of areas used by one group at different times of the year defined their total settlement system. If an area in need of survey includes only some of the resources, the localities encountered will reflect only partial settlement systems. The results from a survey limited by project boundaries which do not represent the total present-day (in a local sense) environment or, even more importantly, the total prehistoric environment cannot be used without severe limitations beyond the immediate survey area.

In addition to the problem of defining the range and distance of resources exploited by prehistoric peoples in a particular region, the implementation of valid survey strategies is further handicapped by the problem of environmental change. The conditions which surround an archeological site today may have little to do with the resources that were available when the site was occupied in the past. Although specific details are more often than not limited or lacking for a particular locale, it is clear that important shifts have occurred. There has been a well-documented shift of coastal boundaries and a succession of forest environments in the Northeast which has had a decisive effect on the availability of food resources in different areas at different times over the last 10,000 years (Swigart 1976; Kraft 1977; Edwards and Merrill 1977). In addition to these long-term natural shifts, more recent construction and agricultural practices have altered the landscape. Even within the last few centuries, natural changes appear to have been of sufficient magnitude to have altered the boundaries between forests and grasslands as well as the composition of vegetational communities (Wood 1976).

Both modern industrial activities and long and short term natural environmental fluctuations make attempts to project into the past highly problematic. Consequently, both the selection of "significant" environmental variables, in particular, and definition of regional survey characteristics, in general, must address this problem of change and define the temporal applicability of any reconstructions or projections of past natural settings. At present, the ability to do so is still limited, especially in the Northeast.

The Coverage and Intensity of Sampling Design

Once the boundaries and environmental variation of a regional survey have been defined, two basic factors determine the validity of its results. The first is coverage. Coverage deals with the size, shape, and spacing of sampling units within the study area. At issue is what approach gives the biggest bang for the buck. Some things work. Other approaches fail. Some archeologists argue for approaching a region using transects across its various environmental zones; others have held that square or rectangular units, spaced according to some statistically valid method, are the most useful (Plog et al. 1978). What has become clear is that the effectiveness of a survey strategy depends on its appropriateness for the area or subunits within it. In every case, the goal must be to provide as much coverage of a region as possible for the least time and effort. The present state of the art does not warrant recommending one shape of sampling units over any other without considering the specific characteristics of the region to be surveyed (LeBlanc 1980).

The use of random statistical samples to avoid the influences of preconceived biases has become basic to regional surveys. The need for randomness is accepted by most social scientists but how it is achieved, described, and interpreted has led to some recent confusion. Two recurring problems in the use and description of statistical approaches have surfaced repeatedly in the literature: 1) a common misuse of statistical concepts; and 2) the misguided assumption that there is a statistically correct, mathematically determined, ideal level of coverage and sample fraction.

Both in this and other regions, planners, reviewers, and archeologists have been trapped into believing or arguing for some ideal, statistically valid sampling fraction, be it 1%, 5%, 10%, or 40%. For example, many have been either led astray or confused by the recent Society for American Archaeology Memoir 28 in which it is argued that a 40% sample in Arizona proves that a 40% sample is the best for all regions in the country (Mueller 1974: 66). This kind of dogmatic nonsense is invalid statistically, and could lead to unwarranted project costs based on false premises. There is no ideal sampling size or fraction, a priori. David Hurst Thomas has aptly pointed out that:

> ...the critical issue in sampling is not <u>fraction</u> at all, but rather the <u>absolute size of the sample.</u> In very large areas, a relatively low fraction is perfectly acceptable: when the area is small, the sampling fraction must be larger. There is not and can not be an "optimum sampling fraction" (1978: 237).

In a recent commentary on common abuses of statistics by archeologists, Robert Dunnell refers to Thomas' "The Awful Truth About Statistics in Archaeology" and reminds us that:

> archaeologists need to be concerned about probabilistic sampling not because it is right in some absolute sense but because it does provide a means of stating the sample/ universe relationship with some precision. Sampling has a role in solving specific problems of representation in specific circumstances; there is no optimal sampling fraction or best sampling strategy apart from the empirical conditions that each investigation poses (1979: 445).

