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Archaeological Inventory Survey Standards and Cost-estimation Guidelines for the Department of Defense

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by
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Current historic preservation legislation requires that Federal agencies inspect their landholdings to identify historic and prehistoric archaeological resources, evaluate these resources to determine their significance, and protect important archaeological resources. To minimize the effects of variable regional conditions and certain methodological biases, Department of Defense (DoD) land managers need some measure of standardization and comparability in the inventory survey procedures and data collection techniques so the degree of survey coverage on different installations can be objectively assessed.

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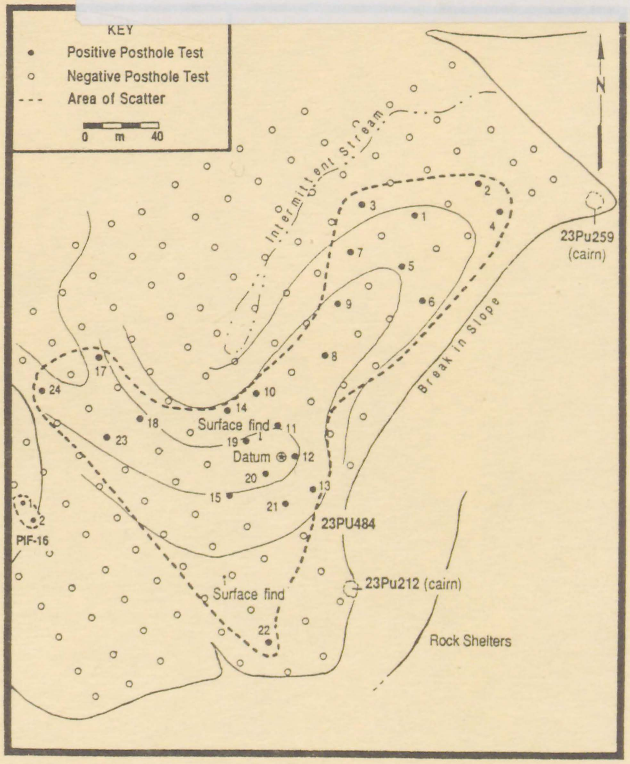

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Legacy Program

The Legacy Resource Management Program was established by the Congress of the United States in 1991 to provide the Department of Defense (DoD) with an opportunity to enhance the management of stewardship resources on over 25 million acres of land under DoD jurisdiction.

Legacy allows DoD to determine how to better integrate the conservation of irreplaceable biological, cultural, and geophysical resources with the dynamic requirements of military missions. To achieve this goal, DoD gives high priority to inventorying, protecting, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner, in partnership with Federal, State, and local agencies, and private groups.

Legacy activities help to ensure that DoD personnel better understand the need for protection and conservation of natural and cultural resources, and that the management of these resources will be fully integrated with, and support, DoD mission activities and the public interest. Through the combined efforts of the DoD components, Legacy seeks to achieve its legislative purposes with cooperation, industry, and creativity, to make the DoD the Federal environmental leader.

Document Preparation

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Executive Summary

Current historic preservation legislation requires that Federal agencies inspect their landholdings to identify historic and prehistoric archaeological resources (among other broadly defined "historic properties"), evaluate these resources to determine their significance, and protect important archaeological resources so information about our cultural patrimony is not degraded or wantonly destroyed. In accordance with the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation, the systematic identification and description of archaeological resources is generally carried out through intensive field survey in which all archaeological resources are inventoried within a predefined study area or a probabilistic sample of that area. Because Department of Defense (DoD) installations and properties are scattered throughout the continental United States, intensive inventory surveys on these lands must be carried out in areas that vary considerably in terms of landscape evolution, land surface conditions, and complexity of the regional archaeological record. Previous surveys have not always paid attention to the biases inherent in their field methods, especially regarding the issues of survey intensity and site definition. To minimize the effects of variable regional conditions and certain methodological biases, some measure of standardization and comparability must be included in the inventory survey procedures and data collection techniques so the degree of survey coverage on different installations can be objectively assessed.

Installation managers must be able to evaluate the level of survey intensity required to find archaeological resources of a certain kind, given local landscape conditions (e.g., surface visibility, accessibility, etc.) and the nature of the regional archaeological record (e.g., variation in site size, obtrusiveness of archaeological resources, site density, site diversity, feature diversity, surface and subsurface artifact densities, assemblage diversity, degree of inferred sociocultural complexity, etc.). In this way, bias assessment can be carried out to determine the probability that certain kinds of resources (e.g., archaeological sites of a certain minimal size, etc.) may be missed by using certain survey procedures.

Finally, inventory survey projects must be explicit about the definition of what is or is not an archaeological site. The archaeological survey literature exhibits considerable variation in the way this fundamental concept has been conceived and used in the field. This situation leads to incomparable results within similar study areas, and it

excludes from analytical study large portions of the archaeological record represented by small, light-density artifact scatters and isolated finds, which often are not considered "sites" in the traditional sense. Some degree of standardization in the definition of this concept is essential for broad comparability of survey results on DoD installations.

The development of standards for site definition and inventory survey procedures in the present document has been based on an extensive analysis of the "gray literature" (conference presentations, unpublished manuscripts, etc.) produced both in cultural resource management contexts and in academic contexts. The analysis provides baseline data for developing regionally and temporally sensitive models of archaeological site characteristics. These regional and temporal models can help to determine appropriate site discovery procedures and levels of survey intensity (i.e., the interval spacing between pedestrian survey crews or between subsurface test-units) for inventory surveys carried out on DoD lands. A number of statistical methods exist in the archaeological literature for accurately predicting the size of sites that a survey design will recover at a given the level of confidence. These are reviewed for their applicability in regionally sensitive survey standards. Recommendations also are made regarding the operational definition of archaeological site to be used in a standard manner in all DoD inventory surveys.

Once regional standards have been established, person-hour or person-day estimates for different site discovery procedures (e.g., pedestrian survey, shovel test-pit surveys, deep coring programs, etc.) can be calculated. These figures can then be used to estimate the cost of conducting inventory surveys on installation lands at an acceptable degree of effectiveness. Estimates of discovery probability should vary depending on the size and density of the sites being prospected since surveying for sites of small diameter in areas of low site density is more labor intensive than surveying for larger sites in areas of higher site density. The expected size/density of the sites to be recovered in an inventory survey, together with the estimates of artifact density and density-distribution, should (a) reflect the local cultural sequence, (b) be explicitly stated in the cultural overview prepared for the installation, and (c) be restated in the installation manager's scope-of-work and in the contractor's survey design as a series of probability estimates for the retrieval of *targeted* archaeological resources.

The overall goal of this project is to provide quantifiable and statistically defensible methods for conducting archaeological survey on DoD lands. It will also result in greater comparability of archaeological survey data from DoD installations across the United States, thereby enhancing cultural resource assessment capabilities between installations having variable landscape conditions and regional prehistories. Finally, the ability to predict accurately the cost of inventory survey will allow installation managers to budget these costs into long-term fiscal planning of the installation's Historic Preservation Plan.

This document is the result of Demonstration Project #302 of the Legacy Resource Management Program, whose purpose is two-fold:

1. To establish DoD-wide standards for archaeological inventory surveys, specifically so that a greater degree of quality control can be imposed over field techniques for site discovery and data collection across the diverse DoD landholdings; and

2. To develop cost-estimation procedures for different site discovery techniques so installation archaeologists and land managers have at their disposal reliable baseline information for fiscal planning related to historic preservation, Section 106 and Section 110 compliance, and long-term resource stewardship.

Since DoD landholdings are scattered widely throughout the United States, archaeological surveys on these lands have suffered from the same general problem found in much of the archaeological literature of North America: *uncertainty* regarding the effectiveness and reliability of the survey methods used, both in the identification and evaluation of archaeological resources. As a result, the DoD, as a large, corporate landholding body, has no systematic way of evaluating the thoroughness of past survey work in order to assess the current state of archaeological knowledge and to plan effectively for future inventory surveys and long-term resource management. A related problem is the *noncomparability* of survey results throughout the DoD and, in many cases, on the same installation.

The treatment and disposition of cultural resources on military installations are regulated by a series of Federal laws, as well as several DoD-specific regulations and guidance documents. The term "cultural resources" encompasses four basic categories: historic real property, historic personal property, historic records, and community resources/lifeways. Archaeological sites, whether prehistoric or historic, are considered *real property*, while prehistoric and historic artifacts fall under the category of *personal property*. The principal Federal laws affecting the treatment of these resources include Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966 (as amended), Executive Order No. 11593 of 1971 (as amended), the Archaeological Resources Protection Act (ARPA) of 1979, and the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (see Blumenthal and Bevitt [1993] for a complete compendium of Federal historic preservation laws and Carnett

[1991] for extended discussion of legislation governing the protection of archaeological resources).

In accordance with the legal obligations set forth in Sections 106 and 110 of the NHPA and Section 14 (a) and (b) of ARPA, installation land managers are required to make a good-faith effort to "develop plans for surveying lands under their control to determine the nature and extent of archaeological resources on those lands" (16 U.S.C. 470mm) and to identify and evaluate the significance of all prehistoric and historic cultural properties for possible nomination to the National Register of Historic Places (16 U.S.C. 470h-2). At the same time, however, their efforts should also contribute to the state of knowledge of the regional archaeological record. To achieve these goals, archaeological field surveys must be carried out involving the physical search for and recording of archaeological resources on the ground (Derry et al. 1985). After a certain amount of planning, background research, and preliminary reconnaissance survey, an *intensive* archaeological survey is usually required in which a careful inspection of the study area is carried out "to identify precisely and completely" all archaeological resources that may be present (Derry et al. 1985:12).

Where the ground surface is obscured by heavy vegetation or where archaeological resources are thought to be buried by later deposition, systematic subsurface inspection of the landscape may be required. Intensive survey should result in an inventory of archaeological resources in the study area, principally those judged to be significant and potentially eligible for nomination to the National Register of Historic Places (Derry et al. 1985). However, the inventory should also include all other archaeological resources located in the survey, such as smaller, more ephemeral sites and isolated finds, which may be important for a fuller understanding of regional prehistory.

The term "archaeological inventory survey," which is used throughout this document, is meant to imply an intensive archaeological field survey that results in a comprehensive inventory of historic and prehistoric sites and other archaeological resources in a given study area. A critical but often overlooked component of such a survey is quality control, which requires that the survey be designed, carried out, and reported in such a way that confidence estimates can be assigned to the reliability of the survey results. That is, there should be some mechanism for evaluating the thoroughness with which an intensive inventory survey was carried out and for concluding with reasonable certainty that all archaeological resources have been identified (or, alternatively, that some portion of the archaeological record was not searched at a given level of thoroughness). A fundamental purpose of the Legacy Resource Management Program is to instill a sense of *stewardship* over the natural and cultural resources located on DoD lands that is compatible with DoD mission activities as well as the public interest. Stronger standards governing archaeological survey methods and greater quality control over reporting procedures are considered basic components of this stewardship (Ramirez 1993).

The intended audience of this study is somewhat narrowly defined by its restricted focus on intensive field survey for purposes of archaeological site discovery and identification. The following groups can benefit from this research:

- DoD archaeologists involved in predictive modeling, survey research design, and archaeological resource management, as well as other DoD cultural resource managers whose responsibilities include historic preservation planning and the management of archaeological resources;
- Archaeological contractors who conduct intensive archaeological inventory surveys and National Register of Historic Places (NRHP) significance evaluations on DoD installations;
- Federal archaeologists from other landholding agencies (such as the National Park Service, Forest Service, Bureau of Land Management, etc.) who must confront the same or similar problems of effectiveness, reliability, and quality control in archaeological survey over extensive and diverse landscapes; and
- The scientific/academic community interested in issues of archaeological survey methodology, predictive modeling, and site discovery procedures.

The substantive content of this document, as well as its policy recommendations and management implications, are aimed primarily at DoD archaeologists and other cultural resource managers working at the installation level. Many DoD archaeologists may already understand the issues discussed in this report and routinely apply in their own contracting procedures many of the recommendations made herein. However, others may not have contemplated these issues fully. Since all cultural resource managers need to have a fundamental understanding of archaeological inventory survey, this document attempts to bring them "up to speed" with the problems inherent in making decisions on archaeological surveys, designing them, and reporting survey results. DoD archaeologists must be able to evaluate and use past survey results for future management decisions. More importantly, as the Contracting Officer's technical representative (COTR), they must be able to help generate effective Requests-for-Proposals and Scopes-of-Work for contracting archaeological surveys, and serve as technical monitors for evaluating project results.

For the DoD archaeologist and installation manager, the way in which archaeological inventory surveys are contracted, conducted, and evaluated is of crucial importance in deciding how the recovered archaeological resources will be managed, both for NHPA Section 106 compliance process and for the long-term preservation and stewardship of these resources, as required by the NHPA (Section 110[a]), ARPA, and

NAGPRA. The Legacy Resource Management Program is an attempt to enhance the stewardship of cultural and natural resources on the DoD lands so that their conservation can be better integrated with the dynamic requirements of military missions and with the public interest (United States Department of Defense 1991). This project was conceived as one component of that endeavor by focusing on the narrow yet important topics of archaeological survey intensity, site definition, and effective site discovery methods and techniques. The policy recommendations developed in this document are intended as baseline standards that will allow DoD archaeologists and cultural resource managers to achieve proactive management of archaeological resources through routine quality control of survey results.

This document is also intended for cultural resource management contractors who conduct archaeological surveys and site-testing operations for the DoD. They need to fully understand the reasons for establishing survey standards within the DoD and the specific nature of those standards (i.e., what aspects of archaeological survey are standardized and what aspects are not affected). They also need to understand the implications of these standards for the contracting process as well as the performance and reporting of survey work. Often as a consequence of "lowest bid" contracting procedures, loosely worded and poorly researched Scopes-of-Work, and little or no agency monitoring of project performance, archaeological surveys result in deficient field research and reporting. Little advancement is made in archaeological knowledge of installation resources and the installation manager has no means of properly evaluating the survey results because methodological procedures and level-of-effort calculations are insufficiently documented. Very often, successive surveys by different contractors on the *same* installation will yield noncomparable results, not because different methodological procedures were used, but rather because the procedures that were used were not described in sufficient detail to permit meaningful comparisons between projects. Many of the policy recommendations proposed in this document are aimed at rectifying this problem through greater attentiveness on the part of DoD archaeologists and installation cultural resource managers in the contracting and monitoring of archaeological inventory surveys.

The third audience for which this document is intended is comprised of Federal archaeologists from other large landholding agencies, especially the National Park Service (Department of the Interior), the Bureau of Land Management (Department of the Interior), and the Forest Service (Department of Agriculture). As is the case with the DoD and its branch services, these agencies exhibit a certain amount of idiosyncracy in their approach to many of the topics discussed in this document. Inevitably, any attempt to establish standards and guidelines for archaeological inventory survey in the DoD will have repercussions for these other Federal agencies as well. Likewise, the development of standards in one agency should not occur in a vacuum, but should draw on the collective expertise of other Federal archaeologists who must confront the issues of site definition, survey intensity, and effective site discovery for the diverse landholdings under their jurisdiction. It is clear that close collaboration and communication on these issues is beneficial to all. In this regard the researcher is pleased to have had the advice of Dr. Francis P. McManamon, Departmental Consulting Archeologist and Chief of Archeological Assistance for the National Park Service and Dr. Joseph A. Tainter, archaeologist for the Forest Service.

The scientific/academic community constitutes the final intended audience of this document. As a "mission-oriented" agency (Swannack 1975), the DoD is required to conduct all of its cultural resource management activities, including intensive archaeological survey and site management, in a way that is compatible with the military mission and its varied impacts on the landscape. Among the diverse military activities that can affect cultural resources are: core facilities management, combat training support activities, and routine land management (Advisory Council on Historic Preservation 1994). Such mission-specific considerations do not normally affect the objectives and goals of academic research.

Still, the DoD recognizes that the Cultural Resources Management (CRM) and academic communities are not mutually exclusive entities but in fact overlap to a considerable degree, especially in their desire to contribute to archaeological knowledge. They share similar research problems and methodological concerns, and each can benefit from the other's experience. The DoD seeks to strengthen the alliance between these communities through formal partnerships in the Legacy Resource Management Program. The DoD also recognizes that the dual goals of legal compliance and proactive long-term stewardship must be carried out in accordance with methodological and technical norms and strictures of contemporary archaeology as an academic and scholarly discipline. The issues of survey intensity and site definition are particularly relevant here as they are still hotly debated topics in current archaeological literature. Both the CRM and academic communities recognize the need to conduct more thorough inspections of surface and subsurface landscapes in the search for prehistoric and historic sites and to make objective bias assessments of past surveys. Likewise, both communities recognize a need to devise meaningful spatial units of analysis that permit efficient management and preservation of archaeological resources in discrete "packages" (i.e., the archaeological site).

A final area of common interest between the CRM and academic communities has to do with the need to record and disseminate "metadata" on the way in which archaeological surveys are carried out, the way in which relevant data categories are defined, and the way in which these data are collected. The prefix *meta-* indicates "that a term is being used to refer to itself" (Rosenberg 1986:117), but at a higher level of abstraction. The term *metadata*, then, can be defined simply as "data about data" (Wertz 1989:69). For archaeological purposes, this involves recording detailed information on such things as the definition of relevant site constituent variables, level of effort expended per unit area in archaeological surveys, methodological and technical procedures used in site discovery and identification, estimates on the reliability and accuracy of survey results, etc. It constitutes information that goes beyond the substantive archaeological results of the survey, but is essential for assessing its effectiveness and its comparability with other survey efforts. In spite of the often different goals of CRM and academic surveys (i.e., legal compliance and stewardship versus pure research), comparability of survey results is always a desirable outcome. For all of these reasons, then, partnerships between the CRM and academic communities can, and should, work toward the benefit of both.

This Legacy document is intended to stimulate discussion and debate among DoD archaeologists and cultural resource managers regarding the archaeological issues of survey intensity, site definition, and the reliability and accuracy of survey results. It also explores the related issues of the contracting process for archaeological surveys and cost-estimation procedures for different site discovery techniques. The DoD has enormous landholdings over the entire United States and its territories with millions of employees. Its varied mission activities affect not only its own properties but other lands and resources as well. Thus it has a considerable legal obligation to comply with Federal laws governing historic preservation and cultural resource protection. It spends millions of dollars on archaeological inventory surveys, but has inadequate tools to evaluate cost/benefit ratios of survey results. The DoD should rightly be concerned about the way in which Federal dollars are spent in the compliance process and in the long-term stewardship of installation resources. Beyond the issues of compliance and stewardship lies the fundamental question of whether the expenditures for intensive archaeological surveys are resulting in real contributions to archaeological knowledge. Are DoD archaeologists and contractors doing an *adequate* and *cost-effective* job for either of these purposes? For the Department of the Army, this issue has been clearly articulated in a recent evaluation of cultural resources conservation requirements (Feige and Strauss 1994:A-81; emphasis added) in the following terms:

> Army undertakings are often delayed by the lack of archeological survey. Less than 10% of Army lands have been adequately surveyed and evaluated for archeological sites. [The] development of faster and more cost-effective technologies for archeological inventory that are standardized across broad regions will allow the Army to be more proactive in this arena and prevent unnecessary delays...[The] development of *standard survey protocols* and *standard statements of work* that meet scientific standards will simplify cost estimates and contracting.

The ultimate goal of this Legacy demonstration project is to foster concrete policy changes in the way in which archaeological inventory surveys are planned, contracted, executed, and reported within the DoD, on all installation lands throughout the United States. In the long run, the establishment of archaeological survey standards will represent a cost-saving effort to gain a more accurate and representative picture of all archaeological resources on installation lands and identify less informative or redundant kinds of resources. If carried out conscientiously, this effort will permit full compliance with the NHPA Section 106 and Section 110 legal obligation and related public legislation, as well as ensure the collection of baseline archaeological information necessary for informed management decisions and long-term stewardship of these resources.

Foreword

This study was conducted for Headquarters, Department of the Army, Environmental Programs Directorate under the Legacy Resource Management Program as part of Legacy Demonstration Project #302, titled "Archaeological Inventory Survey Standards and Cost-estimating System for the Department of Defense." At the beginning of this research the technical monitor was Dr. Constance Ramirez, U.S. Army Historic Preservation Officer; the current technical monitor is Mimi Woods, Environmental Programs Directorate, DAIM-ED-N.

The work was performed for the Tri-Services Cultural Resources Research Center, Planning and Mission Impact Division (LL-P) of the Land Management Laboratory (LL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator, Dr. James A. Zeidler is also a Research Associate in the Department of Anthropology of the University of Illinois at Urbana-Champaign (UIUC). Dr. John Isaacson is Director of the Tri-Services Cultural Resources Research Center. Robert M. Lacey is Acting Chief, CECER-LL-P; Dr. William D. Severinghaus is Operations Chief, CECER-LL; and William D. Goran is Chief, CECER-LL. The USACERL technical editor was Gloria J. Wienke, Technical Resources Center.

COL James T. Scott is Commander and Acting Director, and Dr. Michael J. O'Connor is Technical Director of USACERL.

The cover illustration represents an intensive posthole-testing program carried out as part of a Phase I cultural resources inventory survey at Fort Leonard Wood, Missouri, by the Public Service Archaeology Program (PSAP) of the University of Illinois at Urbana-Champaign. It is reporduced from Figure 35 in *Phase I Cultural Resource Inventory of Selected Tracts at Fort Leonard Wood, Pulaski County, Missouri* by Steven R. Ahler and Jacqueline M. McDowell (1993), University of Illinois, Public Service Archaeology Program, Research Report No. 9 Urbana.

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Tri-Services Cultural Resources Research Center

The Tri-Services Cultural Resources Research Center is a research and technical support center that assists the U.S. military services in the stewardship of cultural resources located within Department of Defense (DOD) installations or facilities. The Center, located at USACERL, helps installations manage their cultural resources and comply with Federal, State, and DOD preservation mandates.

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1 Introduction

Background

In recent years, the discipline of archaeology has made dramatic progress toward refining automated data retrieval and data management techniques. Yet, in spite of these technological breakthroughs, there has been comparatively less attention paid to the questions of quality control and bias assessment in the data acquisition and analysis process. Objective evaluations of the quality and consistency of field and laboratory procedures and their ability to recover systematic and representative data on the archaeology of a regional landscape are not common. At issue is the effectiveness of "archaeologists as measuring instruments" (Plog, Plog, and Wait 1978:413) and the degree of *resolution* that their field and laboratory procedures provide in documenting the archaeological record. As Schiffer (1987:361) has noted, "the small literature [on this topic] is very dispersed and not readily generalized," but enough studies now exist to indicate the nature and severity of the problems that need to be addressed if archaeologists hope to make valid and meaningful statements about the prehistoric and historic past.

One aspect of archaeological field research that has long been recognized for its lack of consistency and comparability of results is the archaeological survey. Much of this variability is due, of course, to the host of decisions that the archaeologist must make in executing a survey under given financial, contractual, and/or temporal constraints and within unique and highly variable landscape conditions and regional archaeological records (see, for example, Judge, Ebert, and Hitchcock 1975; Read 1975; Plog, Plog, and Wait 1978; Schiffer, Sullivan, and Klinger 1978; Schiffer and Wells 1982; Nance 1983; Zubrow 1984; Lightfoot 1986; Schiffer 1987:346-353). While a certain amount of methodological idiosyncracy and design flexibility is to be expected, the fact remains that archaeological survey results often are very difficult to evaluate and compare with respect to their thoroughness and accuracy. A number of archaeologists have commented on the implications of this problem. Two such statements are excerpted below:

> Standard, directly comparable methods of surface survey are lacking in American archaeology...In general, each project uses its own combination of sampling methods and survey techniques, be they systematic or intuitive. This often forces CRM personnel charged with evaluating projects to accept the principal investigator's or project director's own "guesstimate" of the effectiveness of a project

> strategy. Since the evaluator lacks independent measures of survey strategy effectiveness, the evaluation that results is often meaningless (Sundstrom 1993:91).

> Consistency in survey techniques directly affects our perception of the archeological record. With a consistent and accurate picture of the prehistoric use of a region — the sort of pictures acquired through numerous complementary surveys — we should be able to begin to synthesize and analyze many data sets to produce an understanding of past systemic organization. Yet sampling and survey methods vary from project to project to meet each "unique" archeological situation — thus assuring incomparability among surveys (Wandsnider and Ebert 1988:2).

A related problem lies in vastly different degrees of thoroughness and attention to detail in preparing survey reports, particularly with respect to the inclusion of pertinent "metadata" on field conditions, site discovery and data collection procedures, and labor expenditures (see Zubrow [1984] for an enlightening example).

The recognition of such inconsistency and incomparability of survey results has led to repeated, if infrequent, calls for national-level, or at least state-level, standard survey procedures (e.g., Dancey 1988; Roberson 1981) as well as the national-level reporting of survey results in a standard format (e.g., King and Cole 1978). Some 15 years ago, King and Cole (1978) proposed the establishment of a national database which would store "data on the level and quality of archeological surveys in particular areas, and on the locations of information sources." Their argument that standard reporting would be of immeasurable help in historic preservation planning and cultural resource evaluation was both forceful and timely:

> Regarding archeological resources..., we believe the most useful interim planning tool that could be developed would be *a body of consistent, comprehensible, updatable information on the quality of survey work* that has been done in each part of the country, and on the disposition and availability of survey data and other useful information...This would permit an agency planning a project in a given location not only to find out what known archeological properties exist in the vicinity, but also to find out the level and intensity of archeological surveys that have been conducted in the vicinity; what areas in the vicinity have actually been subjected to survey; bibliographic citations to and locations of all reports of archeological fieldwork conducted in the vicinity; and locations of all collection of primary archeological data, artifacts, etc., from surveys and excavations in the vicinity. Using such a system would enable State Historic Preservation Officers and federal agencies to clearly determine the need for archeological surveys prior to particular projects, and to mobilize the necessary data to guide, supplement, or take the place of field surveys (King and Cole 1978:132; emphasis added).

King's proposal has been addressed to a certain extent by the recent implementation of the National Archeological Database (NADB)—Reports Online system (Farley, Limp and Canouts 1991), which is sponsored by the Archeological Assistance Program of the National Park Service and managed by the Center for Advanced Spatial Technology (CAST) of the University of Arkansas. Even here, however, the system is principally designed to provide bibliographic search capabilities on a national scale and provides no information on the complex issue of survey intensity and "the quality of survey work" as suggested by King and Cole (1978:132). Where such information exists, it is generally managed by the individual State Historic Preservation Office (SHPO) or large state-level research institutions (e.g., Byrd 1981) and exhibits varying levels of systematic organization, computerization, and public accessibility. A similar fate has likewise muted the call for national-level standardization of survey procedures to ensure minimal levels of quality control. Autonomous SHPOs typically provide a series of guidelines regarding desired levels of survey intensity, appropriate discovery procedures, and survey reporting in their particular state, but these vary considerably across the country, ranging from stringent to unspecified.

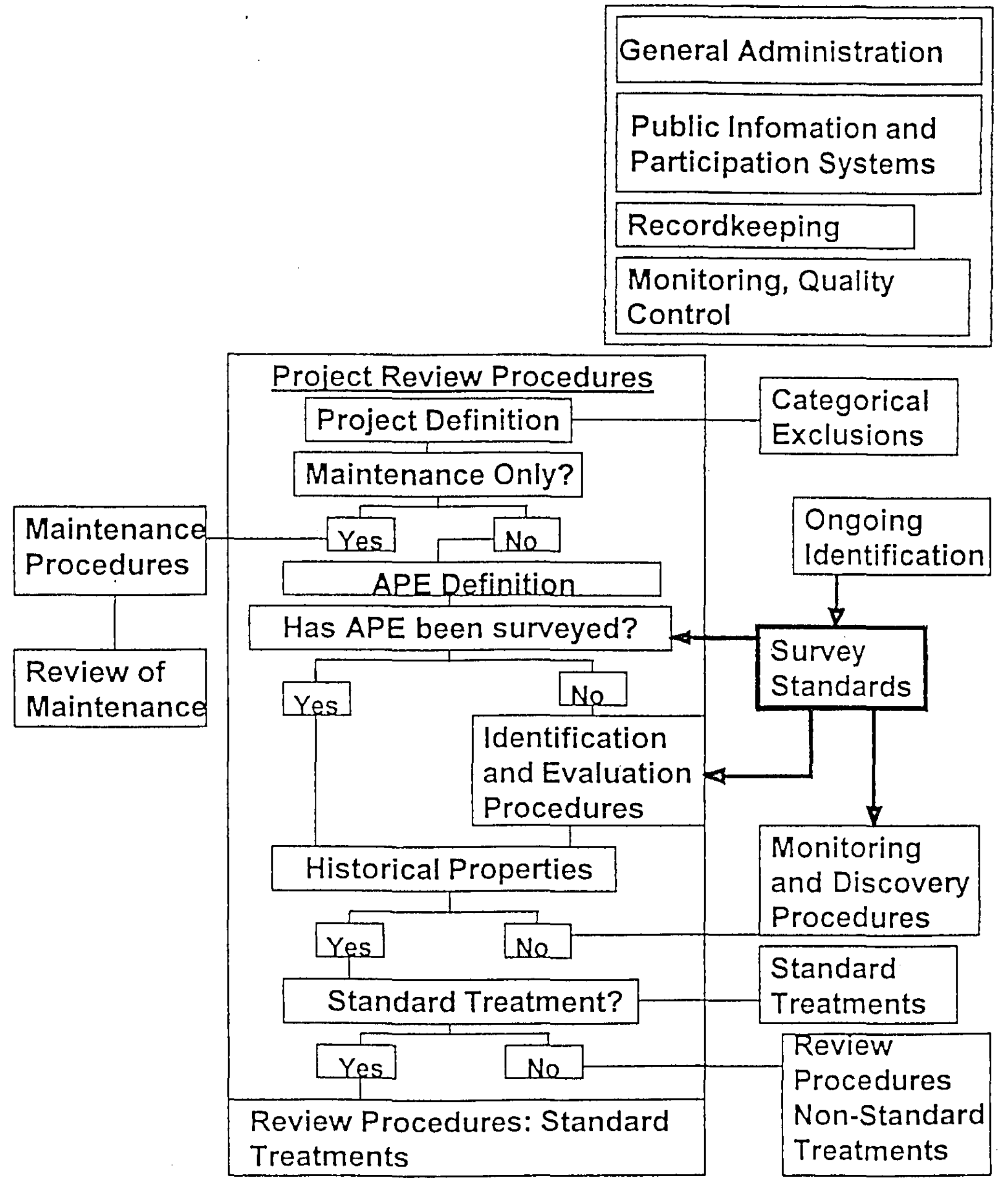
Through the Legacy Resource Management Program, the Department of Defense has taken the initiative of creating standard procedures for conducting intensive archaeological surveys on a nationwide basis. This initiative falls under one of nine legislative purposes of the Legacy Program: i.e., "to establish *a standard Department of Defense methodology* for the collection, storage, and retrieval of all biological, geophysical, cultural, and historical resource information..." (United States Department of Defense 1991:2; emphasis added). Thus one of the many preliminary recommendations of the Legacy working group overseeing cultural resources treated the problem of cultural resources survey (including archaeological field survey) in the following terms:

> DoD should consider developing national standards for cultural resources surveys on its lands, in cooperation with other land managing agencies, and establishing means of accelerating survey efforts on DoD lands and in areas affected by DoD actions. Such surveys should address the full range of cultural resources...*DoD should consider ways of screening data to ensure that it is accurate and sufficient to meet management requirements* (Neumann, Warren-Findley, and King 1991:14; emphasis added).

Given the extensiveness of DoD landholdings throughout the United States and the highly diverse array of cultural resources encompassed by these lands (R. Christopher Goodwin and Associates undated; Advisory Council on Historic Preservation 1994), standardizing survey procedures is not a trivial problem. To be effective, survey standards will have to become *a permanent and routine component* of historic preservation planning on military installations, as well as Requests-for-Proposal and Scopes-of-Work developed for the contracting of specific archaeological inventory surveys.

At this juncture a definition of the term *standard* may be useful. The operational definition used in this document is as follows: "...a prescribed set of rules, conditions, or requirements concerned with the definition of terms; classification of components; delineation of procedures; specification of materials, performance, design, or operations; or measurement of quality and quantity in describing materials, products, systems, services, or practices" (Management Concepts Incorporated 1993:3.8). This definition is purposefully general for application to a broad range of managerial contexts and issues. However, it is highly suited to the purpose of this document and the issue of quality control in archaeological inventory survey. As applied here, emphasis is placed on a set of recommendations, which include rules, conditions, and/or requirements, concerned with (a) defining the terms (especially the concept of *archaeological site*), (b) delineating appropriate procedures for site discovery under a series of variable landscape conditions, (c) specifying of survey design, performance, specific field operations, and reporting requirements, and (d) measuring or evaluating quality in describing the final survey results, be they materials (i.e., analyses of archaeological artifacts, ecofacts, sediments, and related field specimens), services (i.e., survey logistics and level-of-effort estimates), or practices (i.e., the actual field methods and site discovery and recording procedures used).

The importance of survey standards for historic preservation planning and cultural resource stewardship cannot be overemphasized, regardless of the kinds of cultural resource surveys required. As part of the permanent monitoring and quality control component of the typical Historic Preservation Plan (HPP) (Figure 1), survey standards provide a crucial link between evaluations resulting from past surveys and on-going identification tasks, on the one hand, and the periodic implementation and evaluation of specific projects or undertakings requiring Section 106 compliance, on the other. For the specific case of archaeological surveys, consistent information about the locations, spatial structure, and artifact content of sites are needed to establish a baseline of existing knowledge regarding archaeological resources. This background enables well-informed decisionmaking to be carried out regarding the Area of Potential Effects (APE) of a given project, defined by Federal regulation as "the geographical area or areas within which an undertaking may cause changes in the character or use of historic properties, if any such properties exist" (36 CFR 800.2). Under these circumstances, survey standards should determine both the discovery procedure(s) appropriate for examining a given APE and the level(s) of survey intensity deemed necessary given existing information on archaeological resources that are likely to be present in the APE, or different areas within it. They should permit objective measures for data screening and on-going evaluation of survey results to ensure that they meet minimal standards of thoroughness and accuracy (Neumann, Warren-Findley, and King 1991).



(Source: after King n.d.)

Figure 1. Components of a typical historic preservation plan (HHP) showing role of archaeological survey standards in preservation process.

Objectives

The general purpose of this research was to examine the problems of quality control and bias assessment as they affect regional archaeological surveys carried out on Department of Defense landholdings throughout the continental United States, whether these are primarily inventory surveys for cultural resource management and compliance purposes, academically inspired surveys with specified research goals, or some combination of both. Primary concern is given to the overriding question of *survey intensity* or the thoroughness of the landscape inspection procedures used. Stephen Plog and associates (1978:389) have defined survey intensity as "the degree of detail with which the ground surface of a given survey unit is inspected, whether that survey unit is a large region or a small sample unit." However, it is also important to include here the intensiveness of subsurface inspection techniques in areas where the ground surface is obscured by dense vegetation or where archaeological sites may be buried by later depositional processes. At issue is the need to establish adequate levels of survey intensity and appropriate site discovery techniques that address both the specific nature of given regional archaeological structures (Foley 1981a) and the three-dimensional variability of given landscape conditions. The latter can have very significant effects on the *visibility* of archaeological resources at the local and regional scales. The implementation of standards for evaluating surface and subsurface survey intensities has direct implications for the planning and executing of archaeological inventory surveys on DoD lands, especially in developing Scopes-of-Work and calculating appropriate cost estimations.

In accordance with the overall purpose of the Legacy Resource Management Program to protect and conserve the natural and cultural resources on DoD lands "in a comprehensive, cost-effective, state-of-the-art manner" (United States Department of Defense 1991:3; see also United State Department of Defense 1992), this project has two ultimate objectives: (1) to establish consistent and effective standards for archaeological survey and site discovery that address techniques, methods, and intensity; and (2) to develop cost-estimation guidelines that permit greater accuracy and efficiency in the budgeting and scheduling of archaeological inventory surveys. In the course of reviewing a number of issues and problems involved in establishing archaeological survey standards, a series of policy recommendations and their management implications are presented for consideration by DoD archaeologists and cultural resource managers. It is hoped that this document will lead to a productive exchange of ideas and opinions regarding the implementation of archaeological survey standards and appropriate levels of quality control for the evaluation of survey results.