Finally, following the traditions of cartography or map making, archeologists have become accustomed to defining their study areas, sampling units, or individual sites by applying a rectilinear grid system as a convenient way to define locations in space. It is not surprising, therefore, that regional sample units have often been defined as individual squares within a hypothetical checkerboard. Unfortunately, grid systems or survey units tend to cross-out the often irregular boundaries of the natural environment. Because of this problem as well as the advent of more sophisticated locational devices, the use of rectangular sample units may become obsolete. As LeBlanc has pointed out, recent advances in air photography and computer-assisted image enhancement now permit the accurate definition of regions and landscapes which reflect natural forms of the topography or zones of vegetation without the overlying of a rectangular grid system for reference (1980: 213).

Survey Intensity

Regardless of the nature of the statistical sample employed, the discovery of actual sites is dependent on what happens once the search has actually begun in the field. Inadequate surface surveys have often missed deeply-buried archeological sites or even superficially covered sites. Unfortunately for East Coast archeologists, much of the early literature on sampling strategy was developed for arid or desert areas with little ground cover (Dunnell 1979: 445). As local archeologists soon found out, valid statistical sampling units were not enough to find sites under different conditions. Not only is the presence of sites difficult to see in the wooded Northeast, but their boundaries and extent are often impossible to define from surface inspection alone.

It has been established that for any region in question, the number of sites encountered during a survey is directly proportional to the intensity of the regional coverage (Plog et al. 1978: 391).

Plog has shown that in the arid Southwest, the location of 10 sites took 20 person-days, 40 sites took 40 person-days, and between 50 and 60 sites took 80 person-days per square mile. There seems to be no avoiding the conclusion that regardless of the statistical sampling strategy employed, the final results will reflect the effort and intensity of coverage. However, determining the appropriate level of intensity depends upon local environmental conditions (surface cover and vegetation), variations in site size and density, as well as the depth of the archeological remains. In essence, once these factors are taken into account, the level of intensity can be measured by depth and spacing of subsurface probes.

It has become clear to archeologists working in the Northeast that some form of subsurface testing is necessary if sites are to be found and delimited in forested areas. Lovis (1976) approached archeological survey in wooded areas by laying out parallel survey lines at 100 meter intervals and then excavating shallow test pits along the lines every 100 meters. Lovis did find sites but, more importantly, he showed that the test intervals must be spaced to reflect the expected size of sites. Of the 23 sites he could document for size, Lovis found that the mean minimum dimension of sites was only about 30 meters or 1/3 the spacing of his shovel test probes (1976: 370). Tests spread at intervals greater than 30 meters will miss sites of the minimum dimension.

In the same 1976 article, Lovis discussed the use of small (one foot by one foot) shovel probes dug only as deep as the interface between the forest mat and the subsoil. While it may be true that all of his sample was encountered by this means, the technique does not address the possibility of more deeply buried remains. Several recent examples from the Manasquan drainage in Monmouth County, New Jersey, illustrate the problem.

In 1978, the 21st of a series of four foot deep auger borings at 50 foot intervals across the fifteenth hole of a grass-covered golf course along the Manasquan River yielded a deeply buried, Paleo-Indian fluted point (Grossman 1978). Several miles down river in the same drainage, excavations within the bounds of a Woodland site threatened by highway construction produced an additional fluted point buried several feet below the upper cultural materials which had been concentrated in the near surface plowzone. These examples from New Jersey make it clear that widely spaced, near-surface, shovel probes alone may not do the job.

Several recent experiments have demonstrated that evenly-spaced probes of uniform volume can produce significant information on the internal variation of the buried materials within a site. Chartkoff, a California-trained archeologist who is used to highly visible surface traces, has described the utility of evenly-spaced subsurface probes in Woodland sites (1978). With the use of standard auger borings that are screened to define the relative densities of artifactual content, unevenly spaced concentrations of buried cultural materials were located. Based on the auger results, Chartkoff was able to design an excavation strategy at two sites which was aimed at recovering specific kinds of archeological information (1978: 52).

South and Widmer experimented with four foot deep auger probes in a situation where prehistoric and historic remains were covered by more recent 20th century deposits. By comparing the auger results with actual excavation units, they were able to show that the auger probes accurately defined and delimited the separate occupations, revealed functionally significant variations in the material, and defined the location of previously unsuspected prehistoric remains (1977: 129, 148).