It should be noted here that the archaeological issues and policy recommendations discussed in this document are equally relevant for prehistoric and historic archaeology. As South and Widmer (1977:120) have observed, "concepts and methods found valid for recovery and analysis of [prehistoric]...lithics and pottery do not become invalid with the addition of historic documentation." Likewise, even though much historical archaeology is carried out at the site scale and relies heavily on documentary sources for site discovery and significance evaluation, this fact does not make the regional archaeological survey an invalid or irrelevant method for understanding the historic past. Rather, its regional landscape perspective helps correct a fundamental bias created by exclusive focus on sites for which historic records exist (House 1977). To quote House (1977:243) on this point, "confining historical archeology research to sites and phenomena documented in the historic record is an unwarranted limitation of the scope and potential scientific contribution of historical archeology." He argues that regional archaeological surveys using careful surface and subsurface field techniques very often discover "potentially significant [yet] undocumented historic sites... [thus providing] an archaeological record of groups of people and kinds of behavior that are represented only very indirectly—or not at all—in the written record" (House (1977:257). Regional archaeological surveys also provide the capability to make reliable estimates of the relative frequency of different historic site types in a given landscape as well as reveal regional patterns of historic site location (House 1977; McManamon 1990). Such survey results are subject to the same requirements of quality control and bias assessment necessary for evaluating the prehistoric archaeological record.

Scope of Problem: Discovery Procedures and Units of Analysis

Since DoD lands are located throughout the United States, the implementation of a uniform cultural resource management program on these installations must confront the full range of research problems, methodological challenges, and variability in prehistoric and historic cultural complexity and regional landscape conditions common to North American archaeology. For present purposes, this means that special attention must be paid to the degree of fit between inventory survey techniques and levels of intensity, on the one hand, and the modern land surface conditions and archaeological characteristics of the region under study, on the other hand. This requires first that a three-dimensional *project volume* (Wobst 1983) be explicitly defined within which archaeological sites are to be identified. Wobst (1983:56-57) defines this as "that arbitrary unit that is bounded horizontally by the given contract specifications and bounded vertically, at the top, by the present land or structural surface and, at the bottom, by either the depth of penetration of adverse project impacts or by the maximum potential depth of archaeological resources." By assessing the nature of the geomorphic environment and specific landform-sediment assemblages (LSA) within this project volume, a three-dimensional context for archaeological deposits can be established (Bettis 1993). As Bettis has recently observed:

> LSA are associations of modern landforms and underlying sedimentary sequences that have predictable age relationships...[and thus]...form a useful framework for evaluating the potential for an area to contain archaeological deposits. In order to

> accurately assess the record of the human past we must be aware that there is differential representation of past landscapes on the modern landscape, and somehow sample parts of past landscapes that are now in the subsurface. (pp 2-3)

Armed with this geomorphological information and a well-defined three-dimensional project volume, the archaeologist can then develop a predictive model of archaeological site location on the modern land surface as well as a *sensitivity analysis* of probable site locations in subsurface contexts within the project volume. While the term *locational sensitivity* is not widely used in archaeological and geoarchaeological parlance, it is employed here to refer to "a determination of how deeply buried a site may be at any given location" (Chase, Montgomery, and Landreth 1988:169) or whether there is *any* site location potential, given the geomorphological context under consideration. To quote Chase and associates (1988) on this important point:

> Cultural resource management decisions concerning inventory to identify sites are guided by geomorphic variables. Decisions on where to survey for prehistoric sites are tied to pertinent landforms. But the concerns about the probability or sensitivity of sites...are founded on where certain sites may be found and how deeply they are buried...Briefly stated, a certain site may have a high or low probability of occurrence at a specific location depending primarily on the geologic history of the location.

A similar concern is voiced by Bettis (1993:8; see also Artz 1985) with regard to valley landscapes in the following terms:

> It behooves us to have an understanding of the three-dimensional distribution of a valley's deposits prior to undertaking an archaeological survey so that discovery methods can be tailored to the depositional and chronologic patterns of the project area. Without the aid of prior geological studies high probability buried situations may go unrecognized and efforts may be wasted on areas with little or no potential to contain intact archaeological deposits.

The dual problems of dense vegetation which obscures archaeological sites on the modern land surface and depositional processes, which have left other sites deeply buried, can be encountered in a wide variety of field situations. Survey designs and site discovery techniques must be tailored to these landscape conditions if accurate and reliable site data are to be obtained. For example, in most areas east of the Mississippi River, the surface visibility necessary for observing surface archaeological materials is very low, thus requiring the use of subsurface testing strategies for locating and assessing archaeological sites. In riverine floodplains, where active alluviation has left archaeological sites deeply buried, extensive deep coring and selective backhoe trenching may be necessary to locate older prehistoric occupations. Both approaches are routinely employed for purposes of intensive archaeological survey, but contract specifications and funding limitations often restrict the thoroughness with which they can or should be carried out. In many areas of the arid Southwest and Great Basin, pedestrian surface survey has been shown to be successful without resorting to subsurface testing as a site discovery technique. But even in these arid regions, modern or historic aeolian deposition can deeply bury archaeological sites (see, for example, Blair et al. 1990, Schuldenrein 1991, Monger 1993). Higher elevations and wetter environments, such as the Pacific Northwest, may exhibit dense ground cover that can obscure surface indications of archaeological sites (Pettigrew 1985). While the problems of buried sites and poor surface visibility have traditionally been attributed exclusively to the "forested eastern U.S." (e.g., Goodyear et al. 1978:166), the western United States is hardly devoid of forested vegetation, dense ground cover, and depositional sedimentary environments, all of which can obscure archaeological sites. Thus in all regions of the United States, questions of survey intensity (or "level-of-effort") must be addressed, as well as the appropriate discovery procedures for given landscape conditions and geomorphic environments. While it is true that many SHPOs provide useful guidelines that establish minimal standards for survey intensity within a given state, these guidelines vary considerably from state to state. For archaeological surveys conducted on DoD lands, then, consideration must be given to establishing national standards for conducting and reporting intensive archeological surveys.

The central issue is how close to place crew members during surface inspection, or shovel probes and cores during subsurface testing, to recover sites or other cultural remains of a specified size and complexity, under given field conditions and survey designs. Related issues include inspection techniques (e.g., screening versus trowel-sorting of shovel probe fill, the speed with which the ground surface is searched in pedestrian surveys), the geometry of subsurface probe placement (e.g., staggered versus regular grids), and the visibility or obtrusiveness of archaeological artifacts on the current land surface. Presently two installations that purportedly claim to have 100 percent survey coverage may actually have very different levels of confidence in terms of the thoroughness with which the surveys were conducted, and the likelihood that certain kinds of sites were missed. Such differences in the probability of discovering archaeological sites are best termed *confidence thresholds* (Doleman 1988) to distinguish them from the formal statistical concept of confidence limits (see final section of this chapter and Chapter 4 for further discussion of this point). Confidence Thresholds very often result from the fact that the surveys were conducted at different intensities or levels of effort, normally computed as the number or person-days expended per unit area surveyed (square miles or square kilometers) (Plog, Plog, and Wait 1978; Schiffer, Sullivan, and Klinger 1978; Judge 1981; Schiffer and Wells 1982). As

Sundstrom (1993:92) has recently noted: "survey reports often contain a statement that 100 percent coverage was attained by the survey, when, in fact, the probability that the survey was adequate to find all sites present in the area was much lower. The phrase '100 percent coverage' too frequently is merely the opinion of the field director of the adequacy of the survey, rather than an actual quantitative measure." As a result, one installation may only claim a 50 percent confidence threshold in locating sites measuring 30 meters (m) in diameter, while another may have a 90 percent confidence threshold in locating sites of the same size. Therefore, the two hypothetical installations in this example must use a different "calculus" in making cultural resource management decisions regarding surveyed lands. These problems become even more acute in areas where dense vegetation cover or geomorphic processes require some form of subsurface testing to even permit site discovery. In many cases, presentation of survey results includes no evaluation of what kinds of archaeological resources may have been missed and what confidence thresholds can be placed on the resources that were discovered. Likewise, no clear statements are made as to how thoroughly a given land surface was searched when surface visibility was constrained by dense ground cover, nor how constraining the ground cover must be before subsurface testing procedures are implemented. In short, there is no explicit *bias assessment* of site discovery procedures.

To ensure the comparability of survey results and to permit installation managers to objectively evaluate those results for management purposes, it is imperative that standards be implemented to guide the planning and execution of a survey project. These standards include the following three aspects of decisionmaking for archaeological surveys :

(a) that the level of *survey intensity* (surveyor/shovel-test/core interval spacing) selected for a given project or survey tract be fully and explicitly justified in terms of the goals or requirements of the survey, the specific landforms and sedimentary sequences involved, and the nature and complexity of the regional archaeological record under study;
(b) that, for a given level of survey intensity, a specific *minimal confidence threshold* be established for the probability of discovering archaeological sites of a given size and composition known to exist in a given region;
(c) that the site discovery procedures and all other relevant *metadata* used in inventory surveys be explicitly and thoroughly described.

Thus the archaeological survey standards developed herein have less to do with survey design *per se* and more to do with the precise definition of that design and its methodological and observational adequacy for recovering accurate archaeological data. As Altschul (1988:86) has noted:

> ...[T]he selection of sampling technique, sampling fraction and sample size, and sample unit size and shape are decisions that cannot be made in the abstract but are dependent on the nature of the phenomenon of interest and the research objectives...(C)onsistent results have less to do with the sampling design than with issues of survey intensity, site visibility, and sample unit accessibility...

Likewise, the intent is not to impose strict and uniform levels of survey intensity on DoD installations across the continental United States. Rather, the intent is to recommend a specific level or threshold of confidence that a given survey intensity will consistently retrieve certain categories of archaeological data. Chapters 3 and 4 of this document will explore these issues and offer recommendations for improving archaeological site discovery procedures and inventory survey reporting procedures in DoD-sponsored projects.

A related problem that must be addressed in any broad-based cultural resource management program is the definition of archaeological "site." As Klinger (1976:55) has noted: "the problem of site definition has confronted many researchers in a variety of cultural and ecological settings. Site definition as such is not unlike any other variable, in that it is derived from and intimately associated with the overall theoretical and methodological framework or research design." Definition involves the specification of *minimal criteria* by which sites can be recognized and formally defined in the field. Even a cursory review of North American literature dealing with archaeological survey and site discovery reveals a considerable range of variation both in site definition and in site typologies. While site typologies obviously must respond to differences in regional archaeological records as well as different research agendas, such is not the case with the definition of minimal criteria for what constitutes a "site." There are many advantages to standardization of these criteria both for management and for research purposes, but achieving an adequate balance between the cost-effective needs of resource management and the broad data requirements of contemporary archaeological research is still a problem. Accordingly, Chapter 2 will treat the issue of site definition and offer a concrete recommendation for DoD standards based on the prior research of other Federal agencies, notably the U.S. Forest Service.

Finally, since the recommendations mentioned above have direct implications for the planning, contracting, and execution of archaeological inventory surveys, the question of cost estimation related to various kinds of site discovery procedures takes on central importance for ensuring budgetary efficiency, cost-effectiveness, and the timely completion of contractual obligations. Chapter 5 treats this issue along with a brief discussion of the contracting process in the Federal government.

Approach

To examine these problems at a national level and justify the implementation of new standards for inventory survey, an extensive literature review was carried out on various aspects of regional archaeological distributions and survey methodologies throughout the United States. The purpose was to determine whether regional trends could be identified both in the archaeological distributions and in the research agendas and discovery procedures of different archaeologists and institutions, and permit the development of regionally and temporally sensitive models of regional site densities, site size, depth, and diversity, as well as intra-site feature and artifact densities and density-distributions. These trends provide baseline data for the development of confidence thresholds for the recovery rate of archaeological sites of a designated size and complexity, and permit the establishment of standards governing survey intensity and specific site discovery procedures appropriate for given land surface conditions (e.g., pedestrian survey by sampling units, shovel test-pit sub-sampling, deep coring or auger testing, etc.). A number of statistical measures exist in the archaeological literature for accurately predicting the minimal site size and associated artifact densities that a survey design will recover for a given level of confidence (see Chapter 4). One of these will be explored with hypothetical archaeological data as a means of illustrating (a) the need for standards in the specification of confidence thresholds of site discovery probability, and (b) the relative ease with which the calculations of site discovery probability can be carried out in a user-friendly, interactive, DOS-compatible format.

The literature review concentrated on the so-called "gray literature" (conference presentations and unpublished reports and manuscripts) of archaeology dealing with intensive regional surveys. These are generally represented by research monographs and reports having limited distribution and a largely regional readership.

The literature review also involved extensive reading in the academic archaeological literature on research design and field procedures for regional survey and site-testing programs as well as several SHPO guidelines for conducting intensive archaeological surveys at the state level. With regard to the gray literature, two separate studies are involved. The first is a general, broad-based review of intensive archaeological surveys throughout the United States for purposes of extracting regional data on research design, survey methodology, and sampling schemes, as well as specific data (where available) regarding site size/depth, regional site density, and measures of artifact and feature diversity, intra-site densities, and density-distributions. For purposes of cost-estimation calculations, specific data have also been extracted (where possible) on "person-days expended," "level of survey effort," and "site discovery rate" for different kinds of field procedures. As one might expect, the degree to which these kinds of archaeological data and project metadata are routinely reported in survey monographs is highly variable throughout the U.S. Where they exist, however, selected data sets can be used for regional modeling of archaeological distributions and site discovery probabilities through the application of Monte Carlo simulation (see Chapter 4). Other data sets can be used to identify broad regional trends in survey methodology and site discovery procedures for different kinds of landscapes (see Chapter 3). These kinds of data permit the establishment of recommended levels of survey intensity under different land surface conditions and allow for detailed assessments of survey effectiveness, accuracy, and reliability. Table 1 provides a sample entry with a list of the categories for which data was sought in our review of each survey monograph.

As mentioned in the Preface, the term *metadata* is used here simply to refer to "data about survey data." Most important here are statements of the total number of person-days expended in different project tasks, the level-of-effort expended in field survey (calculated as person-days per unit area surveyed), and the discovery rate for sites (number of sites per person-day) and isolated occurrences (number of isolated occurrences per person-day). These values are instrumental in determining the adequacy or effectiveness of a given survey effort and for making objective comparisons between different survey results (Schiffer and Wells 1982; Schiffer 1987). Other relevant metadata include explicit descriptions of field survey conditions (such as accessibility, surface visibility, or other potential impediments to surface inspection), problematic aspects of the local archaeological record (such as low obtrusiveness of surface artifacts or other remains, bias due to previous non-scientific artifact collecting, etc.), and surveyor bias (such as inexperienced field personnel, inconsistencies in survey procedures or data collection techniques, etc.).

It is important to point out that the gray literature was not sampled in a statistical sense; about 100 monographs were selected according to the following three criteria: (1) the reporting of regional survey results had to be sufficiently detailed to provide most of the data categories we were seeking; (2) overall geographic coverage of the monographs examined had to be reasonably broad-based and representative of the physiographic variability and cultural variability of the archaeological record in the United States; and (3) monographs obtained for review had to be reasonably available or obtainable through the University of Illinois Library System, the USACERL Library, and/or inter-library loan programs of both institutions. National-level bibliographic indexes consulted for this research included the *National Archaeological Database (NADB)—Reports* and the *National Technical Information Service (NTIS) Index.* No

Table 1. Sample database record for selected data extracted from archaeological survey monograph.

Keyname	Lightfoot et al 1987
Survey type	probabilistic regional survey, stratified random sampling and stratified judgemental sampling
Study area size	825 ha or 8.25 sq km
Sampling fraction	5%
Sampling unit size	variable: 120-340 m x 20-40 m for transects; 0.5-10 ha for quadrats
Sampling unit shape	variable: transects (stratified random), quadrats (stratified judgemental)
Cultural sequence	Late Archaic, Early, Middle & Late Woodland, Contact
Survey intensity	10 m spacing between shovel probes
Accessability	n/r
Obtrusiveness	low
Surface visibility	low
Total area surveyed	44 ha or 0.44 sq km
No. of sites found	30
Site area found	n/a
Total person-days	220.92 [NOTE: calculation of person-days based on figures presented in Lightfoot 1986]; (Schiffer/Wells: 307)
Mean site density	0.68 sites/ha
Site recording time	n/r
Mean nsite density	0.66 sites/ha
Nsite recording tim	n/r
Level of effort	5.02 person-days/ha or 502 p-d/sq km (Schiffer/Wells: 6.9 p-d/ha)
Discovery rate	0.14 sites/p-d (Schiffer/Wells: 0.10)
Site size	
(mean)	1410 sq m
(sd)	3894 sq m
(range)	4-17400 sq m.
Site depth	
(avg)	35 cm
(range)	0-60 cm
Site density (by...	Site density is given by 6 ecological zones or 'habitats' (3 coastal habitats and 3 upland habitats), as follows: coastal strip = 5 sites/ha; tidal creek = 1.8 sites/ha; salt pond = 2 sites/ha; oak-heath = 0.12 sites/ha; oak-hedge = 0.44 sites/ha; and freshwater = 0.67 sites/ha. Isolated finds given as follows: coastal strip = 10 if/ha; tidal creek = 0.9 if/ha; salt pond = 1.3 if/ha; oak-heath = 0.41 if/ha; oak-hedge = 0.51 if/ha; and freshwater = 1.0 if/ha.
Site d-dist (by...	n/r
Site diversity	5 site types defined: residential bases, field camps, lithic workshops, plant procurement stations, shellfish procurement stations
SPT size/volume	30 cm diam x 40-50 cm deep; est vol: 99,930 cu cm
SPT spacing	
(avg)	10 m
(range)	none
SPT layout	square grid
# of SPT's/sam unit	variable; total # of SPT's: 5523
Feature size	
(mean)	18.25 cm
(sd)	16.30 cm
(range)	3-38 cm
Feature density	n/r
Feature d-dist	n/r
Feature diversity	3 feature classes defined: hearths pits (with shell), and post molds
Art. density (by...	Artifact density given by 6 ecological zones or habitats, as follows: coastal strip = 30 artifacts/ha; tidal creek = 16 artifacts/ha; salt pond = 45 artifacts/ha; oak-heath = 2.4 artifacts/ha; oak-hedge = 7.2 artifacts/ha; freshwater = 8.3 artifacts/ha.
Art. d-dist (by...	n/r
Art. diversity	6 classes defined: chipped stone (13 categories), ground stone, fire-cracked rock, ceramics, shell, vertebrate faunal remains.
Sort key	Northeast (coastal region)
Annotation	See pp.74-76 for discussion of 'diversity indexes' applied to artifact assemblages and specific algorithm for calculating J-index (after Whittlesey and Reid 1982).

claim is made for a statistically defensible representativeness of the gray literature, nor is the "sample" a particularly large fraction of the vast number of potentially informative survey monographs now available in the United States. It is intended to give a *general* idea of broad macro-regional trends in survey methodology, field procedures, reporting standards, etc., and in the nature of the archaeological record itself.

Regionalization of the data has been carried out by grouping the bibliographic references into 8 basic geographic areas each of which is further subdivided into constituent "archaeological regions," giving a total of 44 regions. Standard reference texts have been consulted for this purpose. The basic geographical areas of the continental United States follow the "culture area" scheme of the *Handbook of North American Indians* (W. Sturtevant, general editor) and consist of the following: Northeast, Southeast, Plains, Great Basin, Southwest, Plateau, Northwest Coast, and California (see Table 2). Further subdivision into discrete "archaeological regions" is often a hotly contested issue, but again, standard reference texts have been used for this purpose. Where possible, the *Handbook* subdivisions have been employed (i.e., for the Northeast [Trigger 1978], Great Basin [D'Azevedo 1986], Southwest [Ortiz 1979], and Northwest Coast [Suttles 1990]). In the other four cases, well-known macro-regional summaries by recognized scholars have been used (i.e., for the Southeast [Hudson 1976], Plains [Wedel 1983], Plateau [Aikens 1983], and California [Moratto 1984]).

The second study is aimed at a more detailed treatment of temporal variability in the archaeological record of two contrastive regions: the Illinois region of the Northeastern culture area (see Volume 2) and the eastern region of the Great Basin culture area (see Volume 3). The purpose of selecting these regions is to compare two archaeological sequences that differ markedly in terms of sociocultural complexity and in terms of their corresponding land surface conditions. Because of these differences, archaeological research designs and site discovery procedures demonstrate interesting contrasts and thus serve to illustrate the issue of differential survey intensity. Here emphasis is placed on site-specific excavation and subsurface testing data in order to describe the size and internal complexity of archaeological sites throughout the two sequences. The treatment is not exhaustive, however, in that priority is placed on monographs that provide information on large areal exposures within a given site. Generally these are large-scale excavation/mitigation projects. The site descriptions are assembled by archaeological component following a standard format. That is, for each component, a specific project and the corresponding sites pertaining to that component are enumerated. Table 3 provides a list of the items included in the characterization of each site. This information provides baseline data for detailed characterizations of archaeological sites in these two contrastive regions discussed in Chapter 3, and will serve to illustrate the problem of survey intensity under these different conditions.

Table 2. List of 8 culture areas within the continental United States and their 44 "archaeological regions" as defined in this report.

CULTURE AREA	ARCHAEOLOGICAL REGIONS	REFERENCE
NORTHEAST	5 regions: --coastal --St. Lawrence lowlands --Great Lakes --Ohio Valley --Illinois	Trigger (1978)
SOUTHEAST	6 regions: --south Florida --coastal plain --piedmont --Appalachian highlands --interior low plateau --Ozark-Ouachita highlands	Hudson (1976)
PLAINS	5 regions: --northwestern --central --southern --middle Missouri --northeastern periphery	Wedel (1983)
GREAT BASIN	6 regions: --western --northern --Upper Snake/Salmon River --eastern --southeastern --southwestern	D'Azevedo (1986)
SOUTHWEST	6 regions: --Mogollon --Hohokam --O'otam --Hakataya --eastern Anasazi --western Anasazi	Ortiz (1979)
PLATEAU	5 regions: --middle Columbia River --lower Snake/upper Columbia River --Fraser Plateau --Idaho Mountains --Idaho Plains	Aikens (1983)
NORTHWEST COAST	4 regions: --ocean coast of Washington --Puget Sound --lower Columbia Valley and Willamette Basin --Oregon coast	Suttles (1990)
CALIFORNIA	7 regions: --central valley --central coast --San Francisco Bay --north coast --northeastern --Sierra Nevada --southern coast	Moratto (1984)

Table 3. List of items included in site characterizations.

SITE DESCRIPTION
SITE DISCOVERY PROCEDURE(S)
SITE ASSESSMENT PROCEDURE(S)
INTRA-SITE SPATIAL CHARACTERISTICS --Anthropogenic Soil Horizons --Cultural Features --Feature Density --Feature Density-Distribution --Artifacts --Artifact Density --Artifact Density-Distribution --Associations (if any)
SITE INTERPRETATIONS

Technical Terminology

Before entering into an extended discussion of site definitions and site discovery procedures, it may be helpful to define terminology useful for discussions of archaeological survey methodology and sampling theory. Some of these terms have already been introduced in the preceding paragraphs; they include: precision, accuracy, reliability, validity, bias, and the concept of "confidence."

As Wandsnider and Camilli (1992:170) noted with respect to archaeological survey procedures, "precision, reliability, and accuracy are attributes both of measuring instruments and direct measurements made with those instruments," and as a result precision and reliability are often used interchangeably. Following their usage, and that of Bernard (1988:49), *precision* "refers to the resolving power of the measurement instrument." As used in this document, it directly relates to the survey intensity (i.e., the level of spatial resolution) used in a given site discovery procedure; it is thus an attribute of the archaeologist-as-measuring-instrument. It should be noted that this definition differs in important respects from the traditional statistical definition of precision. In a strictly statistical sense, precision "is a measure of the probability that the *one* sample mean we actually obtain differs by more than some given amount from...the mean of all sample means we *would* obtain, if we were to repeat, independently, the same sampling procedure a large number of times..." (Cowgill 1975:264; emphasis original). This definition is closely related, then, to the common definition of *reliability*, which "refers to the agreement between, or among, two or more measurements made on the same phenomenon" (Wandsnider and Camilli 1992:170); i.e., the consistency and replicability of results. Following Carmines and Zeller (1979:11), it "concerns the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trials," and thus relates to random measurement error.

Accuracy "relates to the deviation between actual and measured. An accurate measuring device produces measurements with a small deviation, i.e., with little bias or systematic error, given the stipulated level of precision" (Wandsnider and Camilli 1992:171). In statistical terms, accuracy refers to "a measure of the extent to which the individual sample means are spread out around...the true population mean" (Cowgill 1975:264).

Validity assessment is somewhat more complicated (see Nance [1987:279-289] and Bernard [1988:48-54] for detailed discussions), but in this case it involves survey effectiveness and systematic measurement error. How well do our survey designs and discovery techniques actually function in the discovery of archaeological sites? How well do these designs and techniques address the variability inherent in the archaeological record? Are there ways to improve upon the validity of a given survey design by adjusting aspects of its site discovery techniques and data collection procedures?

Bias can be defined as "the average deviation from reality by an inferential procedure" (Read 1975:48). In sampling terms, "the bias of an estimation procedure..." is measured by "the difference between the average inferred value that would be obtained if the procedure were used repeatedly to estimate a particular quantity, and the true value of that quantity" (Read 1975:48). Bias is thus conceptually related to accuracy in that the introduction of statistical bias, from a variety of sources, substantially reduces accuracy.

Finally, brief discussion should be given to the special sense in which the term *confidence* is used in this report so as to avoid any confusion regarding its formal statistical use in parameter estimation, such as the calculation of confidence coefficients, confidence levels, confidence limits, or confidence intervals. Throughout this report, the terms *confidence estimate* and *confidence threshold* are used in a general sense for evaluating the results of site discovery probability calculations. As such, they are consistent with the intent and purpose of *discovery model* (DM) sampling (as defined by Nance [1981, 1983, 1990]) in cases where modeling uses the binomial probability distribution (Johnson and Kotz 1969:50-86; Blalock 1979:151). Since the binomial distribution is a discrete distribution, it is generally "not possible to construct a confidence interval for p with an exactly specified confidence coefficient" (Johnson and Kotz 1969:58), although approximate confidence intervals are possible to obtain (Johnson and Kotz 1969:58-61). As used here, however, *confidence* is meant to imply simply the degree of certainty expressed by the site discovery probabilities themselves, which are given as percentages of sites intersected and/or detected for given site sizes, artifact densities, density-distributions, probe sizes, and sampling geometries (Kintigh 1988). To quote Nance and Ball (1989:411) on this point, we wish "to produce approximate estimates of the confidence we would have in our data, that is, to calculate discovery probabilities for sites of given spatial extent, surface artifact density, etc."

Phrased somewhat differently, these percentages can also be used to express the likelihood of discovering all sites of a minimal size or larger; for example, that a given survey design has an 80 percent chance of discovering *all* sites measuring 50 m in diameter or larger. In this sense, the 80 percent serves as a rough estimate of the confidence we may place on the adequacy or effectiveness of the survey design (Sundstrom 1993) for sites of a specified size and composition. If we choose to make this 80 percent level a minimal cut-off point for decisions about survey adequacy, then we can refer to it as a *confidence threshold* below which site discovery probabilities should not fall (see Doleman [1988] for a related use of this term).

In terms of the present study, we are interested in reducing bias in the range of archaeological resources normally identified by traditional survey procedures by pointing out the methodological inadequacy of existing levels of precision or "resolution" used; i.e., their survey intensity. By increasing that intensity, smaller and more ephemeral archaeological occurrences will be identified, thus providing a more accurate, reliable, and representative picture of the total population of archaeological occurrences in a given regional landscape. Greater accuracy and representation are common goals of both research-oriented archaeological surveys and CRM-related inventory surveys. For purposes of quality control and bias assessment, the calculation of site discovery probabilities and the specification of minimal confidence thresholds provide installation archaeologists and project technical monitors with the tools to make objective evaluations of survey effectiveness and adequacy. While many of the ideas expressed in this report have been commonplace in the archaeological literature from the mid-1970s to the present, there is still a considerable lag in their incorporation into institutional research programs *as formal policy*. The purpose of this document, then, is to present a series of recommendations for incorporating these refined survey procedures into DoD policies governing cultural resource management and archaeological inventory surveys carried out on military installations.

2 Site Definition

Sites and Nonsites: Regional Definitions of Archaeological Distributions

One of the most fundamental and firmly entrenched concepts in modern archaeological research is that of the "site," yet paradoxically it is currently one of the most contentious and variably defined concepts in the discipline; (see, for example, the recent discussions of Binford [1992], Dunnell [1992], Ebert [1992], and Fotiadis [1992]). Clearly, some measure of consensus, if not standardization, is warranted in the definition and use of this important concept. As Plog, Plog, and Wait (1978:385) have argued, "one of the most critical decisions we must face if we are to develop survey data with an iota of comparability is the question of what is and what is not a site." Beyond the question of comparability, however, lies the more fundamental issue of the labor time required to locate and record archaeological sites according to a particular definition of what constitutes a "site." As Dincauze, and associates (1980:226) have observed, "...the concept of 'site' which an archaeologist carries into the field has a powerful effect upon the efficiency and productivity of a given survey strategy." Before examining regional trends in site definition throughout the United States, it is necessary to review some of the theoretical and methodological justifications for this variability.

Much of the current controversy surrounding traditional definitions of the archaeological "site" originated in regional-scale archaeological survey projects whose primary, if not exclusive, focus was on prehistoric hunters-and-gatherers and archaeological evidence for foraging activities. By recognizing the ephemeral impact of human foraging activity on a regional landscape and the low level of archaeological visibility such activities generate, it has become clear that the archaeological remains commonly included in the term "site" represent only the most densely concentrated of archaeological materials, usually representing successive occupations at one spatially bounded locality. Prehistoric foragers, however, would have had a much more diffuse impact on the regional archaeological record in terms of their discarded material residues, due to their higher incidence of residential mobility on a seasonal basis (Ebert and Kohler 1988). Due to their relatively low level of sustained occupational intensity, then, their material residues should be characterized by a much broader regional distribution of unobtrusive, low-density, artifact scatters and isolated artifact occurrences than one would expect to find in the case of, say, village-based agricultural societies or complex chiefdoms. Following the work of Binford (1980) on hunter-gatherer settlement systems, Ebert and Kohler (1988:132) view archaeological localities as reflecting a continuum of occupational intensity depending on the *degree of intensification* reflected in the subsistence system(s) under study, ranging from "foraging" to "collecting" to "casual or extensive domestication" to "intensive domestication." As we shall see below, many site definitions commonly used in North America establish minimal criteria which effectively exclude from serious archaeological consideration the ephemeral remains of foragers and collectors. Moreover, they are often regarded as beyond the reach of cost-effective cultural resource management (Klinger 1976; Brooks 1979; Tainter 1983; Barber 1984; Sullivan 1988), since no demonstrable archaeological "significance" can be assigned to them for the normative purposes of the Section 106 and Section 110 compliance process. As Wait (1983:62-62) has pointed out in reference to Southwestern U.S. archaeology:

> The activities of nonsedentary peoples tend to produce thin, diffuse deposits of artifacts whose boundaries are ill-defined. The difficulties of dealing with such deposits are manifested in a common tendency to label them 'lithic scatters,' and to proceed in analysis as if they did not exist. In some research efforts, lithic scatters are ignored even in the data collection stage.

A strikingly similar statement can be found in the literature of eastern U.S. archaeology, as follows:

> Many surveys...record isolated artifacts but do not consider them sites. In other reports, isolated artifacts have been considered spot finds and small concentrations of cultural material—localities... However, in most cases examined, little was done beyond recording the presence of these archaeological manifestations. Implicit (although never too clearly) in the recording of these resources is that they are not considered significant and are summarily not important enough to merit further attention (Brooks 1979:169).

These kinds of unobtrusive, low-density material remains can only be incorporated into the cultural resource management and compliance process through a dual approach that redefines the nature of the archaeological "site" (see below) and that considerably expands the concept of archaeological "significance" so that dispersed and low-density remains are recorded and assessed in terms of the broader archaeological research questions of local and regional importance. As Butler (1987) has pointed out, such unobtrusive lithic scatters *can* legitimately be considered "significant" under the terms of Criterion (d) of the National Register of Historic Places criteria for significance evaluation (Department of the Interior Regulation 36 CFR Part 60). Under Criterion (d), in order for an archaeological site to be eligible for nomination to the National Register of Historic Places, it must "have yielded, or...be likely to yield, information important to prehistory or history" (36 CFR 60.4). The importance or significance of a site, according to Butler (1987), can only be assessed with respect to "the theoretical and substantive knowledge of the discipline" (Butler 1978:821). Thus the essentially ephemeral nature of such sites is not grounds, in and of itself, for exclusion from eligibility. Rather, it is the archaeologists' task, based on current theoretical and substantive knowledge of the archaeological record, to determine if the archaeological *content* of the site warrants a determination of eligibility (DOE) and, hence, preservation and management.

Interest in the study of "small" archaeological sites grew throughout the 1970s (Moseley and Mackey 1972; Dillehay 1973; Talmadge et al. 1977; Ward 1978) as a means of providing a more balanced view of the archaeological record, but little of this early work was explicitly directed toward site discovery through systematic regional survey, or toward the problems posed by highly ephemeral, low-density material remains. Thomas (1975) was one of the first archaeologists to grapple with the problem of treating low-density artifact scatters and isolated finds, which often fall beyond the minimal criteria traditionally associated with the term "site." He argued for a "nonsite sampling" approach, which regards "the *cultural item* (the artifact, feature, manuport, individual flake, or whatever) as the minimal unit, and ignore[s] traditional sites altogether" (Thomas 1975:62; emphasis original). Other variations on this strategy appeared in the 1980s under the rubrics of "off-site archaeology" (Foley 1981a, 1981b), the "mini-site" approach (Isaac, Harris, and Marshal 1981), "siteless survey" (Dunnell and Dancey 1983; Kerber 1993), the "artifact cluster" approach (Wait 1983), and most recently, "distributional archaeology" (Ebert and Hitchcock 1988; Ebert 1992). Regardless of their methodological differences, all of these approaches agree on one fundamental matter:

> A far more useful, less biased model of the archaeological record can be constructed if the objective of data collection is broadly conceived as the recovery of artifacts as opposed to the recovery of sites. Adopting this view, *the archaeological record is most usefully conceived as a more or less continuous distribution of artifacts over the land surface with highly variable density characteristics. Sites* in this context represent only a part of the total record, explicitly defined by density characteristics (Dunnell and Dancey 1983:272; emphasis original).

In the most recent and thorough treatment of this topic, Ebert (1992) has forcefully argued for an explicitly "antisite" perspective on the archaeological record, as follows:

> The greatest impediment to methodological consistency within site-based survey... is the concept of the site itself. Consistency in the definition of a site can never be reached, due to the very nature of the concept. Sites are never discovered during survey; it is always artifacts, features, and other individual, physically real

> materials that we find. Bounded sites and statements about their contents are abstracted—that is, essentially made up—by looking at individual artifacts, and usually if not always by looking at only a portion of those making up the site abstraction (Ebert 1992:69-70).

Since legitimate comparability requires a complete inventory of site contents anyway, in Ebert's view, the notion of a "site" is argued to be not only methodologically unsound, but largely irrelevant *for research purposes*. Since all surface artifacts are to be inventoried, Ebert prefers "distributional archaeology" as a term for this approach, avoiding entirely any use of the term "site." Even related terms for approaches similar to his, such as "nonsite" and "off-site," are avoided since they still imply the existence of sites. "What we need," he argues, "is an *antisite* archaeology, an archaeology that has nothing to do with sites, at least at the methodological level. It may be acceptable to use the concept of sites at an anthropological level, although we have better and more discriminating theoretical terms, and the use of the word 'site' would be confusing" (Ebert 1992:70; emphasis original).

This view is echoed in Dunnell's (1992) recent discussion of the site concept where its ontological reality and, hence, its methodological utility are seriously questioned; (see also Fotiadis 1992). Binford (1992:51) has effectively countered these claims by noting that organized human behavior is sometimes manifested spatially as "...structured consequences of short-term organizations and events of the past," that these "consequences certainly exist...," and that they can be conveniently studied archaeologically by use of the site concept. While not denying the validity and utility of a nonsite landscape approach to the archaeological record in some instances, Binford sees the two approaches as mutually reinforcing and complementary *scales* of analysis depending on which aspects of the archaeological record one is interested in exploring. To categorically deny the existence of archaeological sites, then, would amount to "throwing the baby out with the bath water..." (Madsen 1993:1029).

From a CRM perspective, the nonsite approach is particularly cumbersome since it is unclear how the mapped distribution of individual archaeological artifacts can be effectively managed in all archaeological regions and under variable geomorphic and surface landscape conditions. For example, how would such an approach work in the American Bottoms region of the Mississippi River Basin where the archaeological record is considerably more complex than that found in Ebert's test area in the arid Eastern Great Basin? How would spatially clustered resources such as features or architectural remains be treated in such an approach? How would archaeological resources be identified for purposes of Section 106 and Section 110 compliance and National Register eligibility determinations, if not collectively as sites? How could such resources be effectively managed in the absence of a discrete spatial referent that groups, however imperfectly, perceived clusters of artifacts, features, and other evidence of human behavior, into a site? As Tainter (1983:131) has observed, "archeological institutions usually maintain files of things called 'sites.' If certain archeological manifestations are called something other than 'site,' no formal record may be kept, even though such manifestations are of research importance." Furthermore, the use of other terms such as "cultural properties," "scatters," and "localities" is problematic for purposes of historic preservation and cultural resource management in that they "are not among the manifestations recognized by the National Register of Historic Places" (ibid.) as defined in 36 CFR 60.3. For purposes of NRHP nomination, a *site* is defined as "the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself maintains historical or archeological value regardless of the value of any existing structure" (36 CFR 60.3[l]). The National Park Service (1985:2; emphasis original) has clearly stated this managerial problem in the following terms:

> Site boundaries often are arbitrary distinctions that may not always reflect the spatial concepts implicit in certain theoretical perspectives, notably those of "non-site" or "off-site" archeology. However, in all cases for public administration purposes boundary determinations require a clear notion of which physical features and their mutual relationships are being recognized as a "site." Usually this requires the archeologist to decide, in terms of the concept of "site" being used, the degree of fall-off in cultural material density that is no longer acceptable in order to be considered part of the "site."

Even if one questions the ontological reality of the archaeological site, as do Ebert and Dunnell, might the concept still be a useful heuristic device, a "disciplinary construct" in Fotiadis' (1992:137) terminology, for partitioning the archaeological record into manageable units?

In spite of the growing disenchantment with the concept in some academic circles, and its myopic tendency to skew analytical attention towards high-density clusters of archaeological materials, the *site* is still a useful tool for collecting and analyzing archaeological data over a regional landscape and for organizing and managing archaeological resources in CRM contexts, *as long as its definition is not overly restrictive*. Here we agree with the perspective of Nance (1983:331; emphasis original) which is quoted at length below:

> Archaeologists have long employed the concept of *site* as a fundamental analytic entity. The existence of this entity in the archaeologist's vocabulary relates, of course, to the valid observation that artifacts occur in clusters, representing nodes of depositional intensity within what was probably a diffuse network of activity over the landscape of the past. Thus, while there are often real problems in operationalizing the concept, the idea of the *site* has served archaeologists well, and

> it will, no doubt, continue to do so. The important point is to remain flexible about the kinds of analytic entities we employ when required by specific research objectives...

For purposes of the present report and the overall objectives of the Legacy Resource Management Program, it is strongly recommended that the site concept be retained for archaeological surveys on DoD lands, but that a standardized definition with explicit "minimal criteria" be imposed which is flexible enough to accommodate some of the objections raised by proponents of the nonsite approach, yet practical enough to permit adequate resource management. Such definitions have already been offered in the literature and will be reviewed below. In a similar vain, more analytical attention must be given to "isolated occurrences," or those remains which fall below the minimal definition of a "site." As Klinger (1976:54) observes: "the crucial question...is what configuration of variables must be present for a cultural resource to be recognized."

Regional Trends in Site Definition

Having reviewed the underlying reasons for recent disillusionment with the site concept, it is instructive to examine regional trends in site definition as gleaned from CRM research reports throughout the continental United States. The regional CRM literature has been focused upon here because it is in these research contexts that *operational* definitions are more likely to be found, as opposed to college-level archaeology textbooks for example. The definitions extracted from these reports will serve to illustrate two general points. First, as a whole, site definitions are highly variable. And second, as suggested earlier with regard to unobtrusive, low-density material remains, many site definitions are exclusionary in nature. Both of these have dramatic implications for survey and site comparability within and between archaeological regions.

As an example of the regional variability in site definition throughout the continental United States, Appendix A provides a list of 25 CRM survey projects that were consulted to extract information on site definition. Close to 100 reports were consulted, but in the interest of brevity, only 25 are presented here. In Appendix A, the 25 entries are listed in no particular order. They simply list the author(s) and year of publication, the relevant geographical reference for the work, including one of the eight broadly defined "culture areas" and one or more "archaeological regions" within these eight areas, and the site definition or a summary of whatever relevant information may have been provided. The number preceding each entry is its record number within the database file. Although all eight areas are represented by at least one entry, the coverage is far from even across all eight areas.

In a study dealing with survey methodology and the issue of site definition, Gallant (1986) presents a useful typology of past site definitions commonly cited in the archaeological literature. Gallant's three groupings fall under the headings of (1) benign neglect, (2) correct but vague, and (3) the formalized approach (Gallant 1986:408). In the case of *benign neglect*, "it is assumed that sites are sites and are recognizable as such..." (Gallant 1986:408). In these cases, the site concept is simply left undefined because the archaeological audience to whom the report is addressed is assumed to agree on the definition of such a fundamental archaeological entity.

In the case of *correct but vague*, the definitions are "technically correct but of little operational value in the field, especially in areas where there is a near continuous distribution of material across the region" (Gallant 1986:408). Thus no explicit criteria are provided as to how a "site" is to be distinguished from light artifact scatters not treated as a site even though the "isolated find" category is often recognized. A typical example of such definition is given by the Southwestern Archaeology Research Group (SARG 1974:110) as follows: "A site is defined here as any location characterized by the deposition of the remains of human activity..." Likewise, Judge, Ebert, and Hitchcock (1975:83) state that "archaeological sites represent the activity loci of cultural systems..." College-level archaeology textbook definitions commonly fall into this category where sites are characterized as "...horizontally extensive, well stratified and vertically extensive dense concentrations of artifacts, ecofacts, and features" (Lyman 1985:31). Lyman (1985:Table 1) presents a compilation of 10 "textbook" definitions published between 1965 and 1979 that exemplify this category.

The *formalized approach* is different in that "definitions establish rigid criteria for recognizing sites" (Gallant 1986:408). In this case, specific artifact densities are established as minimal criteria for site definition. In the Southwest, many definitions published during the 1970s seized upon the figure of "at least five artifacts per sq m" (Plog and Hill 1971:8; see also Fuller, Rogge, and Gregoins 1976:68 and Doelle 1977:202) as a cut-off point for inclusion into the site category. While the explicitness of these criteria is to be lauded, such definitions are too exclusionary in that their cut-off point for artifact density is much too high even for the Southwest United States, not to mention other parts of the country. As a result, large numbers of significant archaeological manifestations would go unrecorded unless the artifacts were found in association with cultural features exposed on the ground surface. As Plog, Plog, and Wait (1978:387) have argued: "rigid application of density-based definitions may... result in the systematic exclusion from analysis of systematic components of the archaeological record."

In their view, a site is best defined as "a discrete and potentially interpretable locus of material ...with...boundaries marked by at least relative changes in artifact density" (Plog, Plog, and Wait 1978:389; see also Dunnell and Dancey 1983). This kind of definition, which takes into account regional differences in artifact density, represents a sensitivity to the objectives of the nonsite approach described earlier, but without rejecting the site concept entirely. As Gallant (1986:409) points out: "a step toward an operational definition of a site would be to combine the concept of the spatial distribution of artifacts as a continuum on a regional scale and of high density scatters, or sites, as only one end of that continuum." A good example of this approach can be found in the definitional criteria established by Chase, Montgomery, and Landreth (1988) for surficial material cultural remains in southeast Louisiana. For purposes of their research design, surficial remains are segregated into four categories, as follows:

Site.	An area 15 m or greater in diameter that contains a minimum of 11 artifacts or a feature.
Scatter.	An area containing single artifacts distributed 25 to 50 m apart.
Cluster.	An area 15 m or less in diameter containing between 2 and 10 artifacts.
Isolated Find.	Single items located more than 50 m from another artifact. (Chase, Montgomery, and Landreth 1988:Attachment 3, page 1; emphasis original).

A fourth alternative to these three definitional approaches, also mentioned by Gallant (1986), is the *nonsite approach*. As we have seen, in this case the site concept is avoided entirely in favor of other terminology such as "archaeological resources," "field loci," "cultural acreage," or simply "artifact clusters." Each cultural item takes on primary analytical importance and all surface materials are recorded regardless of their degree of clustering. Representative examples of this approach were discussed in the preceding section.

Table 4 provides a summary chart showing how the 25 definitions listed in Appendix A sort out in terms of the four categories described above. Six of the entries fall readily into the "benign neglect" category either because no definition is provided (7, 17,22, 24) even though certain properties of sites are mentioned (1), or an analytical distinction is made between sites and isolated finds (18). On first glance, one might attribute such neglect to more traditional approaches of older monographs, say from the early to mid-1970s when the question of what constitutes a site was not a major epistemological concern. Such is not the case, however, since all six entries post-date 1975. It probably has more to do with the "provincial" nature of many survey monographs, which have very restricted CRM objectives and are aimed at equally restricted local

Table 4. Classification of 25 site definitions listed by culture area.

CULTURE AREA	TYPE OF SITE DEFINITION				
	Benign Neglect	Correct but Vague	The Formal Approach	Nonsite Approaches	TOTALS:
Northeast			3, 8, 10		3
Southeast	7, 17, 18	4	20	9, 25	7
Plains	1	13			2
Great Basin		12, 16, 21	5		4
Southwest	24	19	6, 11	2	5
Plateau			15		1
NW Coast	22				1
California			14, 23		2
TOTALS:	6	6	10	3	25

or regional audiences such as the CRM client, the local SHPO, and the local archaeological community. There are probably no geographical tendencies in the "benign neglect" approach, and it is likely that examples can be found in all eight culture areas.

Another six definitions can be placed squarely in the "correct but vague" category. Here sites are generically defined as "the locus of past human activities that can be delineated by the presence of cultural features...and/or cultural artifacts" (Lebo and Brown 1990:18). While essentially correct, such definitions do not specify *minimal* criteria by which a site can be defined and recognized in the field. While some of these definitions at least distinguish between the concepts of "site" and "isolated find" (16, 19), no explicit criteria are provided for making this distinction in a consistent and replicable way.

Ten definitions fall into the "formal approach" category in that they all include specifiable quantitative criteria for minimally defining a "site" on the basis of surface artifact density, and for distinguishing it from an "isolated find," "light density lithic scatter," or other "nonsite" archaeological manifestation. This trend is clearly in the majority within our extremely small sample of 25 definitions and represents a laudable advance over the approaches of the previous two categories. However even within this category there is considerable variability in the precise level of artifact density used to define a site. For instance, in the Southwestern United States, Fuller, Rogge, and Gregonis (1977: 68) selected the rather high figure of 5 artifacts per square meter as their cut-off point, while Schlanger and Harden (in Kane et al. 1986:386) use a figure of "at least 20 artifacts (flakes, sherds, tools) within an area of approximately 30 by 30 m," which translates to a density of 0.02 artifacts per square meter. This difference in artifact density measures has dramatic implications for which archaeological resources are included in the "site" category and which are excluded. Obviously, the Schlanger/Harden approach is much more inclusionary in nature than that of Fuller, Rogge, and Gregonis (1977), since their lower artifact density would cover light density lithic scatters and other diffuse surface remains. The "5 artifacts/sq m" criterion used by several archaeologists in the Southwest effectively excludes a broad range of archaeological manifestations. Moreover, such surface artifact densities are actually a rare phenomenon in many study areas. According to Plog, Plog, and Wait (1978:387), for typical puebloan sites in the Black Mesa area and Chevelon drainage of the Southwest, 95 percent of the sites located "had artifact densities lower than 5 per square meter." The Schlanger/Harden definition is also noteworthy in that all surface remains which fall below their 0.02 artifacts/sq m cut-off point are formally treated as "isolated finds" and are duly recorded as such. Thus no archaeological materials are excluded from analytical consideration, regardless of what the critical artifact density is for distinguishing between sites and isolated finds. Of the ten "formal" definitions included in this sample, five of them (3, 5, 6, 14, 15) use the "isolated find" or "low-density scatter" concept as a residual nonsite category (cf. Brooks 1979).

The problem with the "formal approach," of course, is that critical artifact densities are somewhat arbitrarily selected and are usually tailored for the archaeological record of a given region or even a specific study area. While four definitions range between 0.02 to 0.06 artifacts per sq m (5, 6, 14, 15), others range widely from 5 artifacts per 0.65 sq km (the size of a sampling quadrat) (O'Brien, Warren, and Lewarch 1982:339-440) to "a double hand-full of cultural material" within an area of unspecified size (Schiffer and House 1975:48). Consequently, in spite of the greater analytical acuity of the "formal approach," there is little comparability of results from region to region, or even between different survey projects within the same region (see below). Basic measures such as average site density, or the ratio of sites to isolated finds, would not be based on uniform criteria of what is and what is not a site. Moreover, surveys based exclusively on the results of shovel test-pit subsampling cannot even use surface artifact density as a criterion for site definition; rather sites are usually defined on the basis of volumetric measures such as number of artifacts per cubic meter (or per quarter cubic meter), or simply as the number of artifacts per shovel probe where probe size is uniform (see Lightfoot, Kalin, and Moore 1987; McManamon 1984a, 1984b). In these situations, site definition can be quite complex. For instance, Lightfoot, Kalin, and Moore (1987:41-43) distinguish between isolated finds, low density scatters, and high density scatters on the basis of a combination of factors such as the spatial dimensions of contiguous positive shovel probes from initial systematic survey, the percentage of positive shovel probes after secondary testing, and mean subsurface artifact density from all positive shovel probes. Thus landscape conditions which require subsurface testing programs also require different, and more complex, procedures or guidelines for site definition than those normally stipulated in the "formal" approaches. In a sense, the procedure outlined by Lightfoot, Kalin, and Moore (1987) is more akin to the "distributional" approach advocated by Ebert (1992), at least at the methodological level. However, Lightfoot, Kalin, and Moore do not reject the "site" concept entirely. Rather, they assign site designations after analysis of all shovel probe data has been completed (see Seaman, Doleman, and Chapman 1988 for a similar approach to site definition in a surface pedestrian survey).

Finally, "nonsite approaches" are sparsely represented in our sample, comprising only three of our 25 definitions. One of these was developed in the Southwest (2) and rejects the concept of "site" in favor of "cultural acreage" or area of land surface occupied by cultural materials (Marmaduke and Conway 1984). The impetus for this procedure stems from the difficulty of using the *number* of sites to calculate average site density in probabilistic sampling schemes, since the individual sampling unit that cuts across the edge of a larger site or several larger sites may contribute to the over-estimation of regional site densities. Theoretically, a sampling unit should only report the sites that are fully encompassed by its arbitrary boundaries. In archaeological survey, however, it is frequently observed that a sample quadrat or transect actually locates many more sites (and greater site areas) than the unit could actually encompass, a phenomenon known as the "edge effect" (Nance 1983) or "hypothetical coverage" (Plog, Plog, and Wait 1978). The nonsite approach taken by Marmaduke and Conway (1984), then, was focused on recording all surface archaeological manifestation as either isolated finds or larger artifact clusters depicted by 3 density classes (light, moderate, and high) based on a measure of number of artifacts per 9 square meters with sample quadrats measuring 40 acres in area. They argue as follows:

> Conceptual difficulties made the 'site' an imprecise unit of measurement in probability sampling...In particular, the 'site' has an ambiguous meaning for management estimates of potential preservation costs. Therefore,...[we] measured *acres of land* which bear archaeological remains. An added benefit in gauging resources by acreage is the elimination of troublesome edge effects encountered when 'sites' are enumerated in sample surveys (Marmaduke and Conway 1984:92; emphasis original).

The remaining two nonsite approaches, both from the Southeast (9, 25), follow Glassow (1977) in equating "sites" with the generic term "archaeological resources," defined as items, deposits, and/or surfaces exhibiting discrete spatial clustering. Five properties of these resources are also discussed: variety, quantity, clarity, integrity, and environmental context. Sites are then defined on the basis of these field data in terms of specific research problems of the project in question. The nonsite approach is followed here only at the methodological level of data collection in the field, the ultimate purpose being the definition of archaeological sites after laboratory analysis has been completed. No explicit minimal criteria are given, however, as to what constitutes a site. Thus the procedure does not fall into the "formal" approach discussed above, nor does it follow the strict "nonsite" or "antisite" approach of Ebert (1992).

This cursory and preliminary examination of a few site definitions commonly used in the United States demonstrates, above all, the wide variety of meanings or uses implied by the concept. Even within the same broadly defined culture area (e.g., Southeast and Southwest), approaches to site definition appear to be quite diverse (Table 4).

Secondly, some of the definitions common to the "formal" approach tend to be overly exclusionary in that they automatically eliminate from serious study a range of smaller, more ephemeral archaeological manifestations such as light density lithic scatters or isolated finds.

If the high diversity of site definitions is notable at a national level, it is even more striking when documented for a series of ten archaeological contracting institutions who conduct cultural resource management projects on lands within the Southwestern Region of the U.S. Forest Service (i.e., Arizona, New Mexico, and the Texas-Oklahoma Panhandle area; Tainter 1983). Of the ten institutions surveyed, Tainter (1983:131) was able to discern no fewer than "six categories of archaeological site definition," with a seventh category volunteered after the initial inquiry was conducted. These include the following (Tainter 1983; emphasis original):

1. *Behavioral* definitions...[which are] defined as any locus intentionally used by human populations.
2. *Arbitrary* definitions [which] specify that a site is any manifestation displaying a certain debris density (for example, five artifacts per square meter)...
3. *Inclusive* definitions [which] record as a site *any* archaeological manifestation, including isolated items...
4. *Research potential* definitions...which limit archaeological sites to manifestations which contain information that cannot be exhausted at the time of discovery.
5. *Research objectives* definitions [which] argue that the definition of an archaeological site varies with the research goals of individual projects. [Thus] phenomena which are not of interest for specific research questions are not recorded as sites.

6. *Content* definitions [which] specify that sites are features on the landscape that contain a laundry list of items. This list specifies the types of debris often left behind by prehistoric and historic populations.
7. *Density* definitions [which] suggest that the stringency of a site definition varies with the density of archaeological remains...

Tainter then goes on to enumerate a number of conceptual and methodological problems with these definition which render them "unsuitable for management purposes, and often unsuitable for the broader research interests which management is designed to protect" (Tainter 1983).

But apart from their individual unsuitability lies the overriding problem of the *non-comparability* that results from their simultaneous implementation within the same regional area of a Federal land managing agency. The next section briefly considers some of the archaeological implications of this variability in the definition of archaeological sites.

Some Consequences of Variable Site Definitions

Two examples can be used to illustrate the undesirable consequences of variable site definitions in evaluating archaeological survey results within the same study area. Both are "classic" examples drawn from the abundant literature on archaeological sampling and regional survey. The first comes from the Cache River Basin of northeastern Arkansas. As mentioned in the previous section, Schiffer and House (1975:48) defined sites in the Cache River Archeological Project using the subjective quantitative criteria of "a double hand-full of cultural material" within a site area of unspecified size (see Appendix A: Number 20). However, "locations of cultural material not meeting this criterion were not designated as sites but were recorded" (Schiffer and House 1975), presumably as nonsites, isolated clusters, or isolated finds, but with significantly less analytical attention. Klinger (1976) subsequently conducted a regional survey in the Village Creek drainage adjacent to the Cache River study area and found the Schiffer/House definition overly restrictive and exclusionary given the diverse nature of archaeological manifestations in the area. As a corrective measure, he defined a site as "*any* discrete spatial loci exhibiting evidence of past cultural behavior, whether it be a single sherd or flake" (Klinger 1976:55; emphasis original). Perhaps not unexpectedly, this procedure resulted in a much higher density of archaeological sites discovered. In an extension of one of the original transects surveyed by Schiffer and House (Cache Transect 1), which Klinger (1976) refers to as

Village Creek Transect 107, Klinger documented a site density of 30.7 sites per square mile, as opposed to the 11.3 sites per square mile reported by Schiffer and House. As Klinger (1976:55) notes:

> [D]ifferential use of the two basins both prehistorically and historically may account for some of the observed variability. Differences in approach to site definition, however, probably account for most of it...By recording the small sites and isolated items,...one builds a valuable body of regionally derived data from which potentially significant patterns may emerge. This far-reaching problem affects both the archeological community and those governmental agencies responsible for the protection of cultural resources.

A similar case study has been noted in the Southwest. Plog, Plog, and Wait (1978:386) observe that "perception[s] of what a site should actually look like on the ground is too often influenced by the larger, more visible, but less frequent sites present in an area." They use two archaeological surveys in the Chaco Canyon area of New Mexico (Judge, Ebert, and Hitchcock 1975; Wait 1983) to illustrate the point that in areas of large multiroom pueblo sites with standing architectural remains and dense artifact concentrations, pre-ceramic sites with light density lithic scatters are simply not very obtrusive, and hence, are much less likely to be discovered through pedestrian survey. A regional archaeological survey of 52 sq km (20 sq mi) of the Chaco National Monument area recovered a total of 1130 sites. Of these, 1.3 percent (about 15 sites) were assigned a "pre-ceramic" affiliation (Judge, Ebert, and Hitchcock 1975:96-97). In contrast to these results, a regional survey carried out by Wait (1983) in the nearby Star Lake area, where large complex puebloan sites are largely absent, some 109 pre-ceramic sites were located within a study area of 60 sq km (23 sq mi). The question posed by Plog, Plog, and Wait (1978:386; emphasis added) reveals a fundamental problem for archaeological site definition: "Is the difference in the density of pre-ceramic sites between the two areas a real difference in the utilization of the two areas prior to about 500 A.D., or is it the result of the difficulty of *perceiving* sparse lithic scatters as sites when one is working in an area such as Chaco Canyon," where extremely obtrusive archaeological remains are readily observable? In this case, the analytical perception of the archaeologist is of crucial importance. Even though Judge, Ebert, and Hitchcock (1975) very likely included light density lithic scatters in their definition of what constituted a site, such sites may not have been recognized and recorded in quantities that are truly representative of their occurrence in the regional population of sites.

Establishing Minimal Criteria for Site Definition

As stated previously, this report strongly endorses retention of the "site" concept for purposes of intensive archaeological survey on DoD lands. In spite of past ambiguities and misuses of the concept, it still serves as a useful tool both for cultural resource management purposes *and* for academic research purposes, providing of course that the definition is not overly restrictive in terms of the kinds or quantities of material remains which make up the minimal criteria for site attribution. It is argued here that even where the site/nonsite distinction is explicitly made, the distinguishing criteria are either not specified or the nonsite category encompasses too many different kinds of archaeological occurrences to be analytically useful.

Examples of these problems abound in the archaeological literature (Lyman 1985). The establishment of a clear quantitative cut-off point between what one considers a site and what one considers merely "background noise" on the archaeological landscape is the subject of often acrimonious debate. The exchange between MacCord (1988) and May (1988) on where to "draw the line" is instructive in this regard and highlights the regional differences in the archaeological record that underlie the decisionmaking process. Citing cost-effectiveness as his principal criterion, MacCord (1988) places a rather high threshold on his minimal criteria for defining an archaeological site in Virginia. In MacCord's (1988:14) "Cultural Resource Continuum," in order to merit the designation of *site*, an archaeological manifestation must minimally exhibit "[projectile] points, debitage, & FCR [fire-cracked rocks] @ 1 per 10 foot square or 400 per acre." In this scheme, any manifestation having lower densities and less diverse archaeological materials is considered "background noise" and would not even be recorded, much less surface-collected for future analysis. Clearly, the kinds and amounts of archaeological resources excluded in this procedure are probably too excessive for most practicing archaeologists in the United States. Indeed, in May's (1988) response to MacCord's scheme, it becomes clear that such an approach to site definition would effectively eliminate from analytical attention much of the Late Pleistocene archaeological record in areas such as China Lake in the Mojave Desert of California (Davis 1975, 1978).

Plog, Plog, and Wait (1978:389) provide a more reasoned approach to definitions of the "site" and "non-site". According to them:

> A *site* is a discrete and potentially interpretable locus of cultural materials. By discrete we mean spatially bounded with those boundaries marked by at least relative changes in artifact densities. By interpretable we mean that materials of sufficiently great quality and quantity are present for at least attempting and usually sustaining inferences about the behavior occurring at the locus. By cultural

> material we mean artifacts, ecofacts, and features (Plog, Plog, and Wait, 1978:389; emphasis original).

In contrast, a *nonsite* area "is a potentially interpretable but not spatially discrete locus of cultural materials. The materials either (a) are so limited in quantity or (b) cover so broad an area, or both, that meaningful boundaries cannot be defined by normal survey procedures" (Plog, Plog, and Wait 1978).

While these definitions are well conceived and useful, three fundamental problems arise with regard to inventory survey, field recording, and subsequent resource management. First, they do not establish a standardized, quantifiable, cut-off point for distinguishing between a site and a nonsite. Thus the notion of "relative changes in artifact densities" in their definition of "site," while preferable to strict adherence to overly high artifact densities (e.g., 5 artifacts per sq m), must be specified on an *ad hoc* basis for a given region or study area (e.g., Chase, Montgomery, and Landreth 1988), thereby reducing comparability of survey results. Secondly, the discussion of "nonsite" areas provides no guidelines as to how they should be recorded, if at all, in the field. Thirdly, there is no theoretical guidance as to how and why a definition should be operationalized. As Lyman (1985:35; emphasis original) has observed:

> To be sure, the concept of *site* provides us with a useful bookkeeping device, just as the concept of *feature* does. I will not dispute the fact that sites are real empirical phenomena. I emphasize, however, that as empirical phenomena, sites must be defined with empirical criteria in order that they may be recognized. the definitive criteria should be theoretically grounded.

Recommendations

As a means of addressing these issues, a concrete recommendation for a standardized site definition is presented here for future implementation in archaeological survey designs on DoD lands. It derives from suggestions made by U.S. Forest Service personnel (Tainter 1983; see also Sullivan 1988) for purposes of resource management on federal lands under their jurisdiction. Tainter's (1983) stated goal was to develop a site definition that would serve the ends of both research and management, but that did not become a *de facto* significance evaluation. More specifically, he argues that any definition should have the following five essential properties: "1) be easily operationalized; 2) have administrative feasibility; 3) provide results which are comparable; 4) be sensitive to the recognition of low density remains; and 5) focus attention on past behavior which was purposive and patterned, rather than on behavior which was accidental or idiosyncratic" (Tainter 1983:132). Using these criteria as a guide, it can be seen that very few of the site definitions discussed in the preceding sections exhibit all, or even most of these properties.

As a corrective measure, then, Tainter defines an archaeological site as "*any location where human behavior has resulted in the deposition of at least two different artifacts in close proximity, or other evidence of purposive behavior*" (1983:132; emphasis original), such as cultural features, architectural remains, etc. Contextual integrity is also a crucial criterion as implied by the term "deposition...in close proximity." Isolated finds are thus defined as occurrences of a single artifact only or two artifacts of a similar nature. In light of the preceding discussion of variability in site definitions, Tainter's approach is highly attractive because his theoretical rationale is clearly stated, as follows:

> Two *different* objects is the minimal archeological manifestation which will consistently reflect purposive behavior, the type of human behavior which is of anthropological interest. No larger number will be able to consistently identify all significant behavior; the next lower number cannot differentiate accidental loss. Thus, the definition proposed here is one that will allow the most consistent possible recognition of past foraging behavior, a topic of deep concern in the field today. Thus, while derived as a tool for management, this definition is grounded in the most basic concerns of contemporary archeological theory. It is, therefore, also proposed as a tool for research (Tainter 1983; emphasis original).

As a corollary to this basic definition, Tainter has recently implemented the following site concept, along with a series of related definitions and clarifications, for field research in the Cibola National Forest of New Mexico.

> A *site* is a location where one can reasonably infer from the physical remains that a *purposeful activity* took place. The term *purposeful activity* differentiates the remains of sites from remains that one can reasonably infer were lost, discarded, broken, and/or abandoned. The latter are considered *isolated finds*, and are locations where no demonstrable activity took place. In practice, isolated finds will be single items that do not clearly reflect an activity (such as single lithic items, including projectile points), or broken pieces of what had once been a single item (such as sherds from a single pottery vessel). Sites will be indicated by the presence of two or more *different* items, or different classes of items, in close proximity (Dr. Joseph Tainter, Archaeologist, U.S. Department of Agriculture, Albuquerque, NM, professional communication, 1994; emphasis original).

As a tool for cultural resource management, these definitions will ensure that "...when an area is investigated for archeological remains, all evidence of intentional past behavior...[is] inventoried" (Tainter, 1983) in a good faith effort, so that appropriate assessment can be made with regard to protection and future management. Obviously some of the smallest sites identified using this definition will escape detection in many systematic site discovery procedures, such as pedestrian transects with 25-m crew interval spacing or intensive shovel-testing surveys on a grid of 25-m intervals. In these cases, confidence estimates can be placed only the discovery of sites measuring 25 m or larger in diameter. Smaller ephemeral sites (such as those represented by only two artifacts) would still be located and recorded, but with less desirable degrees of confidence (see discussion in Chapter 4). The important point is that such sites are not eliminated from analytical consideration *by the definition itself.*

Some archaeologists have taken exception to Tainter's definition on the grounds that it contains ambiguities which are at odds with its potential use as a standard. Its operationalization in the field is thought to be compromised by the use of "concepts that are subject to interpretation" (McGowan, professional communication, 1994). Tainter (1983), while acknowledging this fact, still argues for its clear rationale and operational utility:

> By and large, this definition is easily operationalized, for there can be no confusion concerning two artifacts. Some ambiguity does remain in certain portions of the definition (such as "different artifacts," "close proximity," and "other evidence of purposive behavior"), but there seems to be no choice except to leave these to the judgement of the investigator. I use the term "artifact" loosely to mean any object made or modified by human action. This could range from substantial structural remains down to isolated faunal elements resulting from butchering (Tainter 1983:132; emphasis original).

One source of skepticism hinges on use of the term "close proximity," since many archaeologists would feel more comfortable placing measurable distance limits on this proximity so as to clearly distinguish a minimal site from two isolated finds. In this case, however, a more useful guide may simply be the determination of "deposition...in close proximity" in which the two artifacts are situated within the same geomorphic/sedimentary context.

At a methodological level, Tainter's definition could be combined with the "inventory approach" to field recording outlined by Sullivan (1988) or the "four-level hierarchical design" proposed by Altschul and Nagle (1988:284-286), wherein all archaeological surface materials are recorded, sites and isolated finds alike. While these approaches are aimed at circumventing site definitions that are highly restrictive and exclusionary in nature, they still provide no guidance as to how a site should be defined even if it is used merely for bookkeeping purposes. The site is defined in a deliberately arbitrary fashion to satisfy managerial concerns, yet the archaeological resources are recorded in their entirety (i.e., at the artifact level) for later aggregation into meaningful analytical groupings. Altschul and Nagle (1988:284) phrase the issue in the following terms: "The problem...is to find a way to fill out site records for [state and federal] agencies using one definition, while retaining the capability to manipulate the data according to any number of other definitions." The operationalization of Tainter's definition, however, would permit the retention of a site concept that is theoretically grounded, yet still compatible with the inventory approaches advocated by Sullivan (1988) and Altschul and Nagle (1988), or with Ebert's (1992) "distributional approach."

It should also be noted that Tainter's definition of archaeological site is compatible with the more complicated process of site definition in shallow subsurface testing programs surveys which employ shovel test-pits, portholes, cores, or augers (see definitions in Chapter 3). For example, in Lightfoot, Kalin, and Moore's (1987:41-43) discussion of archaeological manifestations recovered in shovel test-pit survey on Shelter Island, New York, careful analytical attention is given to the segregation of isolated finds, low density scatters, and high density scatters, largely on the basis of the percentage and spatial dispersion of positive shovel probes and associated artifact densities. Site status is conferred only after the depositional environment of an archaeological manifestation and its spatial distribution have been assessed and purposive behavior can be documented. Thus isolated finds are recorded as such in cases where further testing reveals no contiguous positive shovel probes. Both low and high density artifact scatters become sites only where concrete "behavioral interpretation" is possible (Lightfoot, Kalin, and Moore 1987:43). The importance of utilizing a nonrestrictive site definition that encompasses the special situation of subsurface testing programs cannot be overstated, since the area surveyed in these cases is dramatically smaller than that covered by pedestrian inspection techniques. Hence the artifact densities routinely dealt with in shovel-testing, postholing, coring, and augering procedures are usually much smaller than those found in surface manifestations. Site detection and boundary definition is much more problematic under these conditions (Shott 1989:399) and a considerable amount of negative evidence is necessary before the presence of a "site" can be conclusively ruled out (Stone 1981b; Hasenstab 1986; also see discussion in Chapter 3).

Management Implications

The most obvious management implication of this less restrictive definition of what constitutes an "archaeological site" is the considerable increase in field recording of the more ephemeral archaeological manifestations that were formerly excluded from such analytical attention. This, in turn, will produce corresponding burdens on analysis costs and data storage and management requirements. As a means of making this increased data retrieval mission more efficient and cost-effective, it is recommended that as many of these site recording tasks as possible be automated through the routine use of hand-held data recorders and pen-based computer hardware, together with routine field provenience plotting using electronic distance measuring (EDM) theodolites. Commercial software, now widely available, permits the development of standardized "pop-up" recording forms for use on hand-held pen-based computers. Geographical Information System/Global Positioning System (GIS/GPS) capabilities and database storage are also becoming standard features of these software packages. Regardless of whether the local conditions permit pedestrian inspection methods or whether some form of subsurface testing is necessary, fieldwork should be carried out in three stages, as follows:

1. Survey tract or sample unit inspection for purposes of site/feature/artifact discovery;
2. Field mapping of site characteristics artifact/feature occurrence, surface/sub-surface artifact densities, etc.;
3. Field collecting and/or artifact attribute recording.

Efficient site characterization and attribute recording of artifacts and features require considerable prior knowledge of the local and regional archaeological record; thus all field work should be designed only after the necessary background research and pre-field work planning has been carried out so that standard recording forms can be designed for sites, isolated finds, and artifact attributes pertinent to a given region or locality.

Another problem related to the increased analytical attention given to surficial lithic scatters and other ephemeral sites has to do with their potential treatment in accordance with Federal legislation (especially Sections 106 and 110 of the National Historic Preservation Act) and their evaluation for NRHP significance. Butler (1987), for example, has noted a general reluctance on the part of archaeologists to defend a recommendation of significance for small ephemeral sites such as lithic scatters, even though such a recommendation may be justifiable in certain cases. Rather than enter into the protracted negotiations required by cultural resource law, many archaeologists in such situations would simply declare that this *class* of site is not eligible for nomination to the National Register due to their ephemeral nature. Not surprisingly, then, this mind set could easily translate into a general lack of analytical interest in any of these sites. Butler (1987), on the other hand, recommends that such sites might best be handled through the mechanism of a Programmatic Memorandum of Agreement (PMOA) between an agency (e.g., the DoD), the SHPO and the Advisory Council on Historic Preservation (ACHP) before initiation of field work such that the data recovery necessary to make a significance determination *for this class of sites* is carried out during the initial field work. In his words,

> ...[T]he data potential to satisfy the no-adverse effect determination ...[is] recoverable by provenience plotting, collection, and analysis. When this occurs during the initial field work, the archaeologist's recommendation often could be "yes, the site is important under criterion d) because..., but the surface mapping and collection effectively has mitigated the adverse effects to the site"...[since]...all that could be learned from the site was accomplished during initial recording and collection (Butler 1987:825).