A wide range of techniques and approaches to subsurface testing has been discussed in the literature (Stephenson 1970: 63; Ferguson and Widmer 1976; Percy 1976). Regardless of the equipment preferred, these sources and the examples mentioned above point to the utility, if not the necessity, of deep subsurface probes for site survey in forested environments with low surface visibility. Results to date suggest that: 1) intervals of no less than 100 feet and depths of no less than 4 feet are minimally appropriate; and 2) manual or mechanical borings of comparable volumes can provide significant information on the extent, internal makeup, and range of variation in the buried cultural materials.

Finally, the repeated mention of "site" raises a final, if not somewhat disconcerting, problem concerning the utility of the concept itself. As others have pointed out, it is ironic that at the very moment when the concept of site was becoming codified into legal guidelines of the new federal legislation, North American archeologists began to question the notion altogether (Dancey 1974; Thomas 1974). In his "Up the Creek Without a Site" paper, Thomas cautioned that archeologists were finding only the more visible traces of human settlement and were missing the more temporary encampments for which the traces may be few and widely scattered (1974: 81).

As discussed above, in order to evaluate any find or possible site, it is necessary to contrast it with the range of cultural activities which reflect a full seasonal round of hunting, gathering, and possibly, horticulture. Some of these activities result in large and visible "sites"; others, such as short-term tool-making or food-processing localities, may leave no traces in the archeological record. Such situations defy many current definitions of sites and make formal boundary definitions rather problematic. Although field archeologists and state and federal evaluators are only beginning to grapple with this administrative greasy pig, several recent authors and large, most of these examples have attempted to define the relative density and extent of artifact scatters by mapping the pinpoint location of each identified artifact (Plog et al. 1978: 408-410). Even with this kind of resolution, it is often difficult to match survey results with the current legal definition of a site as a discrete and bounded entity.

Conclusion

In summary, when seen in an historical perspective, contemporary probabilistic sampling can be viewed as a potpourri of approaches derived partially from 19th century assumptions which have blended with more recent North American anthropological insights concerning non-sedentary prehistoric interactions with changing environmental settings. This review of recent examples has highlighted a variety of lessons involving the application and validity of sampling; some of the lessons reflect general theoretical misconceptions, while others reflect problems of method specific to particular regions. These insights are not impediments to the future applicability of this survey approach but should be viewed as building blocks for improvement in the future.

Aside from recent articles pointing out the potential abuses in application and interpretation of statistical techniques, both planners and archeologists have come to realize that, unlike political polls, there is no universal or ideal sample fraction or sample percentage of coverage. Instead, both the level and format of the survey must be tailor-made to the particular regional setting. Nor is there an ideal shape or size of universally prescribable survey units; lines, corridors, squares, or rectangles may be applicable in different settings as units of a statistical sampling approach. It is clear, however, that the level of intensity applied in the field is directly proportional to the number of archeological remains encountered. Furthermore, many sites are either small or buried, and without closely spaced, subsurface testing even the best of statistical samples will miss the evidence.

The first state-funded predictive survey in New Jersey has yielded valuable insights into the process of designing selections of locally valid and empirically observable environmental variables. Initial results have also helped to pinpoint the limitations and biases of existing coverage as well as assumptions about the numbers and locations of prehistoric settlements in southern New Jersey.

Attempts to date have highlighted a critical, although hopefully not insurmountable, stumbling block to the implementation of probabilistic sampling as a doctrinaire planning tool. The environment has undergone continued change over the past 10,000 years. Until it is possible to reconstruct appropriate environmental factors affecting human settlement choices in the past, the ability to project from contemporary settings alone will be limited.

Finally, experience in both arid and forested regions of the United States has highlighted the need for both flexible and staged survey strategies which permit constant readjustment in approach based on increasing levels of insight into each specific region under investigation. Recent experience has shown that there is no one correct method or technique, but that openness to new approaches appears to be the most secure guarantee for positive results. In essence, this brief review suggests that sampling of environmental situations within a region in order to project the probability of sites in unexamined areas is still in its developing stages as a research technique. For both archeologist and planner alike, probabilistic regional sampling has yet to reach the point of being a logistical placebo for planning problems in Cultural Resource Management.

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