The process thus implies a "de facto mitigation" (Butler 1987:825) that is (a) *only* applicable to small, ephemeral, surficial scatters, and (b) is carried out *only* under the aegis of a PMOA for a specified project area. To quote Butler (1987:825) again: "...de facto mitigation is a recognition of the NRHP significant potential in such sites but offers a mechanism for efficiently addressing that potential within the confines of the cultural resource legislation and procedures." This is a far better solution to the "lithic scatter" problem than pretending that they don't exist or that they don't merit the research effort necessary for field recording and laboratory analysis. Butler's solution would also eliminate the high cost in time and resources associated with the relocation of such sites if subsequent visits are necessary for purposes of significance evaluation.

Obviously recording procedures and, to a certain extent the logistics of field recording, will vary from region to region depending on the nature and complexity of the archaeological record and the site discovery procedures required by given land surface conditions. However, some form of intensive surface recording or "total inventory approach" should be used following the guidelines suggested by McAnany et al. (1984), Sullivan (1988), Altschul and Nagle (1988), Ebert and Kohler (1988) and Ebert (1992). Sullivan (1988:84) has described this procedure in the following terms, citing representative examples for the Southwestern literature:

> Sometimes, the artifact content of all but the largest and densest clusters of artifacts can be exhaustively enumerated (e.g., Downum and Sullivan 1988). For large and dense artifact clusters , a form of intensive transect or grid recording may be especially useful (e.g., Rankin 1986:31-36; also Cowgill 1985:384). Thus, in contrast to... [traditional] site characterization procedures..., the inventory method actually counts the number of artifacts of different types that are present on the ground's surface (e.g.,Wilcox et al. 1981).

McAnany et al. (1984) provide a detailed account of their "intensive surface recording" procedures developed during field work in New Mexico, including a list of necessary equipment. Useful comparative data are also presented on the results obtained by intensive surface recording versus sampling of site surface assemblages. Using grid-based artifact recording, Sullivan (1992) presents a specific methodology for partitioning individual lithic scatters within a site into component occupations (subsite areas) through the definition of clinal variation in artifact density. Finally, Ebert (1992:157-172) provides a thorough discussion of his "distributional fieldwork" procedures as carried out in pedestrian survey of arid landscapes in the Eastern Great Basin. For field recording procedures applicable to the special conditions of shovel testing programs, refer to McManamon (1984b, 1984c) and Lightfoot, Kalin, and Moore (1987:41-42). In many situations having variable degrees of ground cover, combinations of pedestrian and shallow subsurface testing (SST) approaches will be warranted (Nance and Ball 1989) and care should be taken that the recording procedures and survey results are comparable (Lightfoot 1989). A standardized site definition applicable to both surface and subsurface manifestations is of obvious importance when different discovery procedures are combined within the same survey project.

A word of caution is warranted, however, regarding the total inventory approach, for it assumes that all researchers and field workers agree on what surface items are worthy of recording. Apart from the ambiguities inherent in the kinds of cultural materials or other items is the issue of size. As Cowgill (1985:381) notes, "unless the surface is actually devoid of small objects altogether, there is simply no lower limit to the size of fragments to be found." Therefore, some cutoff point must be specified; i.e., "some [size] level below which fragments are too small and too insignificant to collect" (Cowgill 1985:381). No suggestion is made here that such a cutoff point be standardized. Rather, that decision should be part of the overall research design tailored for a specific study area and set of research questions. What is essential is that it be explicitly stated for each class of cultural material known to exist in the study area.

3 Regional Archaeological Survey and Site Discovery Procedures

Survey Intensity and Site Discovery Probabilities

One of the most problematic issues in the execution of regional archaeological surveys, whether for inventory or research purposes, is the nature of *survey intensity*; that is, the crew-member spacing by which the surface of a sampling unit or study area is visually inspected for evidence of archaeological manifestations, or the probe spacing in the case of subsurface inspections. An additional aspect of intensity that is directly related to the spacing question is the thoroughness with which the inspection is performed (i.e., its observational adequacy). In the case of pedestrian techniques, this involves the rate or speed with which the surface is walked and the observational capabilities of the individual crew members for a given level of artifact obtrusiveness and surface visibility. As Schiffer (1988:475) notes, the likelihood of site discovery in pedestrian surface survey "varies directly with...[artifact/feature] obtrusiveness and visibility and inversely with the crew-spacing interval." In the case of subsurface testing techniques, such as shovel-probes, thoroughness revolves around the issue of recovery methods (i.e., visual inspection versus screening of probe fill, and the mesh size used for screening). Again, the different observational capabilities of field personnel form a relevant variable for given levels of artifact obtrusiveness and for the recognition of anthropic soil horizons.

Survey intensity has been extensively treated in the archaeological literature dealing with pedestrian as well as subsurface inspection techniques, and its implications for site discovery are intuitively obvious. As Plog, Plog, and Wait (1978:390) noted some years ago, "...unless the intensity of a survey is high many sites will be missed—not simply atypical or very small sites, but typical and relatively large sites. That is, the higher the intensity of the survey, the larger will be the number of sites that will be found." Likewise, in comparing the results of two surveys of the same area in southern Texas that were executed with different survey intensities, Thoms (1979:103) noted "...a direct correlation between a higher intensity survey and a higher density of sites. In other words, as the time spent examining the surface increased, so did the number of sites located and recorded."

Several archaeologists in the Southwestern United States have compiled data on this hypothesized relationship as a means of testing its validity. For example, Plog, Plog, and Wait (1978:391) compiled a list of 12 large-scale archaeological surveys from which they were able to extract data on survey intensity (person days/sq mi) and site density (number of sites/sq mi). A scatterplot of these data show a positive linear relationship having a Pearson's product-moment correlation coefficient of 0.888 (significant at the 0.01 level) for all prehistoric sites. In a slightly different vein, Schiffer and Wells (1982:353) compiled data from 12 archaeological survey projects regarding survey effort (number of person-days expended/sq mi), crew spacing (in meters) and site density (number of sites/sq mi). They show that the relationship between crew spacing and survey effort, while seemingly direct, is actually curvilinear in nature (Schiffer and Wells 1982:352) such that progressively smaller crew spacing (ranging from 50 m to 10 m) results in only gradual increases in survey effort until intervals of less than 10 m are achieved, at which point level of effort increases dramatically. This phenomenon may be due to greater attention paid to the discovery and recording of "nonsite" data in certain surveys, or alternatively, to genuinely low site densities in the study area, which would require shorter crew spacing and slower inspection procedures in order to locate sites at all. Judge (1981:129) has argued that increasing survey intensity involves a "point of diminishing returns;" i.e., a point beyond which surface survey will be nonproductive. While it is true that "as intensity of survey increases, so does the frequency of sites discovered..." (Judge 1981:129), there is an upper limit placed on the effectiveness and productivity of the search procedure. "Even though survey intensity can be increased beyond this point, the information return becomes increasingly less productive due to the limitation on *sites visible from the surface*" (Judge 1981:129; emphasis added).

In recent years, and largely as a result of the increased use of subsurface testing programs, the issue of survey intensity has come into even sharper focus due to the greatly reduced "inspection window" that results from subsurface probing (Wobst 1983). It should be noted that subsurface testing surveys can involve a variety of specific techniques each having different properties, relative site discovery efficiencies, and different costs. To avoid confusion, these are collectively referred to herein as *shallow subsurface testing (or SST) surveys* in that they range only from 50 to 100 cm below the surface and are generally limited to no more than 75 cm in depth. In order of their relative size or inspection window, these techniques can be roughly divided into the following:

1. *shovel-testing* (Dincauze et al. 1980; Gatus 1980; Lynch 1980; Spurling 1980; Stone 1981a; Nicholson 1983; Krakker, Shott, and Welch 1983; McManamon 1984a, 1994; Shott 1985,1989; Nance and Ball 1986, 1989; Lightfoot 1986, 1989; Hasenstab 1986);

2. *postholing* (Fry 1972; Wood 1976; South and Widmer 1977; Nicholson 1983; Wesler 1984; Abbott and Neidig 1993);
3. *shallow coring* (McManamon 1984a; Stein 1986, 1991; Schuldenrein 1991; Hoffman 1993); and
4. *augering* (Baker 1980; Deagan 1981; Nicholson 1983; McManamon 1984a; Stein 1986, 1991; Whalen 1990; Schuldenrein 1991; Howell 1993).

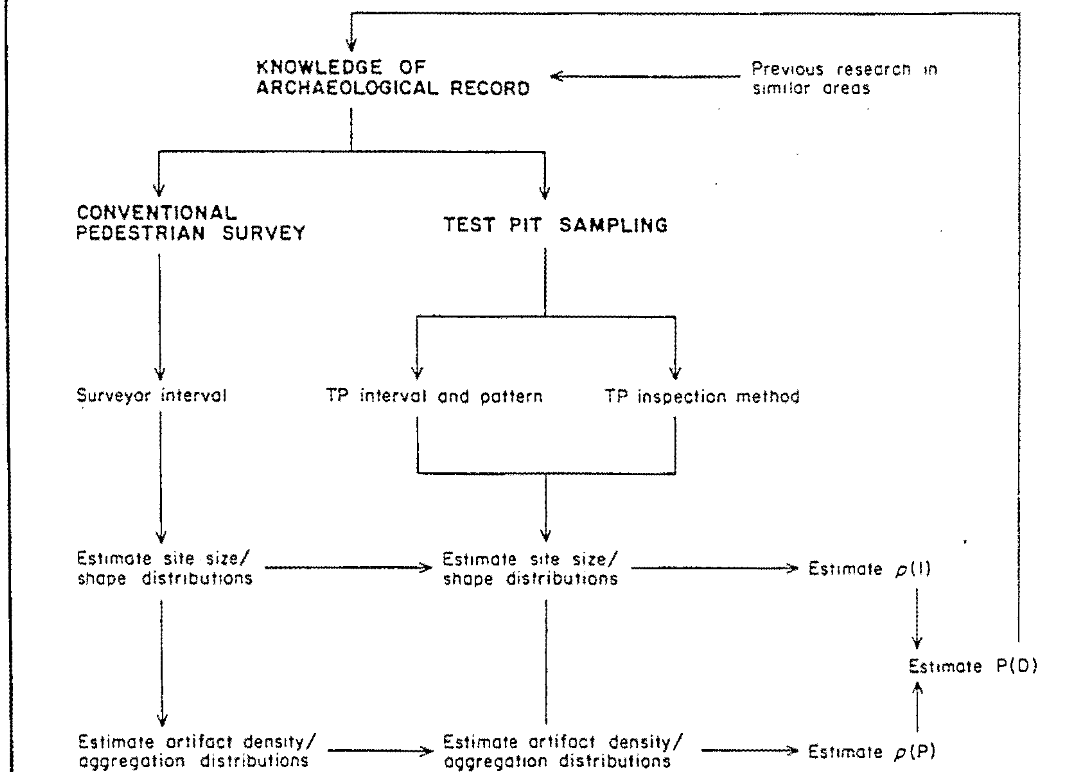
Clear distinctions must also be made as to what *type* of shovel-testing is implied. Chartkoff and Chartkoff (1980), for example, distinguish between "shovel-scraping" (involving a simple scraping of the land surface to clear away vegetation and other debris in search of cultural material), "shovel-divoting" (involving the rapid overturning of soil to the depth of the shovel blade in search of cultural material), and "shovel-probing" (involving the formal, if rapid, excavation of small test units, usually on a systematic grid placed over the survey area). Most archaeologists use the terms *shovel test-pit (STP)* or *shovel-testing* to refer to the latter. Nance and Ball (1986) use the term *test-pit sampling (TPS)* in referring to shovel-testing (see Figures 2 and 3 herein). Such test units can vary considerably in size, from as large as 1 m x 1 m (e.g., Spurling 1980) to 40 cm x 40 cm (e.g., McManamon 1984a), with depths ranging from 10 to 15 cm to 75 cm. Some prefer to execute neatly squared probes to reveal profiled sidewalls, while others prefer a more rapidly executed circular shape. Other variables include the degree to which the fill is inspected for cultural material; i.e., whether it is screened with hardware cloth, trowel-sorted, or only visually inspected as excavation proceeds. Finally, archaeologists vary in the nature of the data that they routinely record on each probe, such as sediment descriptions, rapid profile sketches, in-field tallying and description of cultural materials encountered, etc.

To this array of SST techniques we can also add mechanized techniques for shallow small-scale trenching operations, either with a backhoe or a pipe-trenching device such

PROBABILITY COMPONENT	PROPERTIES OF SAMPLING DESIGN	PROPERTIES OF ARCHAEOLOGICAL REMAINS
Intersection p (I)	Geometry Test pit interval Test pit pattern	Configuration Size Shape
Productivity p (P)	Inspection method Size of test pits Recovery method	Statistical properties Artifact density Spatial clustering

(Source: Reproduced by permission of the author and the Society for American Archaeology from *American Antiquity*, vol 51, no. 3, 1986.)

Figure 2. A formal model of test pit sampling.



(Source: Reproduced by permission of the author and the Society for American Archaeology from *American Antiquity*, vol 51, no. 3, 1986.)

Figure 3. The role of TPS in archaeological survey.

as a "ditch-witch" (Odell 1992). These will not be dealt with here, however, as they are primarily used as intrasite exploration techniques and only rarely in areally extensive site discovery operations, which are the focus of this report.

Increased use of these subsurface inspection techniques in archaeological survey has led to a more formal statistical treatment of site discovery and the calculation of *discovery probability.* Nance (1983:291-292) defines the latter as "the likelihood that cultural remains of interest will be detected within a sampling domain or sampling unit using a specified sampling procedure, given a certain level of sampling effort." This definition applies equally to pedestrian and subsurface survey techniques. In the case of subsurface testing surveys, discovery probability, p(D), can be viewed as the product of two independent probabilities: *intersection probability*, p(I), and *productivity probability*, p(P) (Shott 1985; Nance and Ball 1986:459; see Figure 2). The former refers to the probability that "a test pit intersects a site," while the latter, also termed *detection probability* by Krakker, Shott, and Welch (1983) and Shott (1985, 1989), refers to the probability that "a test pit yields artifacts, given that it has intersected a site surface" (Nance and Ball 1986:459). The important point is that these two probability components depend on properties of a given sampling design as well as properties of the archaeological record. As Figure 2 illustrates, intersection probability is affected by the geometry of the sampling design (i.e., test pit spacing and layout) as well as the configurational properties of the archaeological remains (i.e., the size and shape of archaeological sites and their defining characteristics). In a similar fashion, productivity probability depends on the inspection method of the sampling design (i.e., the size of the test pits and the sifting and recovery methods used) as well as the statistical properties of internal site structure (i.e., artifact/feature density and their degree of spatial clustering).

While full consideration of these independent probabilities is absolutely essential for conducting accurate and reliable subsurface surveys in areas of obscured or buried archaeological remains, it also is highly relevant for pedestrian surveys. Although several archaeologists have examined the properties of sampling design (search geometry and surface inspection method) for their effects on discovery probabilities in the context of surface surveys, very few have considered the effects of the archaeological remains themselves (site configuration and the statistical properties of internal site constituents). As Nance and Ball (1986) argue, both sets of properties should be routinely considered in evaluating both pedestrian and subsurface survey results (see Figure 3). As our knowledge of the archaeological record in a given area increases, "cyclical estimates of site size/shape distributions and artifact density/aggregation distributions" should accumulate, permitting progressively more "accurate estimates of the parameters of the archaeological record" (Nance and Ball 1986:478). These estimates can then be used to refine earlier estimates of the intersection, productivity, and overall discovery probabilities "so that more effective TPS [SST herein] and pedestrian surveys may be designed, or to estimate approximate biases for a given sampling design" (Nance and Ball 1986:478). As stated earlier, greater effectiveness and objective bias assessment in archaeological inventory survey are central concerns of the present project.

In spite of ongoing controversy over the effectiveness and overall utility of subsurface testing as a site discovery technique (Keller 1982; Krakker, Shott, and Welch 1983; Wobst 1983; McManamon 1984, 1994; Shott 1985,1989; Nance and Ball 1986, 1989; Lightfoot 1986, 1989), it is still the only practical alternative for systematic site survey in areas where pedestrian surface inspection is made impossible either by depositional processes or by dense vegetation.

While subsurface testing is admittedly not a very effective technique for intersecting and detecting small sites (i.e., less than 30 m in diameter) with low artifact densities distributed in highly clustered fashion, even in these cases the technique permits reasonable estimation of the probability of not finding them, and is thus preferable to unsystematic search techniques, or worse yet, total avoidance. To quote Nance and Ball (1989:411) on this point:

> What we recommend...is responsible and enlightened use of TPS [SST herein] in conjunction with other search techniques. The usual responses to heavily vegetated areas are either to avoid them if at all possible, or to search only those parts of the area with surface exposures (or to sit around waiting for the heavy equipment to create surface exposures). We feel that a more reasoned, systematic, and aggressive approach is desirable. Hence, we would search surface exposures and examine a survey area, both exposed and obscured parts, using shovel tests (and screens) as well, in an effort to discover as many sites as possible...In short, we recommend imaginative, inventive, and wise use of TPS to help in compensating for the limitations of any single technique in situations that may be physically and intellectually challenging, and therefore demand extraordinary resourcefulness.

Regional Trends in Archaeological Survey Design

With these considerations in mind, it is useful to examine data on archaeological survey design and execution from different regions throughout the United States to illustrate some of the issues surrounding survey intensity and the inherent differences in pedestrian versus subsurface survey methods. Table 5 provides a listing of selected data and results from 62 archaeological survey projects from eight culture areas of the United States, as follows: the Northeast (5 surveys); the Southeast (14 surveys); the Plains (11 surveys); the Great Basin (12 surveys); the Southwest (14 surveys); California (2 surveys); Plateau (2 surveys); and the Northwest Coast (2 surveys). Publication dates span a 15-year period, ranging from 1975 to 1990. Data categories include the Total Area Surveyed (in square miles), the Spacing (in meters) between crew members or subsurface tests (depending on the survey method), the Level of Survey Effort (calculated as number of person-days expended per square mile, after Schiffer and Wells 1983), the Site Discovery Rate (calculated as number of *prehistoric* archaeological sites discovered per person-day, after Schiffer and Wells 1983), the Mean Site Density (calculated as the average number of *prehistoric* archaeological sites per square mile), and finally the Survey Method (whether pedestrian survey or some form of shallow subsurface testing survey). Historic archaeological sites were not included in calculations of Site Discovery Rate and Mean Site Density due to the fact that several of the monographs consulted were not clear on whether the historic sites were later components of prehistoric sites or whether they were exclusively of historic origin. This lack of consistency in defining and reporting historic period sites and artifacts has also been noted by Zubrow (1984) in a comparative study of CRM contract reports in New York and Colorado. Historic sites were thus eliminated from the site tallies for this report so as not to artificially inflate the number of sites discovered. In

Table 5. Selected archaeological survey projects in eight culture areas of the United States showing various aspects of methodology and results.

Reference	State	Area Surveyed (sq mi)	Spacing (m)	Level of Effort (p-d/sq.mi.)	Discovery Rate (sites/p-d)	Mean Site Density (sites/sq.mi.)	Survey Method
Northeast							
O'Brien et al (1982)	MO	44.4	20	20.1*	0.4*	7.9	PED/SST
Canouts (1984)	IL	1.3	14?	64.7	1	64.7	SST
McManamon (1984)	MA	1.6	25	43.4	0.53	121.7	"
Lightfoot et al. (1987)	NY	0.2	10	1300.2	0.14	176	"
Webb et al (1989)	IL	1	n/r	n/r	n/r	36.3	"
Southeast							
Schiffer & House (1975)	AR	13.6	60	6.7*	0.9*	6.25	PED
House & Ballenger (1976)	SC	0.4	15	225	1.76	47.5	SST
Taylor & Smith (1978)	GA/SC	17.4	50	13.8	1.9	25.6	PED/SST
Rodeffer et al (1979)	SC	7.35	15	64	0.8	48.7	PED
Kohler et al (1980)	GA/AL	16.2	30	32	0.1	3.2	"
Waselkov (1980)	AL	10	20	20.1*	0.2*	4	"
Butler et al (1981)	KY	0.9	5	80.4*	0.13*	10.9	"
Lafferty et al (1981)	AR	6.6	25	53.9	0.07	4.1	"
Early & Limp (1982)	AR	1.9	5 to 50	25.6	0.85	38.4	"
Servelio (1983)	LA	16.6	15	80	0.3	22.1	PED/SST
Thomas et al (1983)	GA/AL	3.4	30	13.4*	n/r	6.4	SST
Chapman & Kimball (1985)	TN	4.7	n/r	19.2	1.4	27.4	PED
Sussenbach & Lewis (1987)	KY	4	10 to 20	26.8*	0.33*	8.9	"
Moffat et al (1989)	MO	3.8	20 to 30	16.1*	0.4*	7	PED/SST
Plains							
Scott et al. (1982)	TX	3.9	30	13.4*	0.3*	4.1	PED/SST
Alexander et al. (1982)	CO	59.8	50-75	16.8	0.1	1.6	PED
Eddy et al (1982)	CO	9.8	25	56.1	0.2	11.3	"
Raab et al (1982)	TX	78.4	10	12.5	0.5	5.7	"
Carlson et al (1986)	TX	37.5	30	35.6	0.19	6.7	PED
Carlson et al (1987)	TX	16.2	30	27.2	0.15	4.1	"
Carlson et al (1988)	TX	32.4	30	20.5	0.15	3.1	"
Koch & Mueller-Wille (1989a)	TX	14.6	30	22.9	0.07	1.7	"
Koch & Mueller-Wille (1989b)	TX	25.9	30	18.9	0.2	3.05	"
Lebo & Brown (1990)	TX	21.4	30	13.4*	0.2*	3.2	PED/SST
Mueller -Wille & Carlson (1990)	TX	6.5	30	31.9	0.15	4.9	PED
Great Basin							
Coombs (1979)	CA	26.6	50	23.7	0.11	1.9	PED
Hauck (1979a)	UT	74.5	5 to 20	12.8	0.4	5.1	"
Hauck (1979b)	UT	42	5 to 20	22.4	0.36	8.3	"
Thompson (1979)	UT	16.9	15	14.2	0.9	12.9	"
Reed & Nickens (1980)	UT	22	17	12.8	0.003	1.9	"
Larralde & Chandler (1981)	UT	17.1	15	17.9	0.1	1.9	"
Toepel & Beckham (1981)	OR	2.2	15 to 20	35.7	0.74	26.4	"
Black & Metcalf (1986)	UT	13.9	15	26.8*	0.36	9.6	"
Bradley et al (1986)	UT	0.6	15	32	0.53	14.4	"
Larralde & Nickens (1986)	UT	20	15	15.4	0.083	1.3	"
Gallegos et al (1988)	LA	21	50	12.8	0.31	3.8	"
Tipps (1988)	UT	80.6	15	16	0.12	5.8	"
Southwest							
Hurlbett (1976)	CO	62.9	5	25.4	0.08	2	PED
Rodgers (1976)	AZ	20.7	n/r	4.8	2	9.7	"
Fuller et al. (1976)	AZ	4.5	7.5 to 37.5	32	0.6	19.2	"
Reher (1977)	NM	68.5	32 to 40	14.8	0.3	4.3	"
Biella & Chapman (1977)	NM	14.2	10 to 15	19.5	0.9	18.6	"
Plog (1978)	AZ	2.8	11	71.4	0.2	12.1	"
Hayes et al (1981)	NM						
Transect		19.8	40	11.7	0.7	6.5	"
Inventory		32	8 to 30	34.4	1.5	52.8	"
Eidenbach (1982)	NM	16.1	25	35.9	0.3	9.6	"
Wait & Nelson (1983)	NM	22.8	10 to 15	20.8	0.2	4.8	"
Marmaduke & Conway (1984)	AZ	2.2	15	89.9	n/a	n/a	"
Kane et al. (1986)	CO	3.7	15 to 20	94.2	0.2	16.5	"
Kayser & Carroll (1988)	NM	6.8	20 to 25	17.9*	1.7*	29.8	"
Seaman et al (1988)	NM	5.4	33.3	212.8	1.6	340.6	"
Anschuetz et al. (1990)	NM	8	20	50.25	1.05	52.8	"
Plateau							
Hartmann (1985)	OR	14	10 to 30	20.1*	0.2*	3.8	PED
Oetting (1989)	OR	17.6	30	13.4*	1.16*	2.65	"
Northwest Coast							
Jones et al. (1978)	WA	0.7	5 to 20	69.6	0.4	27.5	PED
Cheatham (1988)	OR	12.3	30	13.4*	0.5*	6.5	"
California							
Bettinger (1977)	CA	3.3	50	81.8	0.2	18.5	PED
Cook & Fulmer (1981)	CA	11.2	50	20.4	0.9	18.9	"

cases of pedestrian survey where no data was provided on number of person-days expended, Level of Effort was estimated using the method suggested by Schiffer and Wells (1983:352), where Survey Effort = 402/crew spacing (indicated in Table 5 by values followed by an asterisk). In some cases these estimates were also used to calculate the associated Discovery Rate. As Schiffer and Wells (1983) carefully point out, these estimates are subject to the vagaries of extraneous variables such as low accessibility and lengthy site recording time, and in such cases should be corrected accordingly. According to Schiffer and Wells (1982:352), "a good rule of thumb is that a large-scale pedestrian survey using 20 m intervals requires about 20 person-days/square mile under average conditions for areas of good visibility and fairly low resource densities." This algorithm will be explored in greater detail in the discussion of cost estimation for pedestrian surveys in Chapter 5. Table 6 provides the means, standard deviations, and sample sizes for these data categories by culture area.

Turning to the data presented in Table 5, the most useful comparisons can be made between the surveys in Northeast and Southeast on the one hand, and those of the Plains, Great Basin, and Southwest, on the other. These two macro-areas illustrate the greatest differences in survey design and site discovery procedures and they also demonstrate interesting internal variability, as discussed later. The culture areas of the Plateau, the Northwest Coast, and California are included in Tables 5 and 6 for general comparison, but samples sizes are too low to conduct detailed evaluations.

In the Great Basin and Southwest, pedestrian surface inspection methods were used exclusively, while in the Southeast and Northeast, due to dense ground cover and generally low visibility, SST methods were either used exclusively or were combined with surface inspection where surface visibility permitted. In the Plains, most surveys were conducted with pedestrian surface inspection techniques. For the two exceptions where SST procedures were used (Scott et al. 1982; Lebo and Brown 1990), no meta-data were provided regarding person-day labor expenditures. Thus the Schiffer/Wells algorithm for estimating level-of-effort in pedestrian surface survey was used and no doubt underestimates real labor expenditures by a considerable margin. As a general rule, SST greatly increases the labor-intensity per unit area surveyed (see discussion by Lightfoot 1986), and this increase should manifest itself in a variety of ways, both in survey design (e.g., field logistics, labor costs, etc.) and in the results obtained.

Regarding the total area surveyed, it is important to note that in the Great Basin, Southwest, and Plains, the total areas surveyed are generally much larger than those in the eastern United States (see Tables 5 and 6). In the Great Basin (mean = 28.1 sq mi) and Plains (mean = 27.8 sq mi), survey tracts were over three times larger that their counterparts in the Northeast (mean = 9.7 sq mi) and Southeast (mean = 7.6 sq mi). For the Southwest (mean = 18.2 sq mi), survey tracts were between 1.9 and 2.4

Table 6. Mean, standard deviation, and sample size values for data categories listed in Table 5, grouped by culture area.

	Mean Area Surveyed			Mean Spacing			Mean Level-of-Effort			Mean Discovery Rate			Mean Site Density		
	x	s	n	x	s	n	x	s	n	x	s	n	x	s	n
Culture Area															
Northeast	9.7	19.4	5	17.2	6.6	4	356.9	629.1	4	0.5	0.4	4	81.3	67.6	5
Southeast	7.6	6	14	25.6	15.1	13	48.4	56.6	14	0.7	0.6	13	18.6	16.4	14
Plains	27.8	23.2	11	30.7	12.1	11	24.5	13	11	0.2	0.1	11	4.5	2.7	11
Great Basin	28.1	25.5	12	20.8	13.7	12	20.2	7.9	12	0.3	0.3	12	7.8	7.3	12
Southwest	19.4	20.8	15	20.8	10	14	49.1	53.1	15	0.8	0.7	14	41.4	87.7	14
California	7.2	5.6	2	50	0	2	51.1	43.4	2	0.5	0.5	2	18.7	0.3	2
Plateau	15.8	2.5	2	25	7.1	2	16.7	4.7	2	0.7	0.7	2	3.2	0.8	2
NW Coast	6.5	8.2	2	21.2	12.4	2	41.5	39.7	2	0.4	0.07	2	17	14.8	2

times larger than their eastern counterparts. Note that these differences are not so much a question of the total project study areas, but rather the proportion of that total study area that the archaeologists believed they could reasonably cover given finite amounts of time, money, logistical resources, and a specified level of survey intensity. As a preliminary interpretation, it seems likely that the severe limitations on surface visibility and accessibility in the eastern United States may be responsible for the generally smaller project study areas. Thus, implementing more labor-intensive subsurface testing procedures (even if combined with traditional pedestrian procedures) may substantially reduce either the sampling fraction selected for study in the case of probabilistic surveys, or the size of the study area defined for total coverage surveys. However, it must be pointed out that this interpretation is based on a very small sample of projects from the different areas and may be invalidated by larger sample sizes.

The most striking effect of the different labor intensities in surface and subsurface surveys is found, not surprisingly, in the category of Level of Effort. A rapid comparison of the values for the Great Basin, Southwest, and Plains, on the one hand, and the Northeast and Southeast data sets on the other, demonstrates notably higher figures for the latter, in which SST methods were used (see Tables 5 and 6). The Levels of Effort for the Great Basin projects and the Plains projects were comparable, with mean values of 20.2 person-days/sq mi and 24.5 person-days/sq mi, respectively. The mean value for the Southwest project was more than double those mean values, at 49.1 person-days/sq mi. This relatively high mean is largely due to an outlier value from an exceptionally intensive pedestrian survey carried out in the Tularosa Basin of New Mexico in which nonsite data collection strategies were used and site definition was carried out at a subsequent stage of analysis (Seaman, Doleman, and Chapman 1988). Level-of-effort for the Phase I survey was given as 212.8 person-days/sq mi (see Table 5). Even by removing this outlier, however, the Southwest data exhibits notably higher levels of survey effort than the Great Basin or Plains (about 37 p-d/sq mi). This fact may be due to a greater concern on the part of Southwestern archaeologists for attaining more intensive levels-of-effort, although the site recording time required for mapping and describing surface architectural features may also be influencing this higher mean value.

In contrast to the more arid areas west of the Mississippi River, the woodland areas of the Northeast, especially, and Southeast show higher levels-of-effort. The mean level-of-effort for the Southeast, where SST techniques are commonly incorporated into pedestrian surveys, is 48.4 p-d/sq mi (Table 6). This figure may be artificially depressed, however, due to the fact that in 6 of the 14 projects for which data was tabulated, the Schiffer/Wells algorithm for estimating level-of-effort was used and thus probably underestimated the true level-of-effort expended. Unfortunately, where SST techniques are used, little or no metadata are provided on their size, depth, spacing, and the total number of tests executed, so separate estimates of SST labor time cannot be computed. Where SST techniques are used exclusively, and the necessary metadata are provided on labor time, the level-of-effort is high (e.g., 225 p-d/sq mi, as reported by House and Ballenger 1976).

For the Northeast, the sample is extremely small and highly variable, but the average level-of-effort for four projects is 356.9 p-d/sq mi. The actual average should be considerably higher, however, due to an artificially low value for one of the projects. The survey by O'Brien, Warren, and Lewarch (1982) in the Prairie Peninsula area of Missouri covered a large area (44.4 sq mi) relative to the other Northeast projects examined, and used a combination of both pedestrian and subsurface testing survey procedures. Unfortunately no person-day per unit area figures are provided for labor expenditure. Thus the use of Schiffer/Wells algorithm for estimating pedestrian survey effort is dramatically underestimating real labor expenditure in this case because it is not accounting for time spent in shovel testing. The latter figure cannot be estimated since no metadata were provided regarding total number of probes executed, although information is available on shovel-probe volume (8000 cu cm), interval spacing (20 m), and sampling geometry (systematic grid). Given the relatively large area actually surveyed in this project and the fact that shovel probes were used in unspecified portions of the study, the real level-of-effort must be considerably higher than the value of 20.1 p-d/sq mi, which is derived from Schiffer/Well's formula.

In contrast to this, one of the Northeast SST figures is exceedingly higher than the rest. Lightfoot, Kalin and Moore's (1983; see also Lightfoot 1986) shovel-probe survey in Long Island had a level of effort of 1300 p-d/sq mi, indicating a rather extraordinary intensity of site discovery and site assessment procedures within a fairly limited study area (0.2 sq mi). This outlier value is probably much higher than that expended in most SST surveys conducted in the Eastern woodlands and it is obviously affecting the high mean value obtained for these projects. Even so, the average value of 356.9 p-d/sq mi may not be that far out of line, especially in cases where surveys must rely *exclusively* on SST procedures to locate sites. One Midwestern archaeologist with ample experience at SST survey has suggested that "costs increase approximately ten-fold [when] moving from straight pedestrian reconnaissance to systematic subsurface testing...techniques" (Dr. Kevin McGowan, Archaeologist, Coordinator for the Public Service Archaeology Program, University of Illinois, professional discussion, 1993). Thus, if pedestrian survey intensity were on the order of 36 p-d/sq mi, a figure in line with the levels-of-effort given in Table 5 for pedestrian surveys in the Southeast, then a ten-fold increase in level-of-effort would approximate the mean for SST surveys in the Northeast. In general, then, it appears that survey tracts in the Northeast and Southeast tend to be smaller than their counterparts in the Plains, Great Basin, and

Southwest. At the same time, levels-of-effort expended in Eastern woodland surveys tend to be higher due to the use of subsurface testing procedures either exclusively, or in combination with pedestrian survey. However, fairly high levels-of-effort are also reported for pedestrian surveys in the Southwest.

Another interesting difference between these areas has to do with Mean Site Density (Table 6). In this case, the Northeast and Southwest data sets display generally higher site densities than their counterparts in the Southeast, Great Basin, and Plains. The mean site density for the Northeast is 81.3 sites/sq mi (sd = 67.6; n = 5), while for the Southwest surveys, the figure is 41.4 sites/sq mi (sd = 87.7; n = 14). In contrast, the mean site density in the Southeast is only 18.6 sites/sq mi, and drops to 7.8 sites/sq mi for the Great Basin and to 4.5 sites/sq mi for the Plains (Table 6). Once again, due to small sample sizes, caution is warranted in using these data for interpretation, but the relationships are still noteworthy. Given these dramatic differences in mean site density, the question arises as to what factors, or combination of factors, are responsible for this variability. While some of the differences may reasonably be attributed to real differences in the archaeological records of the five areas, some of it may also be due to systematic biases in the way archaeologists conduct their surveys and record the results.

One problem is the way in which archaeologists define the concept of *site*, as discussed in Chapter 2, while another has to do with the search procedures used to find archaeological remains. If more inclusive definitions are used for determining what a site is, such that very small lithic scatters come to be included in that category, then clearly overall site density will increase dramatically. In the northeastern SST surveys, such definitions are common (see, for example, Lightfoot, Kalin, and Moore 1987). They appear to be increasingly common in Southwestern pedestrian surveys, as well (e.g., Anschuetz, Doleman, and Chapman 1990). Related to the issue of more inclusive site definitions is the nature of the SST method as a site discovery technique. As Lightfoot (1986) has argued, SST site density estimates will normally be of a much larger magnitude than those found by pedestrian techniques, say, in the Southwest. His average site density estimate for the Shelter Island shovel-testing survey in Long Island was 25 times greater than his estimate for an intensive pedestrian survey in the Pinedale locality of the Southwest. According to him, this discrepancy may be due to a tendency to record fewer and larger sites through pedestrian techniques, while SST surveys tend to locate numerous small sites (Lightfoot 1986). This fact argues strongly for the greater use of *site area* as an estimator of site density, rather than the number of sites. While Lightfoot's argument is much more detailed than the brief summary presented here, it is important to bear these differences in mind when comparing survey results from different regions where markedly different site discovery techniques were used.

The rather low values for mean site density in the Plains and Great Basin (Table 6) are possibly due to genuinely lower frequencies of sites in the archaeological record. However, given the tendency to survey larger tracts of land (27.8 sq mi and 28.1 sq mi, respectively), at generally lower levels-of-effort (24.5 p-d/sq mi and 20.1 p-d/sq mi), the low values may also be partially due to the design of the archaeological surveys themselves. The relatively low mean site density obtained for the Southeastern surveys (18.6 sites/sq mi) is somewhat unexpected (Table 6). However, it may be partially due to the inclusion in the sample of several exclusively pedestrian surveys (n = 9; see Table 5) where low surface visibility may have affected the ability of the archaeologists to locate all sites, or to the use of more exclusionary site definitions. Curiously, the figure of 18.6 sites/sq mi is remarkably close to the figures of 18.7 sites/sq mi obtained for California and 17.0 sites/sq mi obtained for the Northwest Coast (Table 6), both based on extremely small samples.

A related data set from Table 5 that is useful to examine in light of the preceding discussion is the six survey projects carried out on the Fort Hood military installation in the Plains culture area (Carlson et al. 1986, 1987, 1988; Koch and Mueller-Wille 1989a, 1989b; and Mueller-Wille and Carlson 1990). These projects represent different "survey tracts" that received total pedestrian coverage rather than probabilistic sampling coverage. It is instructive because in this case the pedestrian survey methodology and surface inspection procedures were held constant due to strict adherence to standard operating procedures (Briuer and Thomas 1986). Survey spacing was uniformly set at 30 m , although the size of the survey tracts varied (Table 5). While the sample is once again extremely small (n = 6), there appears to be a clear positive correlation between level of survey effort and mean site density. This relationship is depicted graphically in Figure 4. In only one case (survey D) is level of effort not positively correlated with site density. It is very likely that such slight differences in mean site density (ranging from 1.7 to 6.7 sites/sq mi) are due to real differences in the archaeological record across these six survey tracts. There is also a possibility, however, that the differences relate to the levels of survey effort expended in the different tracts, thus introducing an element of systematic error. Such bias can potentially be identified by carefully monitoring survey effort across different survey tracts. Regardless of the hypothetical presence or absence of systematic survey error in this case study, the intention of this discussion is not to criticize or otherwise impugn the solid efforts of the archaeologists who designed and carried out these surveys. On the contrary, it is only because they have provided such detailed metadata on survey logistics and labor costs that these questions can even be posed.

Another useful data set, this time from the Southwest, provides interesting temporal information on the increased levels of survey effort and corresponding increases in the mean site densities recovered by archaeological surveys in recent years, when

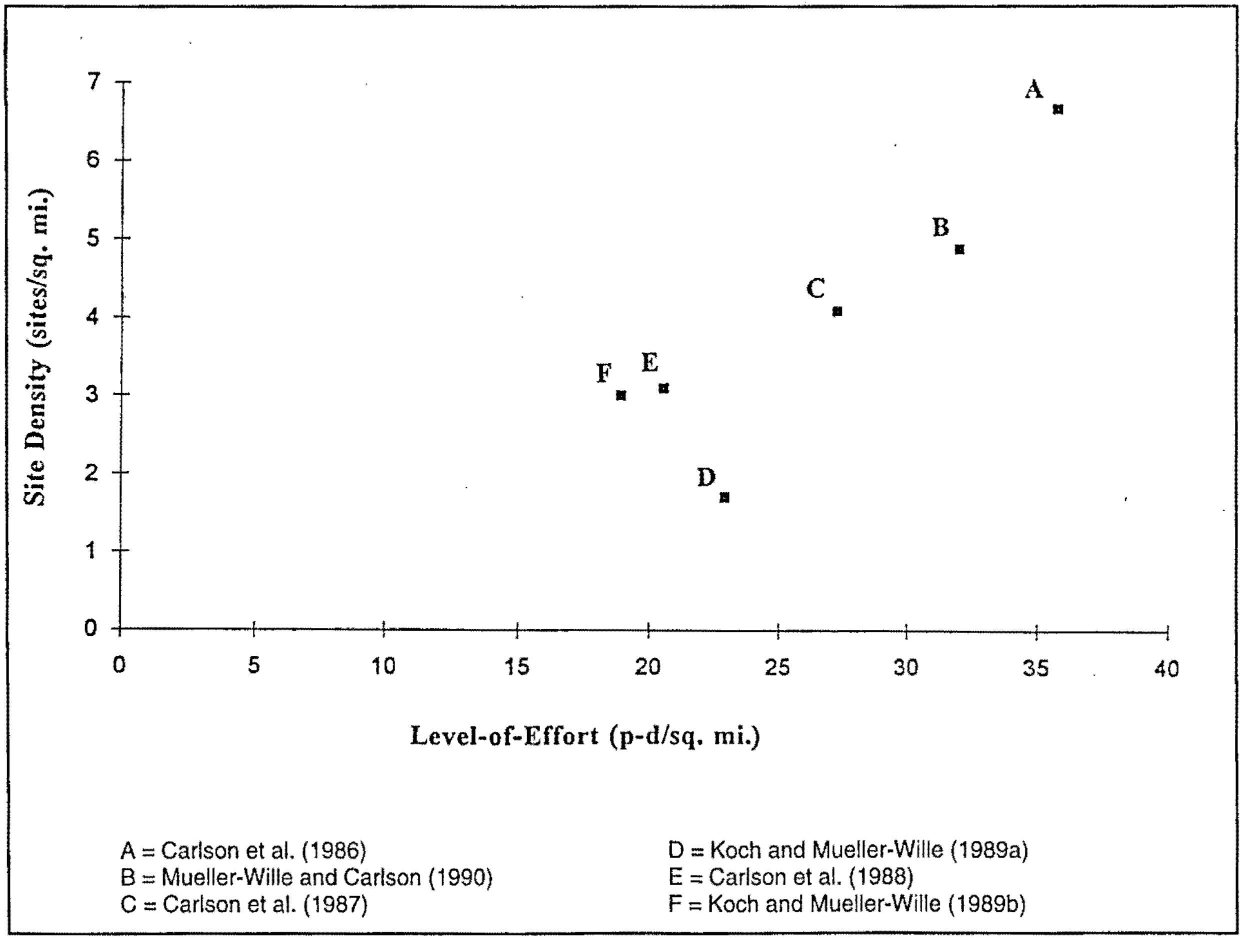


Figure 4. Scatterplot of six archaeological surveys conducted in different survey tracts of the Fort Hood military installation, showing positive correlation between level-of-effort and site density.

compared with the data compiled in the present report (Table 5). Schiffer and Wells (1982: Table 9) compiled a list of 12 archaeological surveys in the Southwest that gives values for Survey Effort, Crew Spacing, and Site Density. The publication dates of these surveys range from 1974 to 1980 with a mean publication date of 1977 (Schiffer and Wells 1982). By calculating mean values for their three data categories, we obtain a mean crew spacing of 25.3 meters (sd = 15.02), a mean survey effort of 27.6 p-d/sq mi (sd = 33.44), and a fairly low mean site density of only 4.29 sites/sq mi (sd = 2.44).

A comparison of these values with those given in Table 5 is revealing. In Table 5, the Southwestern survey projects range in publication date from 1976 to 1990, with a mean publication date of 1982. The list overlaps in time with that of Schiffer and Wells, but has a mean publication date 5 years later that the mean of 1977. It thus illustrates significant differences took place between the 1970s and 1980s in Southwestern archaeological survey design. Table 6 shows the mean values for the corresponding data categories tabulated in this study. Mean crew spacing decreases by 4.5 meters, down to 20.8 meters. Mean level-of-effort increases by over 1.8 times, to 49.1 p-d/sq mi. And finally, mean site density increases rather dramatically by 9.6 times, to a value of 41.4 sites/sq mi. These temporal data clearly demonstrate an increasing concern for survey intensity and level-of-effort that is quite obviously reflected in the number of sites found per square mile of area surveyed. The use of less restrictive site definitions in the 1980s may also be contributing to the elevated site densities.

As this brief discussion of small data sets from the North American archaeological literature has demonstrated, survey design and site discovery procedures can have significant effects on the results of regional archaeological surveys, not to mention the scientific interpretations and managerial decisions based on those results. Variable site definitions and variations in survey intensity have been cited as critical problem areas where some measure of standardization would be desirable. In the next chapter, survey effectiveness and bias assessment are discussed in terms of site discovery probability and the various factors that must be considered in estimating that probability. First, however, the next section explores how the identification of regional site constituents and intrasite spatial structure can aid in the development of survey design and in the calculation of discovery probability. This issue is illustrated through a comparative consideration of the archaeological sequences of two contrastive regions of the United States.

Defining Site Constituents and Intrasite Spatial Structure

For purposes of exploring site discovery probabilities in a given archaeological region, several sets of archaeological data are important. These include site size and shape, as well as several properties of the archaeological materials and residues that make up the site itself. The latter are collectively referred to as *site constituents* (McManamon 1984a) and include the following: artifacts; features; anthropic soil horizons; and chemical and geophysical soil anomalies. Finer distinctions among some of these include the properties of artifact density and density-distribution; tool density and density-distribution; and feature density and density-distribution. Another related category is item diversity (i.e., artifact, tool, and feature diversity), which can be further examined in terms of richness and evenness. These constituents have been treated in considerable detail by McManamon (1984a) among others, and provide useful criteria for the quantitative spatial characterization of an archaeological site. As McManamon (1984a:227) has argued: "the types, frequency, and intrasite spatial distribution of different constituents within a site strongly affect the likelihood of its detection." The implications of this observation are explored in greater detail below.

McManamon (1984a: p 229) notes that data on the relative frequency of occurrence artifacts, features, and anthropic soil horizons, is often difficult to find in excavation reports, although this situation has improved considerably in the ensuing decade. Where such data do exist, they support a "general impression of many archaeologists about the relative intrasite abundance and spatial distribution of these three site constituents" (McManamon 1984a:232-233). *Artifacts*, defined as "the portable products and byproducts of human activities" (McManamon 1984a:228), are almost always the most widespread and abundant of site constituents. Within this broad category, formal *tools* are important to distinguish from other kinds of artifacts since they generally carry a greater interpretive weight as consciously manufactured items having specifiable functions, stylistic information, and/or activity associations. They are considerably less abundant than the generic category of "artifact." *Cultural features,* defined as "sharply delimited concentration[s] of organic matter, structural remains, soil discoloration, or a mixture of these and artifacts" (McManamon 1984a:229), generally fall far behind artifacts in abundance but are nevertheless detectable by subsurface testing procedures (but cf. Hasenstab 1986). *Anthropic soil horizons*, in contrast, are defined as "extensive deposit[s] that might be sharply or diffusely delimited...[that] result from deposition of large amounts of organic remains in a roughly delimited, relatively large (compared to features) area" (McManamon 1984a:229). These phenomena are less well reported in the literature. More often than not their presence is simply noted and analytical attention is restricted to the artifacts or features contained within them; (see Carr [1982] for an important exception). In any case, like features, they "do not commonly approach the extended spatial distribution of artifacts and in some cases might not even exist in a site area or large portions of it" (McManamon 1984a:233).

In support of these relationships, McManamon cites three case studies from the eastern United States that employ different excavation techniques: horizontal stripping of large areas to expose site structure (Illinois); deep trenching in search of buried archaeological sites (Tennessee); and subsurface testing by shovel probes and small test pits (Massachusetts). At the Hatchery West site in Illinois (Binford et al. 1970), for example, 96 6 x 6m surface collection units were placed within the site area before horizontal stripping of the plow zone with mechanical equipment. McManamon (1984a:230) notes that for ceramic artifacts, "90% of the [surface-collected] area was covered by a surface distribution of 1 to 5 ceramic sherds per 6 x 6 m collection unit," or a density of 0.03 to 0.14 sherds/sq m. For chert chippage, 59 percent of the surface-collected area was covered by a surface distribution "of 10 or more per 36 m^2" (McManamon 19841:230), or a density of at least 0.28 lithic pieces/sq m. Ceramic sherds were thus more extensively dispersed over the site surface, but at lighter densities than the chert chippage. McManamon (1984a) argues that the frequencies per unit of both artifact categories "would have been higher and their spatial spread wider if the entire plowzone had been excavated and screened rather than only the surface artifacts collected." In contrast to these site constituents, feature density at Hatchery West was much lower, covering "only about 15% of the subplowzone surface of the stripped area" (McManamon 1984a). Similar relationships are pointed out for two Archaic sites in Tennessee excavated by Chapman (1981), where the excavated distribution of the most frequent artifact type was compared with that for cultural features (McManamon 1984a). At one site (Big Bacon), general cultural debitage occurred in 94 percent of the 5 x 5 ft excavation units and had a mean density of 61 artifacts per 25 sq ft, or 0.23 artifacts/sq m. Features, on the other hand, occur in 61 percent of the excavation units and exhibit a mean density of 1.1 features per 25 sq ft, or 0.004 features/sq m. Likewise, at the other site (Iddins), bifacial thinning flakes were shown to occur in 94 percent of the excavation units at a (converted) density of 0.54 artifacts/sq m. Features, on the other hand, occurred in 67 of the excavation units at a (converted) density of only 0.005 features/sq m. As these values demonstrate, the two sites are quite comparable in their overall artifact and feature densities. Anthropic soil horizons, while widespread at both sites, are shown to be less extensive than was the spread of artifacts (Chapman 1981; McManamon 1984a).

These relationships between the relative frequencies of different site constituents, while certainly not new in the archaeological literature, are emphasized here because they have important implications for site discovery probability. Because artifacts are the most abundant site constituent, they are also the most potentially *discoverable* by initial SST procedures during intensive inventory survey. They are therefore more likely to reveal the presence of an archaeological site with a lesser amount of search intensity than are the other site constituents. This point has been explored in some detail by Hasenstab (1986), who suggests that feature detection (as well as tool detection) are better left for subsequent site assessment procedures after the site has been located, since shovel-probe surveys may not be the most adequate search technique for this task. The importance of features as a site constituent with a high "information load" cannot be overestimated, however, and several archaeologists have concerned themselves with the sampling requirements of intrasite feature discovery in Phase II (site assessment) and Phase III (comprehensive data recovery) archaeological investigations; (see, for example Abbott 1985, Drennan 1987, Shott 1987, Whalen 1990, Hoffman 1993, and Howell 1993).

The spatial distribution of these site constituents, together with the combinations and recurrent associations of these different classes of data, permit the inference of *site structure* (Binford 1978, 1983, 1987; Anderson 1982) or more precisely, *intrasite spatial structure*. Site structure can be defined as the spatial patterning of artifacts, features, and anthropogenic soil anomalies, as well as recurrent associations between any of these site constituents. Models of intrasite spatial structure can be derived from ethnohistoric, ethnographic, and ethnoarchaeological research, or they can be empirically determined from spatial analysis of archaeological data. This type of background research on the local or regional archaeological record should be conducted in the planning stages of an intensive survey. The results should form an integral part of the survey research design as a means of defining the targeted archaeological resources that the survey is designed to locate and identify. Archaeological literature on this topic is quite extensive and a comprehensive treatment is well beyond the scope of this document. A few examples will be mentioned here for their pertinence to questions of site discovery probability and the Illinois and Utah case studies discussed in the following section (see also Volumes 2 and 3).

Perhaps the most common spatial pattern observed in the physical layout of archaeological sites as well as ethnoarchaeologically documented settlements of prestate and preindustrial societies is based on a concentric annular model of multiple activity spaces and differential deposition of cultural debris and residues. The most notable aspect of this differential deposition has to do with the size-sorting of cultural residues and the locational discreetness of primary "micro-refuse" versus secondary "macro-refuse" (Binford 1978, 1983; Hayden and Cannon 1983; O'Connell 1987; Simms 1988; Simms and Heath 1990; Stevenson 1991). This basic "ring model" has been applied to archaeological sites of varying size and internal complexity in societies with fundamentally different subsistence bases, settlement systems, and levels of social and political complexity. These include nuclear family or multifamily hunter-gatherer camp sites (Binford 1983; Chatters 1984; Carr 1991), sedentary or semi-sedentary homestead sites characterized by a "household cluster" (Winter 1976; Benn 1990; Simms and Heath 1990), and entire villages or "plaza communities" of sedentary agriculturalists (Dunnell 1983; Zeidler 1984; Oetelaar 1993).

One of the most interesting properties of this annular model from the perspective of site discovery procedures and probability estimation has to do with the relative proportion of "empty space" within the site boundary, or in Yellen's (1977:103) term, the *absolute limit of scatter* (ALS). That is, the spatial dispersion of artifacts and cultural debris across a site is often discontinuous, regardless of the overall artifact density. In areas where subsurface testing procedures are required either due to dense ground cover or deeply buried sites, this phenomenon takes on special importance. Thomas (1986) provides empirical evidence for "empty spaces" in small, short-term, single occupation sites in the Northeast United States and on the basis of ethnoarchaeological analogies, concludes that the typical hunter-gatherer camp, occupied by two to seven nuclear families, consists of a "nuclear area" of 5 to 7 meters in diameter, surrounded by a peripheral activity zone, 20 m in diameter, which is *50 percent empty space* (Thomas 1986). Indeed, in his tabular summary of the Kung Bushman campsites studied by Yellen (1977), Thomas (1986: Table 1) demonstrates that for those sites the proportion of the site area (ALS) actually occupied by cultural debris ranged from 19.0 to 47.6 percent. As Thomas (1986:119) notes, such discontinuity in the spatial patterning of artifacts on small single occupation sites has the advantage of facilitating the analytical isolation of discrete activity areas. However, a major disadvantage of "spatial discontinuity, and particularly the fact that greater than 50% of the [site] area...within many short-term sites may be devoid of archaeological remains,...[is] that such sites are difficult to locate" (Thomas 1986:119) through SST procedures. To quote Thomas further on this point:

> Where our models indicate that small sites are to be expected in a specific study area, our sampling strategy must be designed to insure a high probability of finding those 20-50 m^2 nuclear activity areas where artifact density is reasonably high, even though the absolute limits of the site (ALS) might encompass 200-1000 m^2. *We must find the sites in spite of the holes within them* (Thomas 1986:119; emphasis added).

The implications of this phenomenon for site discovery through SST procedures are stated as follows:

> ...Where subsurface sampling using small test pits is the only means available for finding buried sites, the use of sample intervals greater than 8-10 m. virtually insures that most single occupations will remain undiscovered unless such occupations overlap one another...Furthermore, given the tight clustering of lithic debris which appears to be characteristic of single occupation sites, the recovery of only one or two flakes in a preliminary test pit should not be discounted as insignificant until a more intensive exploration of the adjacent area can be carried out (Thomas 1986:119).

It is clear from these statements that site size and sampling geometry (intersection probability) alone are inadequate indicators for determining the presence or absence of an archaeological site (cf. Sundstrom 1993). Discovery probability must also account for artifact detection probability and the statistical properties of the archaeological remains themselves (i.e., intrasite artifact density and density-distribution). It should also be noted that "empty spaces" in the spatial dispersion of artifacts and features are by no means limited in their occurrence to small, short-term occupation sites such as those described by Thomas (1986) for the Northeast United States. They can also be clearly observed in the artifact density mapping of larger "homesteads" or seasonally occupied campsites, such as the Orbit Inn site (Utah) studied by Simms and Heath (1990:Figures 3-6), and at larger village configurations of sedentary agriculturalists, such as those of the "Fort Ancient" Mayo site (Kentucky) studied by Dunnell (1983:Figures 6-13) and the "Mississippian" Bridges site (Illinois) studied by Oetelaar (1993:Figures 4-6). What merits further study is the degree to which the "50% or greater" empty space suggested by Thomas for small campsites is maintained or altered as site sizes become progressively larger.

For all sizes of single component or single occupation sites, only certain areas of a given site may have densities high enough to detect with SST procedures. If up to 50 percent of a site surface is "empty space" and much of the rest has low artifact densities, then we have to be sure interval spacing will at least pick up core areas of higher artifact density. This means that *maximum* site size (ALS) may not be the most appropriate analytical unit in all cases. As artifact densities become lower and artifact density-distributions become more clustered or tightly packed over the site, proportionally more of the site surface will be comprised of "empty space" devoid of the archaeological remains that would normally indicate the presence of a site. Where large empty spaces occur within a site boundary, the archaeologist must define the SST sampling requirements necessary to argue that a given number of negative shovel-probes permits one to conclude that no sites exist. Alternatively, if a single artifact is located in one shovel probe, one needs to know how many negative shovel probes in the surrounding area are necessary to conclude that the artifact represents an isolated find (Stone 1981b; Hasenstab 1986). As Hasenstab (1986:3; emphasis added) has cogently stated the problem, we need to establish "exactly how much *negative evidence*...[is] required to reliably claim *absence* of significant data."

Site Discovery in the Eastern Woodlands and the Desert West

In this section, the general dichotomy between site discovery procedures in the eastern and the western United States suggested in the earlier treatment of Tables 5 and 6 will be further explored in light of the preceding discussion of site constituents, intrasite spatial structure, and discovery probability. This will be accomplished by focusing on two specific archaeological regions that demonstrate significant differences both in the nature and complexity of their respective archaeological sequences, and in the landscape conditions that often dictate the kinds of site discovery procedures used in regional surveys. For this purpose, the two regions selected are the "Illinois" archaeological region (primarily the state of Illinois) of the Northeast culture area (see Trigger 1978), and the "Eastern Great Basin" archaeological region (primarily the state of Utah) of the Great Basin culture area (see D'Azevedo 1986). Pertinent comparative data from these two archaeological regions have been amassed in Volumes 2 and 3 according to the data categories listed in Table 3. These compendia permit the development of regionally and temporally sensitive models of archaeological site characteristics and intrasite spatial structure. As such, they serve as examples of the kind of archaeological background research necessary to calculate regional or local site discovery probabilities. They also illustrate the uneven nature of past survey and excavation reports and the difficulties involved in extracting the desired information on site constituents and intrasite spatial structure for all time periods throughout a specified region.

The "Illinois" archaeological region and the "Eastern Great Basin" archaeological region show a number of interesting contrasts. In fact, it is hard to imagine two archaeological regions more different for purposes of examining site discovery probabilities. Beyond the rather obvious physiographic differences in land surface conditions lie the relative complexity of their respective archaeological sequences, as well as the intensity and volume of archaeological research and reporting. Zubrow (1984) provides a similar contrast in a review of contract survey reports from the states of New York and Colorado published between the mid-1960s to 1982.

Whereas the Illinois sequence is conventionally subdivided into nine well-defined periods spanning from about 12000 Before Present (BP) to the present century (Paleoindian; Early, Middle, and Late Archaic; Early, Middle, and Late Woodland; Late Period/Mississippian; and Historic), the comparable time span in the Eastern Great Basin is comprised of only four major periods (Paleoindian, Desert Archaic, Formative, and Historic). Internal phasing of these periods is likewise variable in spatial complexity and temporal resolution. Whereas the former experiences a great deal of temporal instability and rapid evolutionary jumps, culminating in the development of perhaps the most complex hierarchical social formation in North America (i.e., the Cahokia-area sociopolitical system [Bareis and Porter 1984a; Fowler 1989; Milner 1991; Pauketat 1994]), the latter exhibits relative stability over time in basic subsistence adaptations and level of sociopolitical complexity. These differences are reflected quite noticeably in the archaeological record with respect to regional site densities, site diversity, site size/depth variability, the range and complexity of site constituents, and most especially, in the nature of intrasite spatial structure. In addition, different levels of research intensity and project volume probably affect the number of recorded archaeological sites in the two regions. For example, for the state of Illinois alone, there are over 30,000 recorded sites in the files of the Illinois Archaeological Survey as of 1993 (see Volume 2).

Concomitant with all of these distinctions, an even more striking difference can be found in the nature and design of archaeological surveys and in the specific site discovery procedures used in those surveys. With regard to the Illinois archaeological region, either probabilistic sample surveys or systematic inventory surveys have been the norm for locating archaeological sites for at least two decades (see Volume 2). Predictive models of regional archaeological site distribution have also been developed for the entire state, at least in preliminary fashion (Brown 1981). In particular, large, multi-year, CRM right-of-way surveys have resulted in significant contributions to the

Illinois archaeological record (e.g., Bareis and Porter 1984a). In the Eastern Great Basin, on the other hand, a considerable amount of archaeological knowledge is based on intensive excavations over the years at several cave sites and rockshelters where preservation of organic remains has been optimal. These sites are scattered throughout the state of Utah and occur in a variety of physiographic provinces and habitats (see Volume 3). Aikens and Madsen (1986:150) have defended this concentrated analytical attention at cave sites in the following manner:

> The greatest amount of data is derived from lake-margin cave sites around the Great Salt Lake. The larger number of excavations at these dry cave sites appears, superficially, to bias the record, but survey data suggest that the earliest and most persistent focus of human occupation was around lake margins. The larger amount of data from these areas probably represents a reality, not merely sampling bias.

Still, these sites are typically discovered either through purposive archaeological survey or, perhaps more often, on the basis of local informant interviewing. While such survey techniques are useful and certainly have their place in CRM research (Derry et al. 1985), they do not provide, nor are they a substitute for, *systematic regional coverage*. And while the Great Salt Lake cave sites have received proportionally more archaeological attention in terms of their regional or subregional context, the same is not true for the numerous excavated cave sites elsewhere in the state. In the absence of systematic regional survey data, the larger archaeological context of most of these sites is not well known. In a recent review of Great Basin archaeology, Bettinger (1993) comments on the lack of systematic regional archaeological survey in this area as follows:

> ...[A]lthough regional subsistence-settlement patterns remain a major focus of interest at the conceptual level..., the probabilistic regional survey—the archaeological means most appropriate to the study of such phenomena—is today not generally employed...As a result, Great Basin archaeology increasingly lacks an empirical basis for implementing its regional theory. The strategy continues to be used subregionally, especially in cultural resource management and academic programs that target communities or landforms (e.g., dry lakebeds, marshes, alpine steppes) too large to be studied *in toto*...It is important to do this kind of work, just as it is important to excavate single sites. The problem emerges when we obtain a local record and have no reliable basis for deciding how it fits in a larger regional system (Bettinger 1993:52-53).

The same can be said for many of the large, open-air, Fremont village sites. Virtually none of these were discovered through systematic regional survey, nor have any been studied after the fact from the perspective of a subsequent archaeological survey of the encompassing region. This sampling bias in the Fremont archaeological record has been characterized by one Eastern Great Basin archaeologist (Lohse 1980:49) in the following terms:

> As yet there have been no serious studies concerning prehistoric economy and settlement pattern within the Fremont cultural area. The meager information that has been available is not sufficient for any in-depth treatment. Further, no in-field investigation involving either subsistence or settlement pattern has even been attempted. Most of the excavated sites have been the product of salvage work with narrow research goals or the result of field schools with the primary objective centering on chronology. Sites have been considered as cultural phenomena isolated from their exterior world.
>
> Substantial biases exist in prior investigations of Fremont culture. First, sites have been treated as if they were developed in isolation from the surrounding cultural system. Second, a self-fulfilling prophecy has been established, wherein we know what a Fremont site is, so that is what we dig. Excavation has, with few exceptions, involved only "village sites." Other sites, i.e., open campsites, rock-shelters, etc., certainly elements of the Fremont cultural system, have not been touched upon. The result is our present [as of 1980], distorted view of Fremont.

Although these statements were published some 15 years ago, little progress has been made on this problem during the ensuing years. The point of excerpting the above statements of Bettinger and Lohse is not to denigrate the scientific value of the archaeological data acquired in these excavations, but rather to draw attention to probable sampling bias in the existing archaeological record of Eastern Great Basin prehistory and the systematic exclusion of other kinds of archaeological sites that may have made up part of the settlement-subsistence systems of the prominent sites that have been selected for excavation.

Another aspect of regional archaeological surveys in the Great Basin that is worthy of mention has to do with the definition of survey tracts or study areas that was alluded to in the earlier discussion of Tables 5 and 6. There is a tendency in some Great Basin (and Plains) surveys to define inordinately large survey study areas (in the millions of acres) which then require, due to financial and logistical constraints, the selection of probabilistic samples so small (e.g., 1-10 percent) that their survey results may not be truly representative of the total population of sites (e.g., Hauck 1979a, 1979b; Tipps 1988). These situations are largely the fault of the contracting agency (in this case the Bureau of Land Management) and are the unfortunate result of well-intentioned yet overly ambitious or inappropriate Scopes-of-Work and the contracted survey designs that they foster (Berry 1984; see also Fowler 1986). This problem will be treated in greater detail in Chapter 5.

Perhaps the greatest single difference in site discovery procedures between the Eastern Woodlands and the Desert West has to do with basic inspection method; that is, pedestrian survey versus shallow subsurface testing survey. While the former is limited to a two dimensional visual inspection of the exposed land surface only, the latter permits a three dimensional visual inspection of the surface and immediate subsurface, but in an extremely small "inspection window" (Wobst 1983) resulting from test-pits, shovel probes, portholes, or core/auger holes. The two methods are thus fundamentally distinct in their observational capacities and yield results that are not entirely comparable; (e.g., artifact densities measured in square meters versus cubic meters). Both methods permit the discovery of archaeological sites under different land surface conditions, and both permit the delineation of site boundaries. In practice, many surveys in the Eastern Woodlands use SST procedures combined with conventional pedestrian methods, the former being applied only in those survey tracts where reasonably good surface visibility does not exist or where sites are thought to be buried by geomorphic processes. In the Desert West, however, SST procedures seem not to be routinely employed in the occasional situations where the *same obscuring conditions* might exist.

Apart from the obvious situations where dense vegetation may obscure the ground surface and impede thorough visual inspection by pedestrian methods, a more compelling reason for the increased need for SST procedures in the Desert West has to do with natural landscape alteration and the effects of geomorphological processes on the archaeological record of small, ephemeral occupations having relatively low artifact densities. Schuldenrein (1991) has provided the most forceful and convincing argument in this regard, as follows:

> ...[S]ite and settlement profiles in the [arid] west are often (but by no means exclusively) characterized by short-term, single-component occupations with minimal cultural inventories. Even special-activity sites with features may represent ephemeral occupations. Typically their extensive, unprotected surfaces are exposed to the erosional ravages of an expansive terrain (e.g., colluviation, sheetwash, deflation, and gullying). Erosional events are generally episodic and catastrophic (e.g., flash floods, dust storms, landslides), resulting in large-scale and rapid site destruction followed by burial beneath tens of meters of alluvium or redeposited sediment. The limited artifact configurations may be secondary, reflecting transformation by these post-depositional processes...Very often, the only site indicators are fortuitous artifact clusters in erosional pockets or at topographic breaks (Schuldenrein 1991:134).

> In remote settings subject to intensive sedimentation, the detection of small sites is difficult at best. Problems are exacerbated at still smaller sites where discrete cultural stains are absent. Compared to complex village sites along the Mississippi—where activity areas often are offset by rich organic middens, dense anthropogenic refuse, and subsistence remains that impart a singular, readily recognized texture to the matrix—the identifications of small, western sites becomes a prodigious challenge (Schuldenrein 1991:134).

> Sites [in the arid west] are generally small, short term, and contain minimal, often diffuse artifacts that may have been reworked locally by the winnowing action of stream flow. To identify sites it is necessary to recover as much sediment and cultural residue as possible. The subtle, often diffuse, articulations between the natural sediment and cultural residues at such sites are missed easily by standard [i.e., pedestrian] survey techniques... (Schuldenrein 1991:135).

In these situations Schuldenrein recommends the use of shallow subsurface testing procedures, particularly augering with a large diameter (4 in.) bucket auger (Schuldenrein 1991).

Other archaeologists have commented on the need for subsurface testing in certain areas of the western United States where either dense vegetation exists or where post-depositional processes have resulted in buried archaeological sites (e.g., Lightfoot 1989). In practice, however, it seems that once a pedestrian survey design is put into effect, no consideration is given to altering that procedure and applying subsurface testing when obscuring surface conditions are encountered. The obscured surface is simply walked and inspected under less than adequate conditions, or worse yet, it is effectively ignored as an "inaccessible" area within the survey tract. As Lightfoot (1989:415; emphasis original) has observed,

> ...[M]ost large-scale survey projects in the American Southwest crosscut a diverse range of plant communities, soil types, topographic features, and drainage systems. Ground visibility and the potential for buried remains vary accordingly. Yet southwestern archaeologists rarely consider the probability that material remains will be buried, or that these probabilities will vary across different habitats. In truth, parameter estimates for surface surveys need to take into account the probability of *not* discovering buried remains. Otherwise surface surveys risk the problem of discovery bias, in which the most visible surface cultural remains are over-represented at the expense of buried ones.

There are also many habitats in the Eastern Great Basin where surface visibility is probably less than adequate for conducting pedestrian survey due to dense ground cover. These include wetland areas, riverine and lacustrine margins, well-watered slopes and canyons, alpine meadows, etc. For example, one archaeologist with experience in the Great Basin has observed that, "although surface visibility of arid portions of the western United States is generally excellent in the *lower* elevations, surface visibility in the mountainous higher elevations can be as poor as surface conditions in the eastern Woodlands" (M. Kodack, personal communication, 1993; emphasis original). In spite of these land surface conditions, virtually no systematic SST procedures have been carried out here. This point is clearly emphasized in Zubrow's (1984) comparative study of survey reports from the states of New York and Colorado published between the mid-1960s and 1982. "In New York, 56% of the contractors used shovel tests, a virtually unknown technique in Colorado (i.e., less than 2%)... Of the contracts which actually report the number of shovel tests, the average number is 142 for New York and 4 for Colorado" (Zubrow 1984:22).

This is not to say that routine use of SST procedures will always find low density, short-term occupation sites that are either obscured by modern vegetation or by post-depositional geomorphic processes. As mentioned earlier, artifact density and density-distribution are important factors in subsurface site discovery. In the eastern Woodlands, where SST procedures are routinely used, this has been especially true for the Paleoindian period. In a discussion of the relatively low number of recorded Paleoindian sites in the eastern Woodlands, Anderson (1990) has observed that this may be more a problem of sampling bias rather than an archaeological reality. He argues as follows:

> [The]...dearth of intensive fieldwork [directed to Paleoindian components] appears to be primarily because the kinds of assemblages (i.e., extensive or well-stratified) necessary to justify the great expense of areally extensive excavation blocks have only rarely been found during CRM-funded survey and testing efforts. It is questionable, in fact, whether most CRM efforts undertaken in the Eastern Woodlands are adequate *even to locate* the deposits dating to this period, particularly if they are low in density or deeply buried...(Anderson 1990:178; emphasis added).

For the Illinois archaeological region, however, the situation is not nearly as bleak. Several intact, open-air Paleoindian sites have been located through systematic survey and subsurface testing, permitting subsequent surface collection and areal exposure of occupation surfaces (see Volume 2).

A final aspect of archaeological field methods that impinges on the calculation and evaluation of site discovery probability has to do with areal exposure and the routine reporting of site constituents and intrasite spatial structure. The delineation of site boundaries for estimates of site size and shape, the horizontal exposure of occupation surfaces to reveal the density and spatial patterning of various site constituents (artifacts, features, anthropogenic soil anomalies, etc.), and the identification of patterned associations between site constituents are all crucial elements of the archaeological record that enter into evaluations of site discovery probability. As seen in the previous section, knowledge of these categories of information within a given region can help the archaeologist devise the most appropriate site discovery procedures and sampling designs. For SST procedures, these data are necessary for estimating the degree of "empty space" expectable within a site configuration and can help determine the amount of negative evidence that would be required before concluding that there are no significant archaeological resources in the survey tract (Stone 1981b; Hasenstab 1986).

Here again, comparison of the archaeological data from the Illinois region and the Eastern Great Basin region demonstrates considerable variation in this regard. As Volume 2 shows, considerable attention has been given in the Illinois region to the delineation of site size and intrasite spatial structure, while the same cannot be said for the Eastern Great Basin until quite recently (see Volume 3). In Illinois, this has been achieved repeatedly through mechanical stripping of the plowzone followed by the excavation of large horizontal exposures. In so doing, valuable information on intrasite spatial structure is obtained. Notable examples of this approach are the excavations at the Hatchery West site (Binford et al. 1970) and, more recently, the FAI-270 highway mitigation project in the American Bottom of west-central Illinois (Bareis and Porter 1984a). In these cases, a conscious attempt was made to delineate intrasite spatial structure for various components of the archaeological sequence. For the FAI-270 Project, Bareis and Porter (1984b:9) describe this approach as follows:

> We acknowledged in our research design that the FAI-270 alignment represented a sample of American Bottom archaeology, and that even total excavation at any site would recover only a sample of the human activities once conducted there. We believed, however, that it would be possible to excavate completely the entire sample of that activity present at each site after the sample had been adequately defined in a subsurface context. To achieve this goal, we employed paddlewheel scrapers, backhoes, and bulldozers to remove the plowzone and other kinds of overburden... Overall, the primary goal of the fieldwork was to define the community plan at each site.

The positive results of this excavation strategy have been dramatically demonstrated in the extensive series of excavation reports that have been published by the FAI-270 Project in the past decade. Archaeological site constituents are clearly delineated and quantified over broad occupation surfaces, permitting reasoned inferences regarding intrasite spatial structure and the degree of clustering of artifacts and features. Since multiple archaeological components have been studied in this manner, temporal models of archaeological site characteristics and intrasite spatial structure can be postulated as a guide to future survey designs and site discovery procedures.

In the Eastern Great Basin and Colorado Plateau areas of Utah, on the other hand, few conscious attempts at delineating intrasite spatial structure have been made until comparatively recently (e.g., Simms and Heath 1990; Metcalfe and Heath 1990; Quinn, Gundy, and Glenn 1990). For example, Lohse (1980:49) has characterized past excavation strategies at Fremont sites as follows:

> [Domestic] structures are identified within test trenches and completely excavated, but exploration is not continued out onto the associated occupation surface, effectively curtailing any solid statements about intra-site plan...[As a result], we have no real idea of Fremont settlement plan or correspondingly, social organization. A good relative chronology has been built up, although the largest stumbling block in any study focusing on settlement pattern is the general lack of radiocarbon dates off identifiable living surfaces.

As the archaeological data compiled in Volume 3 demonstrate, many of these sites lack a clear definition of site boundary, either from information on the surface distribution of archaeological materials or on subsurface distribution through shovel testing or postholing. Thus no information exists as to site size and shape in spite of the fact that several structures and related features may have been completely excavated at a given site. Cave sites have generally fared better in this regard probably because size and shape are important constraints in site mapping and excavation in these sites. At least one of these cave sites has also received detailed study of intrasite spatial structure (Jennings, Schroedl, and Holmer 1980).

The implications of this rapidly drawn comparison of two archaeological regions of the United States are reasonably clear. If regional patterning exists in the archaeological record itself, as one would expect, this discussion also demonstrates that regional trends exist in *the way archaeological field work is conducted* in these regions. Not only are fundamental site discovery procedures different, but in some cases the background archaeological data that one needs to determine the effectiveness of particular discovery procedures are not readily available. The costs of such background research are not dealt with in this document, but they must be factored into the budgetary planning of any intensive archaeological survey (see recommendations in Chapter 4). The net effect of these regional differences is a general lack of comparability in the research results obtained in archaeological surveys and/or excavations. While the local archaeologist operating in one or another of these regions may not be too concerned with this noncomparability of results, or even with the effectiveness of the site discovery procedures commonly used, this is not the case with a large landholding agency such as the DoD whose stewardship over cultural resources extends across the continental United States. For this reason, specific methods are needed for the evaluation of survey effectiveness and sampling bias. This topic is treated in the next chapter.

4 Survey Effectiveness and Bias Assessment

Background

As mentioned previously, discovery probability is the product of two independent probabilities (site intersection and test-pit productivity), and both of these are affected by (a) properties of the sampling design and (b) properties of the archaeological record (Figure 2). While discussion is aimed primarily at SST survey methods here, it applies equally well to pedestrian surveys. Early applications of SST in the 1970s were primarily concerned with finding sites under conditions of low surface visibility but not with estimating the probability of site discovery under given conditions and sampling designs. Thus little or no concern was shown for objectively evaluating the effectiveness, accuracy, reliability, and validity of shovel-probes. If sites were found, then SST must be effective.

By today's standards, many early SST surveys were constrained by a variety of factors. For example, some failed to make full use of prior knowledge of the archaeological record and the nature of local archaeological sites. In some cases that knowledge was still being developed for many areas so that SST surveys had to be conducted in an exploratory fashion. Others failed to optimize their sampling designs in order to find archaeological remains of a certain minimal size. In other cases, SST surveys were of very low intensity due to financial limitations or a mind-set that regarded SST techniques as a minor and often ineffectual supplement to traditional pedestrian survey coverage. While sites were definitely discovered, there was no explicit bias assessment to determine what kinds of archaeological resources might have been missed in the study area or sampling unit. In short, no confidence estimates could be placed on the survey results. Since few scopes-of-work or SHPO guidelines recommended the inclusion of quality control mechanisms and bias assessment, it is not surprising that survey reports avoided discussion of such topics. If it is not an explicit contractual requirement, the admission of survey bias and missed archaeological resources could potentially result in the rejection of the deliverable product.

In the early to mid-1980s, archaeologists began to examine the statistical and geometrical properties of shovel-test sampling and its relation to the discovery of archaeological sites of varying size, artifact density, and matrix composition (see, for example, Dincauze et al. 1980; Lynch 1980; Stone 1981a; Krakker Shott, and Welch 1983;

Nicholson 1983; Wobst 1983; McManamon 1984a; Shott 1985; Nance and Ball 1986; Lightfoot 1986; and Hasenstab 1986). In their search for relevant analogues in related disciplines, a number of archaeologists began to explore geological literature on pattern drilling exploration and geometrical probability theory for subsurface search strategies that would be applicable to archaeological prospecting. Pertinent geological references on this topic include works by Savinskii (1965), Drew (1967, 1979), Koch and Link (1971:187-228), Singer (1975), and McCammon (1977). Davis (1986:289-295) provides a more recent general treatment of geometrical probability and subsurface geological testing largely based on the work of McCammon (1977). For a mathematical discussion of geometrical probability theory, see Kendall and Moran (1963).

One of the most thorough discussions of the geometrical properties of subsurface archaeological sampling designs is provided by Krakker, Shott, and Welch (1983; see also Nance 1983, McManamon 1984a, and Shott 1985). They explored the way in which test-pit size, spacing, and layout affect discovery probabilities for sites of a given size and artifact density. Both grid pattern surveys and transect surveys are treated. They demonstrate that substantial gains in effectiveness can be achieved by using optimal or staggered spacing of test units in a quadrat or transect sampling unit rather than even spacing in a square-grid pattern. In this case, effectiveness refers to the *minimal* site size likely to be discovered by a given sampling design (i.e., intersection probability). Specifically, they show that the probability of intersecting a site of specified size is directly related to the interval spacing between shovel-probes. Thus regardless of probe layout, "the radius of the largest site that cannot escape... [intersection] is defined by:

$$r = i/\sqrt{2}$$

where r = the radius of the site and i = interval spacing" (Lightfoot 1986:492-493). In other words, "to be certain of finding a site of radius r..., the sampling interval i is calculated as... $i \leq r\sqrt{2}$" (Krakker, Shott, and Welch 1983:471). As a practical rule-of-thumb for gauging intersection probability, they note that "there is a .78 probability of finding [i.e., intersecting] a site with a diameter equal to the grid interval" (Krakker, Shott, and Welch 1983:472). Thus if we wish to know with greater certainty that we will be able to intersect sites measuring 30 m in diameter or greater, then we should space the probes at least 21.2 m apart. Likewise, if we decide to use a 10-m spacing interval, then we are highly likely to intersect all sites measuring 14 m in diameter or greater. These relationships permit the calculation of intersection probabilities for sites of *any* specified size. According to Krakker, Shott, and Welch (1983:472), that probability can be calculated as follows:

$$p = (\pi r^2)/i^2$$

where r = the radius of the site and i = the interval spacing between probes. In terms of number of shovel probes executed, they demonstrate that substantial gains can be made by a relatively modest increase in the number of test units when placed for optimal and/or staggered grid spacing. As we shall see below, a 10-m interval spacing laid out on a staggered grid should theoretically intersect sites measuring 12.7 m in diameter, rather than 14 m, as indicated above.

Finally, Krakker, Shott, and Welch (1983) considered the influence of inspection methods, such as probe size and screening, on site discovery for different artifact densities (i.e., detection probability). Artifact density-distributions are modeled on the Poisson distribution (random dispersion) although the negative binomial density function (clustered dispersion) is mentioned as a fruitful avenue of research on intra-site artifact dispersion (Krakker, Shott, and Welch 1983:477). Indeed, clustered dispersions of artifacts seem to be the norm in most sites studied through spatial analytical techniques to date. On the basis of these theoretical relationships between site sizes, shapes, and internal artifact densities, on the one hand, and the optimizing strategies for test unit spacing and layout on the other, they are able to show how discovery probabilities can be calculated in hypothetical archaeological examples permitting the establishment of confidence estimates for the probability of finding sites of a minimal size and specified artifact density. Thus they "provide a quantitative basis for adjusting shovel-test survey procedures to research goals and labor constraints" (Krakker, Shott, and Welch 1983:480).

Reliable and accurate estimates of discovery probabilities are essential to guarantee the effectiveness of SST survey. When included in a probabilistically based regional sample design, these techniques permit reliable estimation of the actual number of sites present in a survey area. Perhaps more importantly, they permit estimation of the minimal site size and associated artifact density likely to have been missed by a given sampling design. This constitutes an important source of bias in many archaeological surveys and is intimately related to the notion of "intensity" and to the concept of "precision" discussed briefly in the introduction. While many archaeologists superficially associate the term "intensity" with the spacing between crew members in pedestrian survey or the interval between test-pits in subsurface surveys, in reality the term should be expanded to include person-day expenditures per unit area surveyed as well as explicit *bias assessment* of the kinds of archaeological resources likely to have been missed by implementation of a given sampling design, whether the latter is based on surface or subsurface inspection techniques.

Calculating Discovery Probabilities

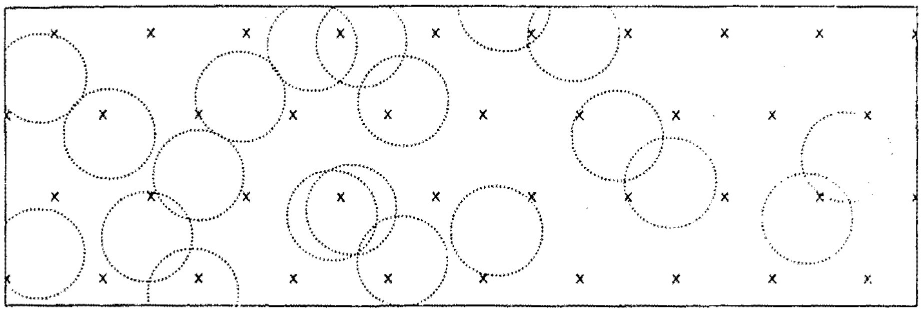
Several procedures exist in the archaeological literature for the calculation of site discovery probabilities, including both hypothetical scenarios and specific case studies using real archaeological data. Many have distinct limitations, however, in terms of their comprehensiveness, their ease of implementation, or both. Sundstrom (1993), for example, has recently presented a mathematical procedure for estimating the adequacy of site survey strategies (using formulas derived from Davis 1986). Her discussion is aimed primarily at the relationship of site size and crew/probe interval spacing for evaluating site intersection probabilities, and doesn't take into account the related issue of artifact detection probability. Rather, it assumes "that intersection is equated with detection," an assumption which by her own admission is "troublesome" (Sundstrom 1993:94). As we have seen, both kinds of probability must be considered in any comprehensive treatment of site discovery probability (Krakker, Shott, and Welch 1983; Shott 1985, 1989; Nance and Ball 1986). This omission seriously compromises the overall utility of Sundstrom's approach for evaluations of SST effectiveness, although it is still helpful for the rapid assessment of pedestrian and SST survey designs, *but only as they affect site intersection probabilities.*

In an earlier study assessing SST survey effectiveness in Massachusetts, Dincauze et al. (1980:Tables 43 and 44) present site discovery probabilities in a useful tabular format with separate tables constructed for "site encounter" (intersection) probabilities and "artifact detection" probabilities. Site intersection calculations are based on 10 different site sizes ranging from 5 to 100 m in diameter and 20 different probe intervals ranging from 5 to 100 m (in 5-meter increments), giving a total of 200 possible outcomes. Probabilities assume a systematic square grid sampling geometry. Artifact detection calculations are based on 10 different test-pit sizes ranging from 20 to 100 cm in width and 19 different artifact densities ranging from 1 to 100 in uneven increments, giving a total of 190 possible outcomes. Probabilities assume a uniform random dispersion of artifacts within a 100 sq m area. Their tabular approach is commendable in that their treatment of overall site discovery probabilities is comprehensive (i.e., it includes both intersection and detection probabilities) and they include a range of possible values for several parameters of the hypothetical survey design and the archaeological record. Two limitations can be pointed out, however. First, the calculated intersection probabilities do not provide for alternative sampling geometries beyond the systematic square grid. Second, the calculated detection probabilities do not provide for alternative artifact density-distributions beyond the assumed uniform random dispersion. Any variation of these parameters would necessitate the construction of new probability tables. Likewise, selection of other parameter values that fall in between or beyond those provided in the two tables would necessitate extrapolation to arrive at the corresponding probability. In fairness to the authors, it should be pointed out that their intent was not to provide a thorough treatment of site discovery probability that could account for all possible scenarios of survey design and archaeological site size and composition. Rather, their intent was simply to illustrate the weaknesses of previous survey designs in the state of Massachusetts (see also Hasenstab 1986).

The basic model of discovery probability presented by Krakker, Shott, and Welch (1983) is comprehensive and its application to real archaeological data by Shott (1985) provides a useful cautionary note on the limitations of SST surveys in certain archaeological situations. As a practical matter, however, the calculation of discovery probability suggested by Krakker, Shott, and Welch (1983) is somewhat cumbersome and limited in the range of conditions or sampling scenarios it explores. As Kintigh (1988a:689) has observed, "the complexity of the mathematical interactions [in the model] makes it impossible to evaluate intuitively many of their practical implications."

A more useful method for calculating site discovery probabilities would be not only comprehensive, but would also be capable of examining a range of sampling scenarios and site characteristics. Ideally it would also be operationalized in a user-friendly, DOS-based format for the personal computer. As a response to these challenges, Kintigh (1988a, 1988b) implemented a Monte Carlo approach that examines the interactions of the multiple probabilistic factors "by operationalizing the random processes with a computer simulation. The averaged interaction of the random processes can be 'observed' in repeated runs of the simulation" (Kintigh 1988a:689; emphasis original). Thus, sampling accuracy, precision, and reliability can all be evaluated by this method. Perhaps more importantly for practical purposes, Kintigh's approach also allows the evaluation of subsurface testing programs over a broad range of hypothetical conditions, such as varying site size, artifact density, density-distribution function, as well as a host of sampling design parameters involving test-pit spacing and layout within a given sampling unit. Basically the method addresses a single fundamental question: "What is the likelihood that a site of a given size and distribution of artifact densities would be missed by a testing program if it exists in the survey area?" (Kintigh 1988a:689). Kintigh's Monte Carlo simulation program (1988b: pp 79-88) permits a thorough examination of this problem with hypothetical site and artifact density data that can be derived from real archaeological case studies or from prior archaeological knowledge of a study area.

The method involves two separate but related components. First the user defines a sampling design in the Program PLACESTP. This includes: (a) specification of the size and shape of the sampling unit or study area, (b) the selection of one of three test unit configurations (hexagonal, staggered, and grid patterns), (c) the spacing interval between test units (optimal or user-specified), (d) the number of lengthwise transects of test units within the sampling unit, and (e) test unit size (in diameter or area). Figure 5, reproduced from Kintigh (1988a:689) , shows an example of a hypothetical sampling unit resulting from this program. In this case a 100 x 300 m survey area is filled with a hexagonal grid made up of 40 test units arrayed in four longitudinal transects. Each test unit measures 40 cm in diameter, a fairly standard size for many



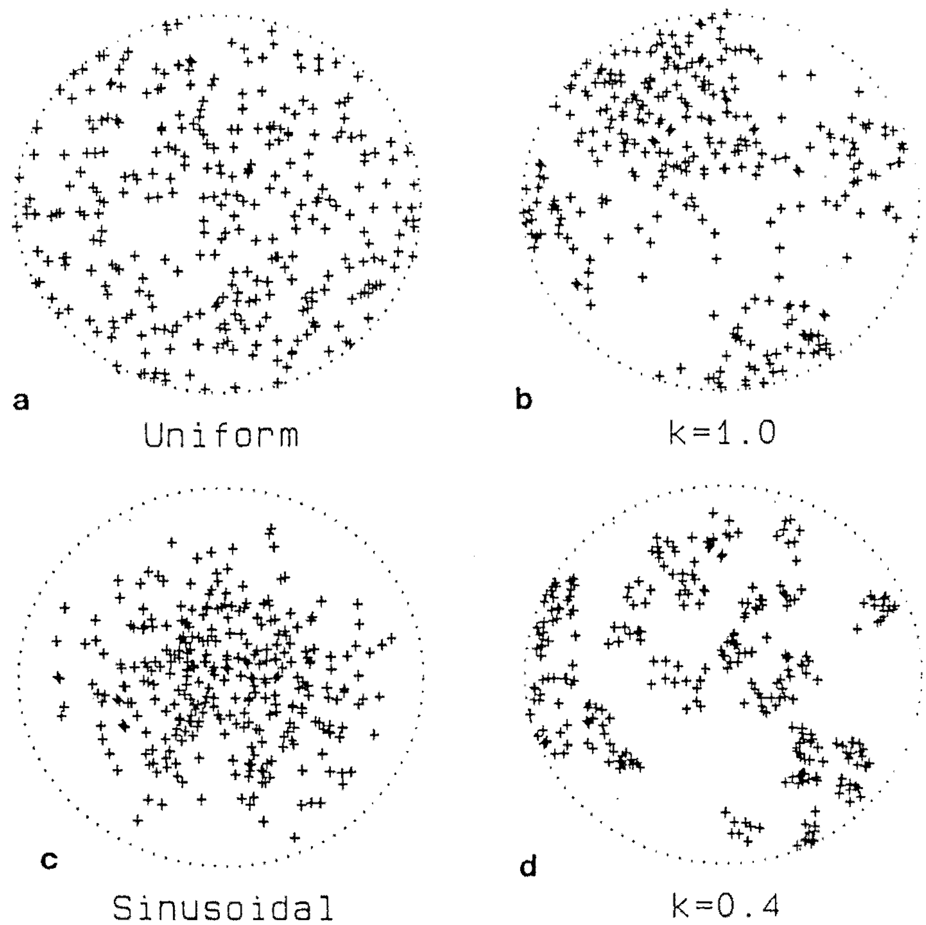
(Source: Reproduced by permission of the author and the Society for American Archaeology from *American Antiquity*, vol 53, no. 4, 1988.)

Figure 5. Example of hypothetical sampling unit resulting from PLACESTP Program.

shovel-testing surveys. The output file from this exercise also includes a statement of the maximum diameter of a site that could escape detection given the test unit spacing and layout employed. The hypothetical sites superimposed on the survey area in Figure 5 approximate the critical size for that test unit geometry. While several of them are intersected by test units, several others fit neatly within the spaces defined by the hexagonal pattern and thus would not be intersected.

The second component, the STP Program, involves the Monte Carlo simulation itself using the test unit geometry set up in the PLACESTP Program. In this case the user defines the hypothetical parameters of the archaeological record needed to estimate discovery probability. These include: (a) site size, (b) artifact density (number of artifacts/sq m), and (c) the *shape* of the artifact density-distribution, or its *density function*. The program permits exploration of several different density functions including uniform, hemispherical, conical, and sinusoidal distributions, and the negative binomial distribution with varying degrees of clustering. Figure 6 shows four examples of different density functions for a hypothetical 20-m-diameter site with a density of one artifact per sq m. Note, for example, the differences in the amount of "empty space" resulting from the negative binomial distributions (Figure 6b and d) when the degree of clustering (i.e., the k parameter) is altered. The number of repeated simulation trials is also specified and depends on the degree of accuracy and reliability desired in the simulation results. One of the advantages of this program is that multiple combinations of these parameters can be specified for a given simulation run so that the results can encompass a wide range of archaeological situations and sampling designs.

As an example, Table 7 illustrates a sample output file from the STP Program pertaining to a 1-hectare sampling unit having 8 shovel-probes measuring 40 cm x 40 cm each, and laid out with optimal spacing generated by the PLACESTP Program.



(Source: Reproduced by permission of the author and the Society for American Archaeology from *American Antiquity*, vol 53, no. 4, 1988.

Figure 6. Four examples of artifact distributions with different density functions.

This results in an equilateral spacing between probes of 43.3 m. Several archaeological parameters are included in this exercise and in each case 1000 simulation trials were run in order to calculate the intersection and detection probabilities (Table 7, column 6). Five site sizes (measured in diameter) were explored: 10 m, 30 m, 50 m, 70 m, and 100 m (column 2). For each site size, 10 simulations were run for each combination of artifact density and density function. Thus for each site size, two density functions were tested: sinusoidal (labeled S in column 3) and negative binomial (labeled N in column 3) with clustering parameter k = 1.0 (column 5). For each of these density functions, then, 5 different artifact densities were tested: 0.1, 0.5, 1.0, 5.0, and 10.0 artifacts per square meter (column 4). The resulting output file produced 50 different Monte Carlo simulations each consisting of 1000 trials. The results for the

Table 7. Sample output file from STP program (Kintigh 1988b) showing probabilities of site intersection and artifact detection with 8 shovel probes arrayed with "optimal spacing" sampling geometry.

File	Site	Artifact Density			No.	Sites Intersected			Sites Detected		
No.	Diam	Fn	Mean	k	Sites	Number	Pct	Hits	Number	Pct	Hits
1	10	S	0.1	0.000	1000	62	6.2	62	1	0.1	1
1	10	S	0.5	0.000	1000	55	5.5	55	5	0.5	5
1	10	S	1.0	0.000	1000	67	6.7	67	4	0.4	4
1	10	S	5.0	0.000	1000	62	6.2	62	25	2.5	25
1	10	S	10.0	0.000	1000	69	6.9	69	43	4.3	43
1	10	N	0.1	1.000	1000	74	7.4	74	2	0.2	2
1	10	N	0.5	1.000	1000	71	7.1	71	6	0.6	6
1	10	N	1.0	1.000	1000	81	8.1	81	6	0.6	6
1	10	N	5.0	1.000	1000	74	7.4	74	31	3.1	31
1	10	N	10.0	1.000	1000	63	6.3	63	41	4.1	41
1	30	S	0.1	0.000	1000	479	47.9	479	6	0.6	6
1	30	S	0.5	0.000	1000	504	50.4	504	34	3.4	34
1	30	S	1.0	0.000	1000	496	49.6	496	73	7.3	73
1	30	S	5.0	0.000	1000	505	50.5	505	229	22.9	229
1	30	S	10.0	0.000	1000	519	51.9	519	320	32.0	320
1	30	N	0.1	1.000	1000	497	49.7	497	8	0.8	8
1	30	N	0.5	1.000	1000	470	47.0	470	29	2.9	29
1	30	N	1.0	1.000	1000	521	52.1	521	71	7.1	71
1	30	N	5.0	1.000	1000	480	48.0	480	183	18.3	183
1	30	N	10.0	1.000	1000	496	49.6	496	303	30.3	303
1	50	S	0.1	0.000	1000	976	97.6	1129	18	1.8	18
1	50	S	0.5	0.000	1000	977	97.7	1143	95	9.5	95
1	50	S	1.0	0.000	1000	982	98.2	1138	188	18.8	188
1	50	S	5.0	0.000	1000	969	96.9	1132	538	53.8	538
1	50	S	10.0	0.000	1000	982	98.2	1142	706	70.6	707
1	50	N	0.1	1.000	1000	985	98.5	1121	13	1.3	13
1	50	N	0.5	1.000	1000	983	98.3	1148	76	7.6	79
1	50	N	1.0	1.000	1000	975	97.5	1116	134	13.4	136
1	50	N	5.0	1.000	1000	979	97.9	1136	454	45.4	486
1	50	N	10.0	1.000	1000	984	98.4	1172	622	62.2	683
1	70	S	0.1	0.000	1000	1000	100.0	1985	27	2.7	27
1	70	S	0.5	0.000	1000	1000	100.0	1969	161	16.1	163
1	70	S	1.0	0.000	1000	1000	100.0	2014	296	29.6	306
1	70	S	5.0	0.000	1000	1000	100.0	1981	808	80.8	923
1	70	S	10.0	0.000	1000	1000	100.0	1955	967	96.7	1254
1	70	N	0.1	1.000	1000	1000	100.0	1920	36	3.6	36
1	70	N	0.5	1.000	1000	1000	100.0	1976	138	13.8	147
1	70	N	1.0	1.000	1000	1000	100.0	1966	252	25.2	277
1	70	N	5.0	1.000	1000	1000	100.0	2005	649	64.9	677
1	70	N	10.0	1.000	1000	1000	100.0	2001	802	80.2	1200
1	100	S	0.1	0.000	1000	1000	100.0	3555	51	5.1	51
1	100	S	0.5	0.000	1000	1000	100.0	3531	271	27.1	285
1	100	S	1.0	0.000	1000	1000	100.0	3577	458	45.8	532
1	100	S	5.0	0.000	1000	1000	100.0	3544	951	95.1	1715
1	100	S	10.0	0.000	1000	1000	100.0	3576	996	99.6	2183
1	100	N	0.1	1.000	1000	1000	100.0	3583	50	5.0	51
1	100	N	0.5	1.000	1000	1000	100.0	3589	228	22.8	245
1	100	N	1.0	1.000	1000	1000	100.0	3581	403	40.3	505
1	100	N	5.0	1.000	1000	1000	100.0	3620	861	86.1	1585
1	100	N	10.0	1.000	1000	1000	100.0	3565	952	95.2	2169

Execution Time 0.1 Minutes

intersection probabilities are given in columns 7, 8, and 9, while those for the detection probabilities are given in columns 10, 11, and 12.

In general terms, within each site size category, substantial gains are made in intersection and detection probabilities as artifact density increases. In all cases, sinusoidal density functions resulted in slightly elevated probabilities when compared to those of the negative binomial function. This is due to the fact that sinusoidal distributions are considerably more clustered around a centroid, while negative binomial distributions are likely to have more open space between groups of smaller clusters (see Kintigh 1988a:693; see also McManamon 1984a) and thus would escape detection in more cases. As is intuitively obvious, the larger the site size, the greater is the probability that it will be intersected (e.g., 100 percent probability for sites measuring 70 m and 100 m in diameter) and detected. Note, however, that even a site measuring 100 m in diameter only has a 5 percent chance of detection if the associated artifact density is only 0.1 artifacts per square meter (column 11), regardless of the density function. Thus light lithic scatters do not stand a very good chance of detection with the present sampling design of 8 shovel-probes in a 1-hectare sampling unit, even if they encompass a relatively large site area. Small sites (i.e., 30 m in diameter and below) do not fare well at this low-intensity sampling design. The highest detection probability achieved even for a 30-m-diameter site was 32 percent (column 11), which was associated with the highest artifact density (10 artifacts/sq m).

When looked at from the perspective of a desired confidence threshold, say 80 percent confidence that sites of a certain size and nature will be intersected , we see that sites with diameters of 50 m, 70 m, and 100 m all have a high chance of being intersected by at least one probe (96.6 to 100 percent in column 8), but that for sites 30 m in diameter and smaller, the chances are exceedingly small that they would even be intersected (5.5 to 52.1 percent in column 8). It is important to note here the distinction between *intersection* and *detection*, however, because ultimately both are necessary to successfully locate a site. If we want to have a confidence threshold of 80 percent or higher that sites of a certain size and nature will be both intersected *and detected*, we can see that the simulated results in Table 7 are not encouraging. Only the archaeological parameters shown in the boxed rows would have an 80 percent or greater chance of being detected. This group includes only sites of 70 or 100 meters in diameter, and within those two relatively large size categories, it includes only those with the highest density artifact distributions (5.0 and 10.0 artifacts per square meter).

In contrast to this low-intensity simulation, it is interesting to note the changes in discovery probabilities when SST intensity is increased dramatically; for example, by increasing the number of probes executed per hectare by 12.5 times. This would result in the execution of 100 shovel probes in a 1-ha sampling unit, with an approximate spacing of 10.2 m between each probe. Table 8 shows the sample output file from the STP program using the same archaeological parameters as in Table 7 for site size, artifact density, and density-distribution, although in this case a staggered grid sampling geometry is used (as it is generally easier to lay out in the field than a grid with optimal spacing). According to the PLACESTP output for this sampling geometry, the minimal site size intersected was 12.68 m in diameter. Again the boxed rows indicate those archaeological parameters for which an 80 percent or greater confidence threshold was attained for site detection. Several aspects of this output file merit

Table 8. Sample output file from STP program (Kintigh 1988b) showing probabilities of site intersection and artifact detection with 100 shovel probes arrayed with "staggered grid" sampling geometry.

File	Site	Artifact Density			No.	Sites Intersected			Sites Detected		
No.	Diam	Fn	Mean	k	Sites	Number	Pct	Hits	Number	Pct	Hits
1	10	S	0.1	0.000	1000	813	81.3	825	9	0.9	9
1	10	S	0.5	0.000	1000	817	81.7	822	64	6.4	64
1	10	S	1.0	0.000	1000	827	82.7	836	113	11.3	113
1	10	S	5.0	0.000	1000	806	80.6	816	347	34.7	347
1	10	S	10.0	0.000	1000	817	81.7	820	422	42.2	422
1	10	N	0.1	1.000	1000	817	81.7	825	9	0.9	9
1	10	N	0.5	1.000	1000	825	82.5	831	60	6.0	60
1	10	N	1.0	1.000	1000	835	83.5	841	95	9.5	95
1	10	N	5.0	1.000	1000	820	82.0	827	328	32.8	328
1	10	N	10.0	1.000	1000	824	82.4	833	477	47.7	478
1	30	S	0.1	0.000	1000	1000	100.0	6348	111	11.1	115
1	30	S	0.5	0.000	1000	1000	100.0	6397	395	39.5	475
1	30	S	1.0	0.000	1000	1000	100.0	6395	655	65.5	927
1	30	S	5.0	0.000	1000	1000	100.0	6375	995	99.5	2745
1	30	S	10.0	0.000	1000	1000	100.0	6346	1000	100.0	3608
1	30	N	0.1	1.000	1000	1000	100.0	6379	85	8.5	88
1	30	N	0.5	1.000	1000	1000	100.0	6329	382	38.2	457
1	30	N	1.0	1.000	1000	1000	100.0	6348	598	59.8	849
1	30	N	5.0	1.000	1000	1000	100.0	6335	963	96.3	2752
1	30	N	10.0	1.000	1000	1000	100.0	6315	994	99.4	3815
1	50	S	0.1	0.000	1000	1000	100.0	15791	224	22.4	257
1	50	S	0.5	0.000	1000	1000	100.0	15802	760	76.0	1345
1	50	S	1.0	0.000	1000	1000	100.0	15856	925	92.5	2306
1	50	S	5.0	0.000	1000	1000	100.0	15893	1000	100.0	7179
1	50	S	10.0	0.000	1000	1000	100.0	15826	1000	100.0	9380
1	50	N	0.1	1.000	1000	1000	100.0	15575	193	19.3	212
1	50	N	0.5	1.000	1000	1000	100.0	15747	703	70.3	1206
1	50	N	1.0	1.000	1000	1000	100.0	15894	907	90.7	2203
1	50	N	5.0	1.000	1000	1000	100.0	16019	999	99.9	7065
1	50	N	10.0	1.000	1000	1000	100.0	15716	1000	100.0	9549
1	70	S	0.1	0.000	1000	1000	100.0	27941	378	37.8	474
1	70	S	0.5	0.000	1000	1000	100.0	27917	901	90.1	2223
1	70	S	1.0	0.000	1000	1000	100.0	27637	983	98.3	4195
1	70	S	5.0	0.000	1000	1000	100.0	28049	1000	100.0	13061
1	70	S	10.0	0.000	1000	1000	100.0	28408	1000	100.0	17180
1	70	N	0.1	1.000	1000	1000	100.0	27823	309	30.9	394
1	70	N	0.5	1.000	1000	1000	100.0	28275	853	85.3	1989
1	70	N	1.0	1.000	1000	1000	100.0	28018	970	97.0	3877
1	70	N	5.0	1.000	1000	1000	100.0	27879	1000	100.0	12475
1	70	N	10.0	1.000	1000	1000	100.0	27739	1000	100.0	17146
1	100	S	0.1	0.000	1000	1000	100.0	48681	561	56.1	854
1	100	S	0.5	0.000	1000	1000	100.0	48407	982	98.2	4172
1	100	S	1.0	0.000	1000	1000	100.0	48380	1000	100.0	7791
1	100	S	5.0	0.000	1000	1000	100.0	48423	1000	100.0	23865
1	100	S	10.0	0.000	1000	1000	100.0	48668	1000	100.0	30826
1	100	N	0.1	1.000	1000	1000	100.0	47932	542	54.2	773
1	100	N	0.5	1.000	1000	1000	100.0	47977	956	95.6	3473
1	100	N	1.0	1.000	1000	1000	100.0	47839	993	99.3	6655
1	100	N	5.0	1.000	1000	1000	100.0	48897	1000	100.0	21471
1	100	N	10.0	1.000	1000	1000	100.0	48545	1000	100.0	29716

Execution Time 1.5 Minutes

discussion when compared to the 8-probe sampling design depicted in Table 7. First, note that in *all* cases intersection probabilities were greater than 80 percent (column 8). Indeed, for all sites larger than 30 m in diameter, regardless of artifact density and density-distribution, intersection probabilities were 100 percent. Thus all hypothetical sites were intersected by at least one shovel-probe. Second, with regard to detection probabilities, note that the simulations resulted in considerable gains over the 8-probe sampling design. As expected, a larger proportion of smaller sites and sites with lighter artifact densities were detected with 80 percent or greater confidence. Third, note that the lightest artifact density of the simulations (0.1 artifacts/sq m) was consistently associated with detection probabilities lower than our arbitrary 80 percent cut-off point, even for the largest site sizes (70-100 m in diameter). Fourth, note that even with a relatively intensive 10-m interval spacing, *no* 10-m diameter sites were detected with a high degree of confidence (80 percent or greater).

The implications of these Monte Carlo simulation results are inescapable. If the goal of a given SST survey is to find evidence for small sites and/or sites with low artifact densities regardless of their size, then shovel-probe spacing and layout are critical variables of sampling design that must addressed in a probabilistically informed manner. Archaeologists must be sure that the sampling geometry and inspection methods are adequate for the task of intersecting and detecting archaeological sites of a minimal requisite size and composition. They must also make a clear distinction between intersection and detection. As we have seen, the fact that a site of given size is highly likely to be intersected *does not guarantee* that site will actually be detected. The probability of detection must also include expectations of artifact density and density-distribution. Archaeologists must consider both intersection and detection probability and have the ability to assign confidence estimates to these probabilities so that reliable assessments can be made of the kinds of archaeological resources that are likely to have been missed by a given SST survey design.

To relate these preceding Monte Carlo exercises to empirical reality, it may be enlightening to examine the simulation results against real archaeological data on site size and intrasite artifact density for cases where these dimensions are relatively reduced (see, for example, Carmichael 1977; Keller 1982; McManamon 1984a; Shott 1985; Thomas 1986; Thorbahn undated). Shott (1985) provides a particularly useful "worst case" scenario in this regard. In a critique of shovel-test sampling as a site discovery technique, Shott (1985:Table 1) presents a list of 46 archaeological sites in which some 19 sites have area measurements (in sq m) and associated intrasite artifact densities (artifacts/sq m). A list of these sites and their size/density data is given in Table 9. Sites are listed in ascending order of size and the original site area measurements have been converted to diameter measurements for ease of comparison with the simulation experiments. When the site data are compiled in this fashion, they demonstrate an interesting phenomenon; intrasite artifact densities, while generally low for all sites in the sample, tend to be higher for sites at the small end of the size continuum. Thus for small sites ranging from only 1.5 m to 21.5 m in diameter, artifact densities range from 0.071 artifacts/sq m to 0.739 artifacts/sq m. Larger sites, on the other hand, ranging in size from 31.6 to 68.0 m in diameter, consistently exhibit artifact densities much lower than 0.10 artifacts per sq m, ranging from a high of 0.084 to a low of 0.002 artifacts/sq m. The inverse nature of this relationship is not completely understood but it has dramatic consequences for site discovery probability.

These consequences can be illustrated by comparing the Michigan site data with the simulation exercise presented in Table 8 for the intensive 100-probe/hectare sampling scheme. Using only the site size data, we can see that all sites greater than or equal to 30 m in diameter would have a 100 percent probability of being *intersected*, but not necessarily detected (see Table 8, column 8). For smaller site sizes, 10.9 to 21.5 m in diameter, intersection probability would drop somewhat but would still remain above 80 percent (Table 8, column 8), while for the smallest sites, 1.5 m and 7.4 m in diameter, intersection probability would fall well below the 80 percent confidence threshold. Detection probabilities, however, present a somewhat bleaker picture, even with this relatively intensive sampling scheme (100 probes/ha). For example, for sites over 30 m in diameter, the highest artifact density is 0.084 artifacts/sq m for a site measuring 55 m in diameter. The closest approximation for these variables in Table 8 would be the 50-m diameter site with a density of 0.1 artifacts/sq (columns 2 and 4). The corresponding detection probabilities for these variables range from 19.3 to 22.4 percent depending, respectively, on whether a negative binomial or a sinusoidal artifact distribution is being simulated (column 11). Detection probabilities for the remainder of the sites greater than 30 m in diameter would be considerably lower due to their extremely low artifact densities. For the smaller sites (i.e., less than 30 m in diameter), the slightly higher artifact densities are still not high enough to compensate for the small site sizes. Even a 30-m diameter site with a density of 0.5 artifacts/sq m has only a 38 to 39 percent chance of detection (column 11). As Table 9 shows, the size/density combinations for the smaller Michigan sites are even lower than this hypothetical example, thereby precluding their detection at reasonably high confidence threshold (e.g., 80 percent or higher). Thus, while the larger size (greater than 30 m) of certain sites favors their intersection, the consistently low artifact densities on these sites results in very low probabilities of detection. Conversely, for sites with relatively higher artifact densities (greater than 0.1 artifacts/sq m), which should favor site detection, the extremely small size of the sites (less than 22 m in diameter) still results in generally low probabilities of detection.

Table 9. Site size and intrasite artifact density data for 19 archaeological sites in central Michigan.

Site	Site Size (m in diam)	Artifact Density (#/sq m)
20AC98	1.5	0.739
20AC99	7.4	0.444
20AC79	10.9	0.192
20AC75h	13.4	0.348
20AC81h	13.4	0.155
20AC93	13.4	0.221
20AC64	13.5	0.071
20AC77h	21.5	0.326
20AC63	31.6	0.043
20AC96	32.3	0.032
20AC69	37.3	0.01
20AC88	40.2	0.013
20AC89	40.2	0.01
20AC80h	53.9	0.013
20AC65	54	0.001
20AC74h	55	0.084
20AC91	56.9	0.026
20AC71	57	0.006
20AC87	68	0.002

(Source: after Shott 1985:Table 1).

It should be noted, however, that Shott's archaeological data may represent uncommonly low values when compared to figures from elsewhere in the United States. For example, in New England, an area not known for its complex and highly visible archaeological record, McManamon (1984a: Table 4.15) presents site size/density data for a series of 13 sites in southeastern Massachusetts (originally documented by Thorbahn undated). These sites range in size from 17.0 to 143.3 m in diameter with intrasite artifact densities ranging from 7.1 to 128.9 artifacts/sq m (see Table 10). Even a cursory comparison of these site variables with the simulated values given in Table 8 indicates that all of these sites would have very high intersection and detection probabilities in an intensive 100-probe/ha sampling scheme. Since the simulation exercise represented in Table 8 was not developed with such high artifact densities in mind, it may be useful to present two additional Monte Carlo simulations that more closely approximate the Massachusetts site data discussed by McManamon (1984a), while using the same sampling intensities and geometries as those used in Tables 7 and 8 for comparison; i.e., 8 probes/ha with optimal spacing and 100 probes/ha with staggered spacing, respectively.

Table 10. Site size and intrasite artifact density data for 13 archaeological sites in southeastern Massachusetts.

Site	Site Size (m in diam)	Artifact Density (#/sq m)
9DP	17	128.9
7GP	33.5	35
7RP	40.9	22.8
7SP	41.9	101.3
7TP	43.3	12.1
7PP	53.4	14.5
7DDP	88.8	71.7
7HHP	91	60.3
7CP	104.2	7.1
7MP	113.9	28.5
7AP	126.2	64.6
7UP	128.3	7.2
7KP	143.3	72.4

(Source: after McManamon 1984a:Table 4.15).

Table 11 shows the sample output file from the STP program using the 8 probes/ha sampling intensity in an optimally spaced sampling grid. In this case, however, seven site diameter categories have been simulated (20 m, 40 m, 60 m, 80 m, 100 m, 120 m, and 140 m in diameter; see Table 11, column 2) in combination with eight artifact density categories (10, 20, 40, 60, 80, 100, 120, and 140 artifacts/sq m; see Table 11, column 4) as a reasonable approximation of the variability expressed in the Massachusetts data set. The density-distributions remain the same as those simulated in Table 7; i.e., the sinusoidal distribution and the negative binomial distribution with the k parameter equal to 1.0 (see Table 11, column 3). As the simulation results demonstrate, the relatively low sampling intensity results in a spacing between probes of about 43.30 m. Thus the maximum size of an undetected site would be on the order of 50 m in diameter. This fact is clearly expressed in the Table 11 simulation results even considering the relatively high artifact densities found in the Massachusetts data set. For example, at this sampling intensity, a 20-m diameter site with an artifact density as high as 120 artifacts/sq m would still only have a 23 to 25 percent chance

Table 11. Sample output file from STP program as in Table 7, applied to archaeological data.

NOTE: Output reflects 8 shovel probes (measuring 40 x 40 cm) arrayed with "optimal spacing" sampling geometry. Site parameters have been modified to cover a broader rage of site sizes (20 - 140 m in diameter) and higher intrasite (10 - 140 artifacts per sq m) than is the case in Table 7.

File	Site	Artifact Density			No.	Sites Intersected			Sites Detected		
No.	Diam	Fn	Mean	k	Sites	Number	Pct	Hits	Number	Pct	Hits
1	20	S	10.0	0.000	1000	233	23.3	233	125	12.5	125
1	20	S	20.0	0.000	1000	236	23.6	236	169	16.9	169
1	20	S	40.0	0.000	1000	238	23.8	238	184	18.4	184
1	20	S	60.0	0.000	1000	231	23.1	231	190	19.0	190
1	20	S	80.0	0.000	1000	240	24.0	240	195	19.5	195
1	20	S	100.0	0.000	1000	251	25.1	251	211	21.1	211
1	20	S	120.0	0.000	1000	233	23.3	233	189	18.9	189
1	20	S	140.0	0.000	1000	253	25.3	253	216	21.6	216
1	20	N	10.0	1.000	1000	234	23.4	234	141	14.1	141
1	20	N	20.0	1.000	1000	250	25.0	250	190	19.0	190
1	20	N	40.0	1.000	1000	248	24.8	248	216	21.6	216
1	20	N	60.0	1.000	1000	282	28.2	282	245	24.5	245
1	20	N	80.0	1.000	1000	228	22.8	228	206	20.6	206
1	20	N	100.0	1.000	1000	260	26.0	260	239	23.9	239
1	20	N	120.0	1.000	1000	252	25.2	252	237	23.7	237
1	20	N	140.0	1.000	1000	244	24.4	244	230	23.0	230
1	40	S	10.0	0.000	1000	790	79.0	790	481	48.1	481
1	40	S	20.0	0.000	1000	798	79.8	798	588	58.8	588
1	40	S	40.0	0.000	1000	786	78.6	786	628	62.8	628
1	40	S	60.0	0.000	1000	796	79.6	796	662	66.2	662
1	40	S	80.0	0.000	1000	796	79.6	796	659	65.9	659
1	40	S	100.0	0.000	1000	794	79.4	794	686	68.6	686
1	40	S	120.0	0.000	1000	790	79.0	790	695	69.5	695
1	40	S	140.0	0.000	1000	789	78.9	789	683	68.3	683
1	40	N	10.0	1.000	1000	796	79.6	796	469	46.9	469
1	40	N	20.0	1.000	1000	771	77.1	771	579	57.9	579
1	40	N	40.0	1.000	1000	815	81.5	815	718	71.8	718
1	40	N	60.0	1.000	1000	794	79.4	794	727	72.7	727
1	40	N	80.0	1.000	1000	808	80.8	808	733	73.3	733
1	40	N	100.0	1.000	1000	788	78.8	788	736	73.6	736
1	40	N	120.0	1.000	1000	785	78.5	785	744	74.4	744
1	40	N	140.0	1.000	1000	795	79.5	795	757	75.7	757
1	60	S	10.0	0.000	1000	1000	100.0	1566	886	88.6	939
1	60	S	20.0	0.000	1000	1000	100.0	1526	953	95.3	1105
1	60	S	40.0	0.000	1000	1000	100.0	1551	983	98.3	1206
1	60	S	60.0	0.000	1000	1000	100.0	1546	991	99.1	1287
1	60	S	80.0	0.000	1000	1000	100.0	1557	994	99.4	1309
1	60	S	100.0	0.000	1000	1000	100.0	1559	995	99.5	1344
1	60	S	120.0	0.000	1000	1000	100.0	1504	996	99.6	1333
1	60	S	140.0	0.000	1000	1000	100.0	1545	995	99.5	1364
1	60	N	10.0	1.000	1000	1000	100.0	1587	760	76.0	1008
1	60	N	20.0	1.000	1000	1000	100.0	1560	856	85.6	1195
1	60	N	40.0	1.000	1000	1000	100.0	1528	926	92.6	1326
1	60	N	60.0	1.000	1000	1000	100.0	1525	941	94.1	1358
1	60	N	80.0	1.000	1000	1000	100.0	1581	968	96.8	1462
1	60	N	100.0	1.000	1000	1000	100.0	1527	965	96.5	1431
1	60	N	120.0	1.000	1000	1000	100.0	1515	964	96.4	1424
1	60	N	140.0	1.000	1000	1000	100.0	1545	977	97.7	1469
1	80	S	10.0	0.000	1000	1000	100.0	2478	981	98.1	1525
1	80	S	20.0	0.000	1000	1000	100.0	2452	1000	100.0	1796
1	80	S	40.0	0.000	1000	1000	100.0	2465	1000	100.0	1960
1	80	S	60.0	0.000	1000	1000	100.0	2474	1000	100.0	2081
1	80	S	80.0	0.000	1000	1000	100.0	2427	1000	100.0	2102

1	80	S	100.0	0.000	1000	1000	100.0	2503	1000	100.0	2174
1	80	S	120.0	0.000	1000	1000	100.0	2499	1000	100.0	2221
1	80	S	140.0	0.000	1000	1000	100.0	2477	1000	100.0	2202
1	80	N	10.0	1.000	1000	1000	100.0	2483	865	86.5	1533
1	80	N	20.0	1.000	1000	1000	100.0	2479	955	95.5	1890
1	80	N	40.0	1.000	1000	1000	100.0	2422	982	98.2	2124
1	80	N	60.0	1.000	1000	1000	100.0	2469	989	98.9	2239
1	80	N	80.0	1.000	1000	1000	100.0	2457	991	99.1	2256
1	80	N	100.0	1.000	1000	1000	100.0	2478	993	99.3	2332
1	80	N	120.0	1.000	1000	1000	100.0	2437	988	98.8	2302
1	80	N	140.0	1.000	1000	1000	100.0	2476	991	99.1	2367
1	100	S	10.0	0.000	1000	1000	100.0	3600	998	99.8	2240
1	100	S	20.0	0.000	1000	1000	100.0	3593	1000	100.0	2595
1	100	S	40.0	0.000	1000	1000	100.0	3565	1000	100.0	2839
1	100	S	60.0	0.000	1000	1000	100.0	3579	1000	100.0	2996
1	100	S	80.0	0.000	1000	1000	100.0	3566	1000	100.0	3064
1	100	S	100.0	0.000	1000	1000	100.0	3583	1000	100.0	3132
1	100	S	120.0	0.000	1000	1000	100.0	3593	1000	100.0	3160
1	100	S	140.0	0.000	1000	1000	100.0	3518	1000	100.0	3119
1	100	N	10.0	1.000	1000	1000	100.0	3568	946	94.6	2153
1	100	N	20.0	1.000	1000	1000	100.0	3601	987	98.7	2737
1	100	N	40.0	1.000	1000	1000	100.0	3586	997	99.7	3111
1	100	N	60.0	1.000	1000	1000	100.0	3595	1000	100.0	3269
1	100	N	80.0	1.000	1000	1000	100.0	3574	1000	100.0	3353
1	100	N	100.0	1.000	1000	1000	100.0	3615	1000	100.0	3434
1	100	N	120.0	1.000	1000	1000	100.0	3542	1000	100.0	3360
1	100	N	140.0	1.000	1000	1000	100.0	3579	1000	100.0	3424
1	120	S	10.0	0.000	1000	1000	100.0	4558	1000	100.0	2996
1	120	S	20.0	0.000	1000	1000	100.0	4646	1000	100.0	3539
1	120	S	40.0	0.000	1000	1000	100.0	4605	1000	100.0	3846
1	120	S	60.0	0.000	1000	1000	100.0	4536	1000	100.0	3931
1	120	S	80.0	0.000	1000	1000	100.0	4574	1000	100.0	4037
1	120	S	100.0	0.000	1000	1000	100.0	4521	1000	100.0	4066
1	120	S	120.0	0.000	1000	1000	100.0	4570	1000	100.0	4118
1	120	S	140.0	0.000	1000	1000	100.0	4507	1000	100.0	4118
1	120	N	10.0	1.000	1000	1000	100.0	4582	980	98.0	2843
1	120	N	20.0	1.000	1000	1000	100.0	4600	995	99.5	3514
1	120	N	40.0	1.000	1000	1000	100.0	4488	999	99.9	3828
1	120	N	60.0	1.000	1000	1000	100.0	4494	1000	100.0	4061
1	120	N	80.0	1.000	1000	1000	100.0	4584	1000	100.0	4248
1	120	N	100.0	1.000	1000	1000	100.0	4548	1000	100.0	4296
1	120	N	120.0	1.000	1000	1000	100.0	4644	1000	100.0	4403
1	120	N	140.0	1.000	1000	1000	100.0	4583	1000	100.0	4382
1	140	S	10.0	0.000	1000	1000	100.0	5409	1000	100.0	3704
1	140	S	20.0	0.000	1000	1000	100.0	5431	1000	100.0	4245
1	140	S	40.0	0.000	1000	1000	100.0	5528	1000	100.0	4686
1	140	S	60.0	0.000	1000	1000	100.0	5433	1000	100.0	4740
1	140	S	80.0	0.000	1000	1000	100.0	5529	1000	100.0	4914
1	140	S	100.0	0.000	1000	1000	100.0	5478	1000	100.0	4974
1	140	S	120.0	0.000	1000	1000	100.0	5445	1000	100.0	4983
1	140	S	140.0	0.000	1000	1000	100.0	5457	1000	100.0	5020
1	140	N	10.0	1.000	1000	1000	100.0	5437	994	99.4	3336
1	140	N	20.0	1.000	1000	1000	100.0	5477	997	99.7	4164
1	140	N	40.0	1.000	1000	1000	100.0	5464	1000	100.0	4668
1	140	N	60.0	1.000	1000	1000	100.0	5455	1000	100.0	4933
1	140	N	80.0	1.000	1000	1000	100.0	5403	1000	100.0	5011
1	140	N	100.0	1.000	1000	1000	100.0	5500	1000	100.0	5189
1	140	N	120.0	1.000	1000	1000	100.0	5536	1000	100.0	5274
1	140	N	140.0	1.000	1000	1000	100.0	5447	1000	100.0	5178

Execution Time 0.4 Minutes

of being intersected (column 8) and a 19 to 24 percent chance of being detected (column 11). These probabilities provide rough approximations for Site 9DP in the Massachusetts data set in Table 10 which has a site size of 17 m in diameter and an intrasite artifact density of 128.9 artifacts/sq m. For a 40-m diameter site with an artifact density of 10 artifacts/sq m (cf. Site 7TP in Table 10), intersection probability increases to 79 to 80 percent while detection probability increases to 47 to 48 percent. For a site of the same size but with an artifact density of 100 artifacts/sq m (cf. Site 7SP in Table 10), intersection probability remains at the 79 percent confidence threshold, while detection probability increases to a range of 69 to 74 percent, depending on the density-distribution. Note that the 60-m diameter site size category marks a significant juncture in detection probability at this low level of sampling intensity. With only one exception (a 60-m diameter site with a density of 10 artifacts/sq m and clustered density-distribution), all sites above 60 m in diameter have a better than 85 percent chance of being detected at artifact densities ranging from 10 to 140 artifacts/m. In terms of the Massachusetts data set, then, the seven sites, which range in size from 88.8 to 143.3 m in diameter (Table 10), would all have a 100 percent probability of intersection *and* detection (Table 11, columns 8 and 11, respectively), with the possible exception of Site 7CP (104.2 m in diameter with a density of 7.1 artifacts/sq m). This site can be compared with the simulated probabilities for a site measuring 100 m in diameter and a density of 10 artifacts/sq m (Table 11) which still yields a relatively high detection probability of 94.6 to 99.8 percent (column 11).

As might be expected, the increased sampling intensity of the 100 probes/ha simulation results in very significant gains in discovery probability for sites sizes and artifact densities comparable to those in the Massachusetts data set. Table 12 shows the sample output file from the STP program using the same sampling intensity and geometry as in the case of Table 8; i.e., 100 probes per hectare in a staggered sampling grid. By comparing these simulated values with those of the sites listed in Table 10, it becomes clear that *all* combinations of site size and artifact density in the Massachusetts data set would easily be detectable at this level of sampling intensity. Even the smallest site (9DP), with a diameter of only 17.0 m, would be detected with a confidence estimate greater than 99 percent due to its relatively high artifact density (128.9 artifacts/sq m). Likewise, even the lowest artifact density (7.1 artifacts/sq m at Site 7CP) is associated with a site of sufficient size (104.2 m in diameter) to ensure detection at the 100 percent confidence threshold.

As these examples illustrate, Monte Carlo simulation provides a useful method for experimenting with hypothetical outcomes of sampling design geometry and various properties of the archaeological record. Several options exist for the application of such exercises. As Kintigh notes, "[t]he method can either be used ex post facto to

Table 12. Sample output file from STP program as in Table 8, applied to archaeological data.

NOTE: Output reflects 100 shovel probes (measuring 40 x 40 cm) arrayed with "staggered grid" sampling geometry. Site parameters have been modified to cover a broader range of site sizes (20 - 140 m in diameter) and higher intrasite artifact densities (10 - 140 artifacts per sq m) than is the case in Table 8.

File	Site	Artifact Density			No.	Sites Intersected			Sites Detected		
No.	Diam	Fn	Mean	k	Sites	Number	Pct	Hits	Number	Pct	Hits
1	20	S	10.0	0.000	1000	1000	100.0	2974	978	97.8	1657
1	20	S	20.0	0.000	1000	1000	100.0	2977	1000	100.0	2002
1	20	S	40.0	0.000	1000	1000	100.0	2956	1000	100.0	2209
1	20	S	60.0	0.000	1000	1000	100.0	3006	1000	100.0	2397
1	20	S	80.0	0.000	1000	1000	100.0	2949	1000	100.0	2388
1	20	S	100.0	0.000	1000	1000	100.0	2993	1000	100.0	2471
1	20	S	120.0	0.000	1000	1000	100.0	2955	1000	100.0	2495
1	20	S	140.0	0.000	1000	1000	100.0	2968	1000	100.0	2492
1	20	N	10.0	1.000	1000	1000	100.0	2987	910	91.0	1717
1	20	N	20.0	1.000	1000	1000	100.0	2963	969	96.9	2163
1	20	N	40.0	1.000	1000	1000	100.0	2980	991	99.1	2510
1	20	N	60.0	1.000	1000	1000	100.0	3062	995	99.5	2748
1	20	N	80.0	1.000	1000	1000	100.0	2992	996	99.6	2748
1	20	N	100.0	1.000	1000	1000	100.0	3024	998	99.8	2795
1	20	N	120.0	1.000	1000	1000	100.0	2934	999	99.9	2750
1	20	N	140.0	1.000	1000	1000	100.0	2976	999	99.9	2841
1	40	S	10.0	0.000	1000	1000	100.0	10619	1000	100.0	6255
1	40	S	20.0	0.000	1000	1000	100.0	10670	1000	100.0	7375
1	40	S	40.0	0.000	1000	1000	100.0	10571	1000	100.0	8214
1	40	S	60.0	0.000	1000	1000	100.0	10645	1000	100.0	8677
1	40	S	80.0	0.000	1000	1000	100.0	10580	1000	100.0	8795
1	40	S	100.0	0.000	1000	1000	100.0	10646	1000	100.0	9061
1	40	S	120.0	0.000	1000	1000	100.0	10690	1000	100.0	9180
1	40	S	140.0	0.000	1000	1000	100.0	10681	1000	100.0	9227
1	40	N	10.0	1.000	1000	1000	100.0	10560	1000	100.0	6390
1	40	N	20.0	1.000	1000	1000	100.0	10821	1000	100.0	8139
1	40	N	40.0	1.000	1000	1000	100.0	10636	1000	100.0	9053
1	40	N	60.0	1.000	1000	1000	100.0	10431	1000	100.0	9407
1	40	N	80.0	1.000	1000	1000	100.0	10676	1000	100.0	9819
1	40	N	100.0	1.000	1000	1000	100.0	10668	1000	100.0	9976
1	40	N	120.0	1.000	1000	1000	100.0	10540	1000	100.0	10025
1	40	N	140.0	1.000	1000	1000	100.0	10530	1000	100.0	10040
1	60	S	10.0	0.000	1000	1000	100.0	21769	1000	100.0	12998
1	60	S	20.0	0.000	1000	1000	100.0	21738	1000	100.0	15490
1	60	S	40.0	0.000	1000	1000	100.0	21100	1000	100.0	16734
1	60	S	60.0	0.000	1000	1000	100.0	21771	1000	100.0	18008
1	60	S	80.0	0.000	1000	1000	100.0	21325	1000	100.0	18016
1	60	S	100.0	0.000	1000	1000	100.0	21394	1000	100.0	18416
1	60	S	120.0	0.000	1000	1000	100.0	21559	1000	100.0	18904
1	60	S	140.0	0.000	1000	1000	100.0	21323	1000	100.0	18801
1	60	N	10.0	1.000	1000	1000	100.0	21741	1000	100.0	13303
1	60	N	20.0	1.000	1000	1000	100.0	21426	1000	100.0	16243
1	60	N	40.0	1.000	1000	1000	100.0	21469	1000	100.0	18436
1	60	N	60.0	1.000	1000	1000	100.0	21623	1000	100.0	19519
1	60	N	80.0	1.000	1000	1000	100.0	21541	1000	100.0	19910
1	60	N	100.0	1.000	1000	1000	100.0	21560	1000	100.0	20235
1	60	N	120.0	1.000	1000	1000	100.0	21581	1000	100.0	20401
1	60	N	140.0	1.000	1000	1000	100.0	21721	1000	100.0	20734
1	80	S	10.0	0.000	1000	1000	100.0	33827	1000	100.0	20928
1	80	S	20.0	0.000	1000	1000	100.0	34344	1000	100.0	24899
1	80	S	40.0	0.000	1000	1000	100.0	35064	1000	100.0	28175
1	80	S	60.0	0.000	1000	1000	100.0	34824	1000	100.0	29201
1	80	S	80.0	0.000	1000	1000	100.0	34305	1000	100.0	29532

1	80	S	100.0	0.000	1000	1000	100.0	34518	1000	100.0	30127
1	80	S	120.0	0.000	1000	1000	100.0	34300	1000	100.0	30321
1	80	S	140.0	0.000	1000	1000	100.0	34196	1000	100.0	30513
1	80	N	10.0	1.000	1000	1000	100.0	34315	1000	100.0	21026
1	80	N	20.0	1.000	1000	1000	100.0	34548	1000	100.0	26298
1	80	N	40.0	1.000	1000	1000	100.0	34621	1000	100.0	29911
1	80	N	60.0	1.000	1000	1000	100.0	34931	1000	100.0	31546
1	80	N	80.0	1.000	1000	1000	100.0	34555	1000	100.0	31988
1	80	N	100.0	1.000	1000	1000	100.0	34648	1000	100.0	32502
1	80	N	120.0	1.000	1000	1000	100.0	34171	1000	100.0	32382
1	80	N	140.0	1.000	1000	1000	100.0	33788	1000	100.0	32242
1	100	S	10.0	0.000	1000	1000	100.0	48081	1000	100.0	30630
1	100	S	20.0	0.000	1000	1000	100.0	47724	1000	100.0	35457
1	100	S	40.0	0.000	1000	1000	100.0	47968	1000	100.0	39335
1	100	S	60.0	0.000	1000	1000	100.0	48933	1000	100.0	41614
1	100	S	80.0	0.000	1000	1000	100.0	48878	1000	100.0	42624
1	100	S	100.0	0.000	1000	1000	100.0	48088	1000	100.0	42448
1	100	S	120.0	0.000	1000	1000	100.0	48330	1000	100.0	43173
1	100	S	140.0	0.000	1000	1000	100.0	48569	1000	100.0	43723
1	100	N	10.0	1.000	1000	1000	100.0	48847	1000	100.0	29849
1	100	N	20.0	1.000	1000	1000	100.0	48079	1000	100.0	36491
1	100	N	40.0	1.000	1000	1000	100.0	49043	1000	100.0	42226
1	100	N	60.0	1.000	1000	1000	100.0	48317	1000	100.0	43677
1	100	N	80.0	1.000	1000	1000	100.0	47515	1000	100.0	43977
1	100	N	100.0	1.000	1000	1000	100.0	47838	1000	100.0	44973
1	100	N	120.0	1.000	1000	1000	100.0	47903	1000	100.0	45468
1	100	N	140.0	1.000	1000	1000	100.0	47792	1000	100.0	45725
1	120	S	10.0	0.000	1000	1000	100.0	61600	1000	100.0	40662
1	120	S	20.0	0.000	1000	1000	100.0	62222	1000	100.0	47503
1	120	S	40.0	0.000	1000	1000	100.0	61715	1000	100.0	51376
1	120	S	60.0	0.000	1000	1000	100.0	62237	1000	100.0	53816
1	120	S	80.0	0.000	1000	1000	100.0	61971	1000	100.0	54570
1	120	S	100.0	0.000	1000	1000	100.0	62568	1000	100.0	56037
1	120	S	120.0	0.000	1000	1000	100.0	61174	1000	100.0	55184
1	120	S	140.0	0.000	1000	1000	100.0	61932	1000	100.0	56313
1	120	N	10.0	1.000	1000	1000	100.0	61924	1000	100.0	37774
1	120	N	20.0	1.000	1000	1000	100.0	62200	1000	100.0	47339
1	120	N	40.0	1.000	1000	1000	100.0	60983	1000	100.0	52626
1	120	N	60.0	1.000	1000	1000	100.0	63235	1000	100.0	57036
1	120	N	80.0	1.000	1000	1000	100.0	61882	1000	100.0	57422
1	120	N	100.0	1.000	1000	1000	100.0	62116	1000	100.0	58317
1	120	N	120.0	1.000	1000	1000	100.0	62293	1000	100.0	59108
1	120	N	140.0	1.000	1000	1000	100.0	61766	1000	100.0	59019
1	140	S	10.0	0.000	1000	1000	100.0	76030	1000	100.0	52093
1	140	S	20.0	0.000	1000	1000	100.0	74872	1000	100.0	58831
1	140	S	40.0	0.000	1000	1000	100.0	74864	1000	100.0	63771
1	140	S	60.0	0.000	1000	1000	100.0	74189	1000	100.0	65178
1	140	S	80.0	0.000	1000	1000	100.0	74427	1000	100.0	66752
1	140	S	100.0	0.000	1000	1000	100.0	73744	1000	100.0	66960
1	140	S	120.0	0.000	1000	1000	100.0	74337	1000	100.0	67878
1	140	S	140.0	0.000	1000	1000	100.0	74407	1000	100.0	68618
1	140	N	10.0	1.000	1000	1000	100.0	74749	1000	100.0	45929
1	140	N	20.0	1.000	1000	1000	100.0	73842	1000	100.0	56172
1	140	N	40.0	1.000	1000	1000	100.0	74479	1000	100.0	64164
1	140	N	60.0	1.000	1000	1000	100.0	74869	1000	100.0	67820
1	140	N	80.0	1.000	1000	1000	100.0	74391	1000	100.0	68853
1	140	N	100.0	1.000	1000	1000	100.0	74529	1000	100.0	70043
1	140	N	120.0	1.000	1000	1000	100.0	75330	1000	100.0	71546
1	140	N	140.0	1.000	1000	1000	100.0	73715	1000	100.0	70576

Execution Time 5.4 Minutes

evaluate the results that are achieved by a testing program or, perhaps even more usefully, it can be used to examine 'what if' scenarios in order to better plan a testing program" (Kintigh 1988a:689; emphasis original). In either case, the method permits objective assessment of survey effectiveness (i.e., discovery probability) as well as sampling bias. As such, it should become an integral part of the archaeologist's methodological repertoire in the planning and execution of regional archaeological surveys and intrasite testing programs. Neither CRM-based inventory surveys nor research-oriented probabilistic surveys can escape the need for bias assessment and the explicit definition of survey intensity and both of these items should be explicitly discussed in contractual scopes-of-work and in research proposals and survey designs.

Recommendations

The five policy recommendations presented below are designed to ensure that installation managers pay greater attention to survey effectiveness and bias assessment in the inventory surveys conducted under their purview. It is likely that many cultural resource managers on these installations are already cognizant of these issues and routinely consider them in the planning and monitoring of surveys. It is clear, however, that the degree of oversight on these issues is highly variable from installation to installation; thus the development of clear guidelines is desirable. The recommendations are offered as an initial step in developing clear guidelines and are aimed at both the DoD installation manager and the archaeological contractor.

1. Assessment of Regional Landscape Conditions by the Installation Manager

To develop a comprehensive Historic Preservation Plan on installation lands in which archaeological inventory surveys are contemplated, a thorough assessment must be made of the regional landscape conditions that affect both the sedimentary contexts of the archaeological resources and the survey methodologies and site discovery procedures used to discover those resources. While this may seem intuitively obvious, in practice it is not often carried out as a *prerequisite step* to inventory survey planning and execution. Thus, installation managers need to carry out (or contract out) a comprehensive geomorphological and environmental study of the regional landscape before designing and initiating an inventory survey in order to ascertain surface and subsurface landscape conditions pertinent to different kinds of archaeological occupations. Appropriate site discovery procedures can then be developed depending on the nature of these landscape conditions. For instance, if it is known beforehand that buried sites may exist in aggrading alluvial environments that will be affected by military training activities, then deep coring programs can be planned accordingly, in addition to conventional pedestrian survey of the land surface. It is also imperative that objective assessments of vegetation ground cover and degree of surface visibility be carried out before survey design planning so that proper consideration can be given to the surface area requiring some form of SST survey in lieu of pedestrian inspection methods. In many cases, seasonal considerations may be important in assessing the degree of vegetation cover, in which case surveying can be scheduled for the time of the year when surface visibility is optimal. If these decisions are made on an *ad hoc* basis as survey proceeds, a practice quite common in archaeological survey, survey scheduling and execution may be seriously compromised by the increased labor-input demanded by an unforeseen and hence unplanned SST survey. The repercussions of this situation for budgetary planning are obvious.

2. Specification of Anticipated Archaeological Resource Targets and Predictive Models of Archaeological Site Location across the Landscape by the Installation Manager

Installation cultural resource managers need to use regional archaeological overviews and previous background research on installation resources to determine the minimal kinds of archaeological resources they hope to find through inventory survey procedures. Background research should include a wide variety of sources such as past archaeological survey and excavation reports for projects conducted on installation lands and adjacent areas, ethnographic and historical data, information obtained through Native American consultations, interviews with artifact collectors and amateur archaeologists, etc. Based on these diverse data sets, installation managers need to specify in their Request for Proposals (RFPs) the *anticipated archaeological resource targets* (Dincauze et al. 1980) that they want an archaeological inventory survey to find, whether they are prehistoric or historic. Such targets would typically specify sites of a minimal size (e.g., 10, 20, or 30 m in diameter), but they could also include sites of a given size that *also* exhibit artifact densities of a specified magnitude (e.g., 0.1, 1, 5, 10, or 50 artifacts per sq m) and density-distribution (e.g., uniform, lightly clustered, strongly clustered, etc.). Information on these kinds of properties of the local archaeological record can sometimes be gleaned from regional overview literature or survey and excavation reports from previous archaeological projects in the area (see, for example, Volume 2). This type of background research and report evaluation should become a routine and on-going task so that the installation manager is able to make the informed "cyclical estimates of site size/shape distributions and artifact density/aggregation distributions" recommended by Nance and Ball (1986; see Figure 2 herein). A number of helpful guidelines and suggestions exist in the archaeological literature for evaluating past survey and excavation reports for these and other purposes (see, for example, Dincauze et al. 1980; Schiffer 1987:339-364; and Kvamme 1988a). If an installation manager knows what to expect in the local archaeological record, he or she is in a better position to decide which resources are likely to be missed through the implementation of a given survey design and level of survey intensity. By specifying and justifying these archaeological resource targets (and their associated discovery probabilities), objective bias assessment of the ensuing survey results becomes possible.

This background information on anticipated resource targets should be combined with assessments of regional landscape conditions to permit the development of predictive models of where such targeted resource will likely be located in the landscape. Thus, for different kinds of resources (e.g., sites of a particular cultural component, of a particular functional category, etc.), low, medium, and high locational "probability surfaces" (Kvamme 1988b) and subsurface "sensitivity areas" (Chase, Montgomery, and Landreth 1988) can be delimited for testing by a given survey design. The low-to-high grading would correspond, respectively, to areas of the landscape where (a) no relevant archaeological resources can be anticipated, "(b) where there are only weak or contradictory expectations, and (c) where expectations have some degree of confidence" (Dincauze et al. 1980:179). Both the targeted archaeological resources and the probability/sensitivity areas should be clearly specified in both the RFP and the contractual Scope-of-Work (SOW) for a particular survey tract or project study area. For those cultural resource managers not familiar with the issue of predictive locational modeling in archaeology, excellent overviews and applications can be found in Kohler and Parker (1986), Judge and Sebastian (1988), and Allen, Green, and Zubrow (1990).

In many cases, the background archaeological data necessary for developing predictive models simply may not exist. In these situations, compliance surveys as well as probabilistically based sample surveys should be designed to ensure the collection of reliable and representative archaeological data that could be used for predictive modeling at a future time (Altschul and Nagle 1988). According to Altschul and Nagle (1988:260), three objectives should be kept in mind for these initial surveys:

> In order to create a predictive model, a survey design must be developed that will provide sufficient data to calculate estimates on various aspects of sites and site locations, allow the identification of all or of a high proportion of magnet sites, and allow us to assess the effects of depositional and postdepositional processes. By nature, such a design must be multifaceted since each of these objectives can best be met through a different survey strategy. For example, parameter estimates rely on some type of probabilistic sampling foundation, while discovery of magnet sites or paleo land surfaces is best done by purposely selecting areas for examination.

These kinds of initial surveys should also provide useful preliminary data on site size variability and surface/subsurface artifact densities that can then be used to determine targeted archaeological resources in future surveys and to calculate discovery probabilities (see below).

3. Routine Calculation of Discovery Probabilities through Monte Carlo Simulation by the Installation Manager

Installation managers should make greater use of the quantitative methods and techniques available in the discipline of archaeology for estimating the site discovery probabilities of given survey designs. These kinds of simulation experiments should be routinely carried out in all stages of planning and monitoring archaeological inventory surveys, from the evaluation of previous surveys, to the development of Requests-for-Proposals and Scopes-of-Work (RFPs and SOWs) for future surveys, to the monitoring of surveys in progress and the evaluation of final survey results. It is recommended that IBM-compatible software for carrying out these calculations, such as Kintigh's PLACESTP and STP programs (1988b), be made available to installation managers through a site licensing agreement. Hardware requirements for this software are very minimal (IBM personal computer or compatible machine with at least 256K of memory and a math co-processor). Alternatively, similar programs could be developed for implementation on either DOS-based or UNIX-based platforms. Monte Carlo simulation software will allow installation managers to explore the full range of variables involved in calculating site discovery probabilities based on prior knowledge of the local archaeological record culled from regional overviews, past archaeological surveys, ethnographic and historical data, informant interviews, and/or specifically contracted background studies. Eventually this should be a cumulative effort where the calculation of discovery probabilities is progressively improved as more and more archaeological data become available and installation managers become more knowledgeable about what kinds of archaeological resources to anticipate. Adequate use of such software may require the development of specialized training workshops so that installation managers have a full understanding of the archaeological problem and the somewhat complicated mathematical underpinnings of discovery probability. Such workshops could also aid installation managers in tailoring the simulation experiments to the specific needs of their installation.

4. Specification of Sampling Design, Site Discovery Procedures, and Pertinent Logistical "Metadata" by the Archaeological Contractor

To maintain quality control over the planning and execution of inventory surveys and at the same time permit the evaluation of survey results, overall survey effectiveness, and sampling bias, it is imperative that the principal investigator(s) of the archaeological contractor provide detailed records of the sampling design and all aspects of the specific site discovery procedures used. What King and Cole (1978:132) were arguing more than 15 years ago is still true in many areas of the country; that survey reports and inventory listings of historic properties often provide "no basis for considering the reliability or availability of the data. Even more important, the lack of an identified property in a given area does not necessarily mean that there is nothing there. The inventory [by itself] provides no way of differentiating between areas that have been closely surveyed and found wanting and areas that have simply never been surveyed."

While many archaeologists are exemplary in this regard, there are two areas of reporting that need explicit guidelines and perhaps standardization in reporting. The first has to do with the clear description of "survey space" (i.e., the total area surveyed within the larger study area, if these two are not isomorphic) together with its precise placement on the study area map. While this task is routinely carried out for purposes of report generation, the precise spatial information on "area surveyed" is very often left out when site data are transformed into a GIS data base. Obviously knowledge regarding where sites were *not* found is as important as knowing where they *are* found when carrying out GIS-based spatial analyses.

Secondly, stricter guidelines should be implemented regarding including certain kinds of logistical metadata associated with inventory surveys that are essential for evaluating survey effectiveness and ultimately, intensity. These include such factors as accessibility, obtrusiveness of archaeological remains, degree of surface visibility, the nature of the site discovery procedures used, and most importantly, total number of person-days expended. Standard DoD guidelines should be developed for describing the percentage of surface visibility in a rapid and objective manner. For example, geographers recommend that "the most effective estimations are made using categories rather than continuous scales" (Lounsbury and Aldrich 1986:67). They suggest using the following ranges for percentage estimations: 1 to 10 percent, 10 to 25 percent, 25 to 50 percent, 50 to 75 percent, and 75 to 100 percent. More specific percentage estimations, say 46 percent surface visibility, are probably not possible anyway (Lounsbury and Aldrich 1986;p 67) nor would they be very objective. More importantly for present purposes, a specific cut-off should be selected and strictly adhered to regarding the point at which surface visibility is so low that subsurface testing becomes an absolute necessity. In the literature reviewed for this report, few archaeologists discuss this critical issue (see Scott, McCarthy, and Grady 1978 for an important exception). Following the guidelines for subsurface testing issued by the Illinois State Historic Preservation Office (1990:2), a surface visibility of 25 percent or greater is recommended as a reasonable cut-off point for reliable site discovery by surface inspection alone. Where surface visibility drops below the 25 percent threshold, systematic subsurface testing procedures should be used (as stipulated in the sample SOW for the Poinsette Range in Appendix B). In situations where the vegetation cover has a patchy character, a survey tract can be gridded completely for subsurface testing but only those areas exhibiting dense vegetation cover would receive test units while the open areas would be covered by pedestrian inspection. "This testing procedure is designed to capture the mosaic appearance of field conditions while maximizing the use of available [visibility] conditions" (McGowan, professional discussion 1994).

Finally, a reasonable estimate of person-days expended per unit area surveyed is an absolute necessity for evaluating survey effectiveness and relative intensity. These estimates should also include specification of the discovery procedures used in different portions of the study area or different phases of the project. This information is essential for calculation of the Level of Survey Effort (person-days per square mile) and Site Discovery Rate (number of sites discovered per person-day) discussed by Schiffer and Wells (1982), yet it is rarely included in archaeological survey monographs.

As a general guideline for the different categories of metadata that should routinely be reported at the end of an intensive archaeological survey, see Table 1, which is a sample database record resulting from the literature review of survey monographs conducted for this report. The key items from this list are as follows: Survey Type, Study Area Size, Sampling Fraction (if applicable), Sampling Unit Size (if applicable), Sampling Unit Shape (if applicable), Survey Intensity (see below), Accessibility, Obtrusiveness, Surface Visibility, Total Area Surveyed, No. of Sites Found, Site Area Found (total), No. of Non-Sites Found, Total Person-Days Expended, Mean Site Density, Site Recording Time, Mean Non-Site Density, Non-Site Recording Time, Level-of-Effort (person-days/ha), and Discovery Rate (# sites/# non-sites per p-d). All site discovery techniques used in the survey should also be clearly described.

5. Specification of Survey Intensity by the Archaeological Contractor

As stated previously, many archaeologists commonly associate survey intensity with crew spacing or shovel-probe interval. While spacing is definitely relevant, in practice the situation is more complex, as we have seen in the preceding two sections. Apart from crew spacing and shovel-probe interval, decisions as to level of survey intensity carried out by an archaeological contractor should minimally include discussions of the following three points, both in the initial proposal and in the resulting survey report:

1. the minimal size and complexity of archaeological "sites" (i.e., expected artifact/feature densities and density-distributions) in a given study area, as stipulated in the SOW;
2. the degree of "obtrusiveness" and "visibility"of these archaeological remains; and

3. the degree of confidence (probabilistically derived) that can be assigned to the site discovery probabilities of a given sampling geometry for the nature of archaeological remains defined in (1) and (2).

In short, there should be an explicit discussion of anticipated resource targets required by the contractual agreement and a statement of the probabilities of intersection and detection of these resources (Dincauze et al. 1980; Hasenstab 1986; Nance and Ball 1986). Obviously survey intensity will have to be defined differentially depending on whether the intended site discovery procedure is pedestrian surface survey, intensive subsurface testing survey, or a combination of the two. But regardless of the procedure(s) used, if smaller, relatively unobtrusive archaeological occurrences are expected to be missed by following a particular survey procedure and level of intensity, then that shortcoming should be objectively evaluated and explicitly stated. As a general policy recommendation, it is suggested that survey intensity be increased over those levels normally used in inventory survey and that greater use be made of SST survey techniques wherever the ground surface is obscured by vegetation cover, and DST survey techniques wherever archaeological sites are thought to be deeply buried by particular geomorphic conditions. This is essential if archaeologists and cultural resource managers seek information on *all* site occurrences in the regional archaeological record, not just the immediately visible and easily discovered portion. As a somewhat arbitrarily chosen *minimal* figure, it is recommended here that an 80 percent confidence threshold be required as a preferred "detection" probability for a given set of targeted archaeological resources. The importance of selecting a specific cut-off point or *confidence threshold* cannot be overemphasized. As Sundstrom (1993:93) observes, actual discovery probabilities derived from field survey "can then be compared to a standard, whether 100 percent or lower, in order to judge the adequacy of the survey strategy. This method may be especially useful in determining whether an area should be considered for CRM purposes to have been surveyed." However, the use of "intersection" probabilities alone as a standard confidence threshold should be avoided (cf. Sundstrom 1993) since, as we have seen earlier, relatively high intersection probabilities (i.e., greater than 80 percent) often can be attained even in cases where associated detection probabilities are extremely low due to low intrasite artifact densities (see, for example, Tables 7 and 8).

Management Implications

The principal management implication of the foregoing policy recommendations is the increase in labor-intensity and data recording required by progressively more intensive survey coverage in pedestrian surveys and the increased use of SST procedures where surface landscape conditions warrant it. The increase in labor-intensity will require a major rethinking of funding requirements for inventory surveys and this, in turn, will require greater fiscal responsibility, greater planning, and more accurate cost estimation on the part of cultural resource managers. Regarding the use of SST procedures, difficult decisions must be made as to when they should be used and at what level of intensity, given finite financial resources. As Krakker, Shott, and Welch (1983:479-480) observe:

> At some point shovel-test survey becomes excessively labor intensive in comparison to the research goals, and in each survey the decision whether or not to use shovel-test sampling should probably rely at least in part on archaeological judgement. We emphasize, however, that rigorous sampling procedures permit the exact calculation of probabilities of site discovery and thus make evaluating the results of surveys possible. Furthermore, rigorous sampling is essential for comparison between the results of different surveys.

In order to mitigate, at least partially, the high cost of intensive SST survey procedures on DoD lands, it is important that installation managers carefully evaluate local landscape conditions to assure themselves that the necessary conditions exist for subsurface testing. By also evaluating prior information on the local archaeological record, they can develop "probability surfaces" and "sensitivity areas" for the differential likelihood of locating archaeological resources of a given type. SST intensity could then vary within these areas, with the lower probability areas receiving slightly lower SST intensity. In no case, however, should low probability areas be completely ignored or "written off" as insignificant. Rather, their low probability status should be explicitly tested with appropriate site discovery procedures, but with lower confidence estimates regarding the anticipated target resources. As an example, a 30-m staggered grid could be used instead of a more intensive 10-m grid. Should that result in higher-than-expected site discovery, then the "sensitivity" model would have to be revised and more intensive procedures implemented. In both cases, however, calculation of discovery probabilities and objective bias assessment are possible through Monte Carlo simulation, thus permitting comparability of survey results.

The complete exclusion from analytical attention of any zones within the project study area should be acceptable only where modern landscape alteration and military impacts have effectively removed, covered over, or totally destroyed large tracts of the natural land surface (e.g., by modern construction, road-building, intensive training exercises, etc.). On many DoD installations, such impacts will tend to reduce the projected costs of labor-intensive SST procedures by eliminating large tracts of land from the project study area. For example, in a predictive modeling study carried out on the Fort Drum, NY, military reservation, Hasenstab and Resnick (1990) included in their analysis a thorough field inspection of "ground disturbance areas" (GDAs). This resulted in the exemption from archaeological survey of 13 percent of the installation “on the grounds of being either totally disturbed or excessively wet” (Hasenstab and Resnick 1990:296). On other types of installations, these impacts are much greater. On many Air Force bases ranging from 5000 to 8000 acres, for example, landscape alterations required for the construction of buildings, roads, hangar/runway complexes, and other infrastructural works will often affect a major portion of the installation’s property (John Isaacson, Principal Investigator, U.S. Army Construction Engineering Research Laboratories, Champaign, IL, professional discussion, 1994). Wright-Patterson Air Force Base, OH, provides a particularly good example. In a GIS-based predictive archaeological modeling study of this installation, undisturbed soils were found on less than half of the installation’s 8,000-acre property (Isaacson et al. 1992:Figure 2). All installation managers must consider these impacts and disturbance processes in their Historic Preservation Plans and in the specific planning and implementation of archaeological inventory surveys. General overviews on this topic in the archaeological literature include Wood and Johnson (1978); Wildesen (1982), and Brace and Klein (1984). Briuer and Niquette (1983) provide a general discussion of military impacts and Carlson and Briuer (1986) provide a case study on the monitoring of military impacts at known archaeological sites on the Fort Hood, TX, military reservation.

The increase in site recording that results from greater survey intensity and more inclusive site definitions is a problem faced by all archaeologists. The obvious solution is increased implementation of automated field recording techniques, such as hand-held calculators and data-recorders, pen-based computer hardware, electronic distance measuring (EDM) equipment, etc., which permit downloading of field data on a daily basis for management, analysis, and storage in master databases. Many of these same automated systems are now being implemented by natural resource managers on military installations, so that collaborative efforts in the procurement, use, and maintenance of such equipment at the installation level are now possible. It is imperative that automated recording devices and specific hardware and software suitable for archaeological field recording of SST data, controlled surface collection data, and limited site descriptions be thoroughly evaluated by the DoD so that specific guidelines can be established for their future field application by installation managers or the archaeological consultants that they contract.

5 Contracting and Cost-estimation Procedures

The Contracting Process

Before considering the problem of cost estimation for the various site discovery techniques mentioned in previous chapters of this report and the corresponding cost of post-field analysis and report-generation, it may be worthwhile to review briefly the related issue of contract specifications as they affect the planning and execution of inventory surveys and Section 106/Section 110 compliance on DoD lands. The cultural resource management literature of the mid- to late 1970s produced a flurry of articles treating the issue of contract specifications and scopes-of-work, perhaps because the contractual relationship between agencies and archaeologists was in an exploratory phase; (see, for example, Anderson 1974; Carpenter 1974; Schiffer 1975; Cunningham 1976; Schiffer and Gumerman 1977; Butler 1978, 1979; Carbone 1979; Flynn 1979; Mayer-Oakes 1979; and Rogge 1979). A major complaint at that time was that scopes-of-work were commonly written by agency personnel having little or no expertise in the field of archaeology (Schiffer 1975; Schiffer and Gumerman 1977; Butler 1979). Thus the terms of the research design and the logistical parameters of the field work were often dictated by the sponsoring agency "...without benefit of any archaeological input" (Schiffer and Gumerman 1977:85). This situation has changed somewhat in the intervening years, as more and more government agencies and private corporations have added archaeologists to their staff. As a result, the contracting personnel ultimately responsible for preparing RFPs and contractual SOWs at many Federal agencies now routinely depend on the active input of experienced archaeologists who have a clearer idea of how archaeological fieldwork should proceed in a logistical sense. While this trend is not as widespread as it should be, it has permitted many large-scale CRM projects to be rightly subdivided into "manageable stages, with earlier ones feeding information into subsequent stages" (Schiffer 1975:2). A multi-stage approach provides greater decisionmaking flexibility for the contractor undertaking the research and also gives the contracting agency a greater ability to monitor the progress and evaluate the results of each stage of the research as it proceeds.

In spite of this overall increase in archaeological input, however, problems still exist in the contracting process. Even in the 1990s, the task of preparing RFPs and SOWs specifically for archaeological surveys or for significance evaluations of known archaeological sites sometimes falls on agency personnel with little or no training in archaeology nor familiarity with current Federal legislation governing these resources. As a result, contractual language often exhibits little sensitivity to the complex decisionmaking issues encountered in planning and executing inventory surveys for Section 106/Section 110 compliance. It is not necessary that archaeologists actually write the final scopes-of-work since they are usually unfamiliar with the technical language and legal aspects of such documents. For this reason, the task of preparing a comprehensive scope-of-work should ordinarily be carried out by an agency's Contracting Officer, who is the ultimate legal authority in all aspects of contract procurement and administration. Nevertheless, the expertise of a seasoned archaeologist or cultural resource specialist is indispensable in providing that officer with technical guidance and advice as a Contracting Officer's Technical Representative (COTR).

A COTR's duties usually include, but are not limited to, the following twelve tasks (Management Concepts Incorporated 1993:1.11-1.12):

- Establishing program or project objectives;
- Developing requirements;
- Scheduling;
- Estimating;
- Budgeting;
- Developing quality controls;
- Developing specifications and work statements;
- Developing specific project plans, including financial status;
- Coordinating project planning with the contracting office;
- Evaluating proposals;
- Participating in the source selection process; and
- Monitoring work progress; identifying delays, determining needed changes, and suspensions.

For the contracting of archaeological inventory surveys or other kinds of archeological investigations, an experienced archaeologist or cultural resource specialist should be sought on matters involving the planning, implementation, monitoring, and report evaluation of an archaeological survey project. They should also be capable of providing the Contracting Officer with expert advice on Federal historic preservation legislation.

One consequence of poor archaeological input in the preparation of a SOW is the implementation of inappropriate or ineffectual site discovery procedures for certain landscape conditions or ground cover circumstances. If it is not *explicitly stated* in the SOW when and under what conditions subsurface testing must be implemented, or that the fill of all subsurface probes must be screened with one-quarter inch hardware cloth, then contractors cannot be expected to perform these tasks on a routine basis or with the rigor that an agency archaeologist or cultural resource specialist may desire. In many SOWs, there is also a misconception that inventory surveys need only locate surface sites or those sites that fall within the proposed project impact. Many archaeologists, however, take a more comprehensive approach to survey work and view intensive archaeological inventory surveys as a mandate to locate *all* sites within a given study area, regardless of depth below surface. This view is shared by agency archaeologists and contractors alike (Jameson, Ehrenhard, and Husted 1990:4, 6; McGowan, personal communication, 1994). Here extensive background research on local geomorphological conditions, as well as some geoarchaeological fieldwork, may be required to determine the feasibility of locating buried archaeological sites. While it is sometimes difficult to make this an immediate goal of a given survey project, it is nonetheless a reasonable long-term objective for a comprehensive Historic Preservation Plan (HPP). In the terminology adopted by the Legacy Resource Management Program, such a view implies the notion of *stewardship* (U.S. Department of Defense 1991, 1992; Neumann, Warren-Findley, and King 1991) and an installation HPP should foster the long-term stewardship of all archaeological resources on DoD lands, not just the readily visible ones. While "management involves control over resources and in the case of cultural resources includes identification, evaluation, preservation and use[,]...stewardship adds an ethical dimension to the process of management..." (Neumann, Warren-Findley, and King 1991:9).

Scopes-of-work, then, need to be written from the perspective of this comprehensive approach to the archaeological record and the Section 106/Section 110 compliance process. Archaeological input and expertise should be sought only from archaeologists whose academic background and cultural resource management experience *at least* satisfy the minimal qualifications required of the contractor's Principal Investigator. This will hopefully ensure that the SOW reflects a thorough knowledge of (a) the regional archaeological record under consideration, (b) the necessary discovery procedures for locating archaeological sites under local landscape conditions, (c) the procedures necessary for evaluating site significance (whether during initial survey work or during a later phase of site testing) and making nominations to the National Register of Historic Places, and (d) the current Federal legislation governing historic preservation and the treatment of archaeological resources. The SOW should "state clearly and simply how recommendations about NRHP eligibility are to be developed and justified in terms of research potential such that those recommendations may be judged against an offeror's research design" (Jameson, Ehrenhard, and Husted 1990:7). The SOW should also stipulate that the contractor be required to report all pertinent metadata regarding level-of-effort expended in the execution of field work. These points will be taken up later.

Appendix B contains a series of documents to aid the installation archaeologist or cultural resource specialist in preparing scopes-of-work or statements-of-work in the capacity of a COTR. The first is a two-page checklist of information that should be included in a SOW (U.S. Army Corps of Engineers [USACE] 1994: pp 6.5-6.6). The second is a two-page sample format for a SOW showing the order and content of each item (USACE 1994:6.7-6.8);. The third is a two-page list of "helpful hints" to guide the preparation of a SOW, especially with regard to the use of proper language (USACE 1994:6.9-6.10). These documents were prepared by the Contracts Office of the U.S. Army Construction Engineering Research Laboratories (USACERL), but follow general guidelines for the preparation of SOWs found throughout the Federal government. These are followed by two sample scopes-of-work, prepared by the Tri-Services Cultural Resources Research Center at USACERL, that exemplify the comprehensive approach to archaeological inventory survey. The first SOW was developed for a prehistoric and historic archaeological survey project at the Poinsette Air Force Range in South Carolina and includes both the preparatory background research leading to a comprehensive research design, and the actual implementation of the archaeological survey in accordance with that design. It also incorporates many of the policy recommendations presented in this document regarding site definition, survey intensity, bias assessment, and metadata reporting. The second SOW was developed for an Indefinite Delivery contract (see discussion below) for broadly conceived cultural resource investigation involving archaeological services (background research, geomorphological and environmental reconstruction, and archaeological reconnaissance and testing surveys) as well as architectural services (background research and architectural survey and assessment) (USACE 1994:10.21-10.27).

Additional examples of SOWs for cultural resource investigations on a DoD installation can be found in Jackson et al. (1993:Appendix E). These were prepared for implementation at Fort Hood, TX, a large military installation with extensive archaeological resources. A helpful case study for developing significance standards at this installation is provided by Ellis et al. (1994). Two very useful government documents to help the installation cultural resource manager prepare SOWs are the Department of the Army's (1986) pamphlet entitled *Service Contract Administration* and the Office of Federal Procurement Policy (1980) pamphlet entitled *A Guide for Writing and Administering Performance Statements of Work for Service Contracts.* Finally, the National Park Service's document entitled "Federal Archeological Contracting: Utilizing the Competitive Procurement Process" (Jameson, Ehrenhard, and Husted 1990) contains an excellent discussion of the competitive proposal process and the preparation of detailed SOWs.

Beyond the RFPs and SOWs, however, lies a another stumbling block in the archaeological contracting process, especially with regard to Federal contracts. It has to do with the fundamental structure of the contract itself, which generally lies outside the control of agency archaeologists and cultural resource specialists. Butler (1978, 1979) has examined in some detail the two prevalent forms of Federal contracts used for archaeological research: the Firm Fixed Price (FFP) contract and the Cost Reimbursement (CR) contract.

These can actually be considered two broad categories or "families" of contracts, each having a series of variants. In the FFP category are four contract types: the firm-fixed-price; the fixed-price with economic price adjustment; the fixed-price incentive; and the fixed-price with redetermination. The CR category also includes four basic contract types: cost and cost-sharing; cost-plus-incentive-free; cost-plus-award fee; and cost-plus-fixed-fee. It is important to note three other "special use" contracts also exist, one of which has important implications for Federal archaeological contracting. These are the time-and-material (labor-hour) contract; the letter contract; and the indefinite delivery (ID) contract. The latter can be further subdivided into the definite quantity contract, the requirements contracts, and the indefinite quantity contract. Although detailed treatment of these variants lies beyond the scope of this report, the fundamental differences between the FFP, the CR and the ID/IQ contracts will be explored briefly. Comprehensive treatment of this topic can be found in the Federal Acquisition Regulation (48 CFR Part 1), Sub-Chapter C, Part 16, entitled "Types of Contracts". Fixed-Price contracts are treated in FAR, Sub-Chapter C, Sub-Part 16.2; Cost-Reimbursement contracts in Sub-Part 16.3; and Indefinite Delivery contracts in Sub-Part 16.5.

Butler notes that archaeological research, because of its complex multi-phased design and largely uncertain or unpredictable results, is best handled by the Cost Reimbursement contract. In such cases, "the exact cost is unknown, the end product can only be generally described, and/or the exact steps and specifications necessary to reach the end product cannot be detailed..." (Butler 1978:742). In contrast, the FFP contract is more appropriate in cases where "the price (cost) is firm and fixed;...when a known end product can be specified;...[and when] all intermediate steps and procedures used to achieve the end product can also be specified..." (Butler 1978:741). Significantly, the former "are usually awarded on the basis of the quality of the proposal in combinations with reasonable cost" (Butler 1978:742), while the latter are "usually awarded on the basis of the lowest monetary bid" (Butler 1978:741-742). CR contracts typically allow (and require) a great deal of contract monitoring in all phases of the project, since "the burden for completion of the contract lies with the government" (Butler 1978:742), rather than with the contractor.

In spite of the greater suitability of CR contracts for conducting archaeological research, it is an unfortunate reality that "most archaeologists have been doing archaeology for the government under the firm fixed price contracts" (Butler 1978: 743). According to Butler (1978:743):

> ...[M]ost [Federal] agencies continue to use the firm fixed price contracts, partly because the agencies do not employ professional archaeologists in the contracting procedures and/or because they do not understand the real problems of doing archaeology. Also, the contracting officers for these agencies stick with the kind of contract they know best—the firm fixed price—and try to make it applicable to archaeology by attempting to specify all steps, procedures, and end products.

This is generally the case within the Department of Defense, where installation contracting officers often find the FFP format more convenient for fiscal purposes and because the burden for completing the project rests wholly with the contractor, and not on the government (Butler 1978:743). While these are certainly legitimate concerns, it is argued here that the FFP, if it is to be used for contracting archaeological research, requires additional modification to permit (a) the establishment of a fixed firm price for each *phase* of a multi-stage project and (b) the *incremental dispersal* of funds in accordance with the successful completion of each phase stipulated in the SOW. Such a procedure would allow the investigation to proceed in a well-planned and orderly fashion with step-wise evaluation of the project results. By establishing in the SOW discrete phases for the project, and permitting the incremental dispersal of funds at the completion of each stage, the installation, as contracting agency, can monitor to a greater degree the progress and quality of the project results in accordance with the specifications of the SOW (as in the case of CR contracts). It would also permit a greater degree of fiscal closure as the project proceeds, thereby eliminating the often lengthy waiting period involved for a single large dispersal of funds at the end of a multi-phase project. Cost overruns and deadline overruns are common consequences of the uncertainty and unpredictability involved in cultural resource management, and particularly in archaeological inventory surveys and site significance testing. These can be handled more efficiently in an incremental fashion through routine.project monitoring, as in the case of the CR contract (Butler 1979). Ideally such contracting should be contemplated within the larger framework of the installation HPP so that planning and budgeting can be accomplished in a timely fashion. As Jameson, Ehrenhard, and Husted (1990:p 6) observe, "...a phased program of deliverables, tied to specific contractual milestones and a phased payment system, is a good approach that allows for progress monitoring and quality control." This issue will be taken up again in the Recommendations section later in this chapter.

Another aspect of both FFP and CR contracts that merits discussion has to do with the competitive bidding process. Several archaeologists have noted that awarding contracts on the basis of the lowest monetary bid, while satisfying bureaucratic and budgetary needs, does not always produce the best, or even adequate, archaeological research results (see, for example, Butler 1979; Lacey and Hasenstab 1983). Lacey and Hasenstab (1983) provide a detailed analysis of this problem as it affected cultural resource management, and particularly the quality of CRM reports, in the state of Massachusetts during the 1970s. They observe that:

> ...[T]he competition for "rewards" in contracting situations is seen to lead to an emphasis on the satisfaction of bureaucratic and budgetary demands rather than the integrity and utility of the archaeology *per se*, given that contract allocation decisions may not rest with archaeologically informed personnel, or that those personnel are subject to another tier of non-archaeological constraints (Lacey and Hasenstab 1983:32).
>
> With the increasing emphasis on competitive bidding procedures which had been initiated at the federal level around 1975, the effective discrimination between qualitatively different proposals was reduced to a more commercial, perhaps "rational,"concern with cost. Our interpretation suggests that this funding structure had a negative impact on the quality of reports, especially during periods when contracts were scarce. The increased potential of poorly conceived and insufficiently sensitive proposals to be awarded contracts on the basis of cost begins to be realized at this point (Lacey and Hasenstab 1983:45).

This situation is a continuing danger of the FFP contract format and one that agency archaeologists should constantly try to avoid. This can be accomplished by establishing tightly worded, comprehensive, and thorough SOWs for each phase of a project. The intent of the SOW, then, should be to ensure that all truly competitive proposals would hypothetically accomplish the same research results with the same attention to quality control, and that the *only* difference between them is their monetary value.

An alternative to the FFP and CR contract formats, and one that effectively resolves many of the problems that they produce for the archaeologist, is the Indefinite Delivery/Indefinite Quantity (IDIQ) contract. As Minor (1992) has recently noted, a number of Federal agencies have begun to hire CRM contractors under indefinite services contracts since they provide a number of features mutually beneficial to the contracting agency and the archaeological contractor. Generally, ID contracts are used in cases "where the exact time of delivery is not known at the time of contracting" (Management Concepts Incorporated 1993: p 4.27). For purposes of procuring the services of an archaeological contractor, the Indefinite Delivery/Indefinite Quantity (IDIQ) contract is ideal, especially when compared with the FFP contracting format discussed by Butler (1978, 1979). A lengthy description of the IDIQ format is warranted in this regard:

> This type of contract provides for the furnishing of an indefinite quantity, within stated limits, of specified supplies or services, during the contract period, with the deliveries to be scheduled by the placement of [task] orders to the contractor. The contract provides that the government will order a stated minimum quantity of the supplies or services and that the contractor will furnish the minimum and any additional quantities not exceeding a stated maximum...An indefinite quantity contract may be used where it is impossible to determine in advance the precise quantities of the supplies or services that will be needed by the agency during a definite period of time and it is not advisable for the agency to commit itself for more than a minimum quantity. Advantages of this type of contract are: [a] flexibility with respect to both quantities [of services] and delivery scheduling; [b] supplies or services need to be ordered only after actual needs have materialized; and [c] the obligation of the agency is limited (Management Concepts Incorporated 1993:4.28-4.29).

Under these contracts, then, contractors submit competitive proposals "citing their experience and qualifications, as well as their rates. The agency then selects a contractor, generally for a 1-year period, with annual renewal options for 2 to 5 years. All subsequent work orders are simply negotiated between the agency contracting officer's representative and the contractor" (Minor 1992:22). The importance of this latter provision cannot be overemphasized. By using successive "task order" contracts once an IDIQ contract has been awarded to a given contractor, the COTR (i.e., the agency archaeologist or cultural resource specialist serving as the COTR) may be delegated the authority to issue individual task orders, subject to review by the contracting officer to ensure adequacy. This procedure permits the agency archaeologist to have maximal input into the planning, implementation, and monitoring of a project and ensures a multi-stage or phased work plan by making each phase a separate task order. By definition, it also ensures the incremental dispersal of funds by project phase. The procedure for executing a task order is fairly simple:

> Task orders may be initiated after receipt of a contractor's proposal for task accomplishment. The contractor's proposal must indicate the level of effort and skill levels to be employed, and the estimated cost of performance, in terms of either dollars or labor-hours. The COTR authorized to issue task orders must determine that the proposal is acceptable. Task orders should be issued in writing and before commencement of work. They should include, but not be limited to, the following information: [a] date of order; [b] contract and order number; [c] description of the task to be performed; [d] description of the end item (as appropriate); [e] DD Form 254 and 1423; [f] exact point of pickup and delivery; [g] inspection and acceptance codes; [h] period of time in which the services are to be performed; [I]

> estimated amount and level of effort by labor category; and [j] list of government-furnished material and the estimated value thereof (Management Concepts Incorporated 1993:4.29-4.30).

As a contracting mechanism for archaeological purposes, then, the IDIQ contracting format has several advantages that are beneficial to both Federal agencies and their contractors. As Minor (1992:23) points out:

> In removing the necessity to put each project out for bid, indefinite services contracts streamline the contracting process, saving time and energy—and therefore money—for both the agency and the contractor. Another advantage of indefinite services contracts is that an agency has a contractor "on call" for responding to emergencies (e.g., accidental exposure of human skeletal remains). Finally, a more intangible, but nevertheless important, advantage of indefinite services contracts is that they tend to impart a feeling among contractors of working with, not just for, the Federal agency.

Given all of the advantages of IDIQ contracts over the more common FP and CR contracting mechanisms, it is the duty of DoD archaeologists and cultural resource specialists to actively pursue, through their contracts office, the IDIQ contract as a means of procuring archaeological services from private contractors. Where this is not feasible at the installation level, the archaeologist or cultural resource specialist should seek the help of other DoD agencies involved in archaeological compliance, such as the nearest district office of the U.S. Army Corps of Engineers or the Tri-Services Cultural Resources Research Center at USACERL (Champaign, IL), where IDIQ contracts are already in place for this type of work. As mentioned previously, Volume 3 contains a sample scope-of-work for an Indefinite Delivery contract prepared by the Tri-Services Cultural Resources Research Center (see also Jackson et al. 1993: Appendix E).

Cost Estimation for Pedestrian Survey

Before treating cost-estimation procedures for each of the three discovery techniques treated in this report (pedestrian, SST, and DST) and the corresponding cost of post-field analysis and report-generation, some discussion is warranted with respect to the units by which these estimates should be measured. Several options exist for this purpose, including total project costs, dollar costs per unit area surveyed, time estimates per unit area surveyed or per test unit completed. Of these, the latter generally yield the most consistent and comparable results, as they eliminate many extraneous variables from consideration. These typically take the form of person-day estimates per unit area surveyed at a given level of intensity or crew/SST/DST interval spacing.

McManamon (1984a) provides a useful discussion of this issue with respect to subsurface probes, but his statement applies equally to other site discovery techniques:

> Total project costs are not good measures for comparison because they vary according to a variety of factors independent of discovery technique costs, such as remoteness of the study area, amount of travel to and from portions of the area being tested, the ease or difficulty of movement due to vegetation or topography, and the ease or difficulty... [of] excavation due to soil conditions. The combinations of these kinds of factors makes total project costs unique to the specific conditions encountered and the manner with which they were dealt. Cost in dollars is not the easiest way to compare techniques either. Dollar costs depend upon the cost of labor, which can vary independently of the discovery technique used. Instead,... cost...[can be] figured indirectly in the time required to complete individual [subsurface] tests or for test coverage of standard-sized areas (McManamon 1984a:262).

The estimates of person-days per unit area surveyed or tested, then, are essentially measures of the "level-of-effort" expended for given levels of survey intensity, as discussed in earlier sections of this report. As McManamon (1984a: p 262) points out, these estimates "then can be used with the standard cost of labor for the project to compute dollar costs if they are desired." Other mitigating circumstances such as travel time, difficulty of movement within the survey area, etc., can then be factored into the estimation on the basis of local experience.

For pedestrian survey, the archaeological literature provides few specific algorithms for calculating estimated costs. Perhaps the most useful and explicit is that offered by Schiffer and Wells (1982) in their review of archaeological survey research in southwestern Arizona. This was discussed briefly in Chapter 3. Using data derived from a limited number of pedestrian surveys (12 projects), they demonstrate the close relationship between crew spacing (intensity) and level-of-survey-effort, acknowledging at the same time the importance of other variables on level-of-effort such as recording time, accessibility, etc. In spite of these extraneous variables, however, "crew spacing seems to account for a considerable portion of the variation in survey effort" (Schiffer and Wells 1982:351). Their specific estimation of level-of-effort required per unit area of survey tract is based on "the number of person-days needed to cover one square mile at a given crew spacing, assuming that all work time is spent walking within the sample units. The number of miles that must be walked is simply 1609.347 m/square mile divided by crew spacing" (Schiffer and Wells 1982:351). If surveyors walk an estimated 3 miles per hour, this gives a figure of 536.449 hours/crew spacing.

"Dividing the previous result by 8 hrs/day yields an equation for the absolute minimum survey effort" (Schiffer and Wells 1982:351), as follows:

$$\text{Minimum Survey Effort} = 67 \text{ days/crew spacing (m)} \qquad \text{[Eq 1]}$$

This equation was then calculated for the 12 test cases and compared with the actual person-day expenditures for each one. This provides a "useful ratio ranging from 3.7 to 8.6, with a mean of 6.0" (Schiffer and Wells 1982;p 351). The wide range in this ratio is thought to reflect the extraneous variables affecting labor expenditure, such as recording time, accessibility, etc. Schiffer and Wells use the mean value of 6.0 as a multiplier for Equation 1 in order to calculate the level-of-survey-effort required to cover a survey tract of a given size at a given level of intensity. As mentioned in Chapter 3, they suggest the following equation:

$$\text{Survey Effort} = 402\text{/crew spacing (m)} \qquad \text{[Eq 2]}$$

Its utility for making cost-estimates of pedestrian survey tracts is stated in the following terms:

> To use Equation (2), one divides 402 by crew spacing (in meters) to obtain the estimated number of person-days per square mile. If the survey involves low accessibility and lengthy recording time, then the estimate should be raised by about 30 percent. Reductions can similarly be made. A good rule of thumb is that a large-scale pedestrian survey using 20 m intervals requires about 20 person-days/square mile *under average conditions for areas of good visibility and fairly low resource densities*(Schiffer and Wells 1982:351 emphasis added).

It is important to note that this algorithm should be used only as a general guideline or "rule of thumb" in making cost-estimates for pedestrian survey, and not as a cookbook recipe. Schiffer and Wells are careful to note the potential effects of reduced accessibility, poor surface visibility, difficult terrain, site density, internal site complexity, etc., on cost estimates. These effects must be factored into the estimate by knowledgeable archaeologists having previous field experience in the study area. Bearing these considerations in mind, then, Table 13 presents the estimated level-of-effort required (in person-days per unit area) for different survey intensities. The survey intensities are expressed as crew interval spacings ranging from 5 to 50 meters with the corresponding person-day estimates expressed in square miles, square kilometers, hectares, and acres.

Table 13. Estimated level-of-effort required (in person-days per unit area) for different crew interval spacings in pedestrian survey, based on algorithm developed by Schiffer and Wells (1982).

	Estimated Level-of-Effort Required			
Crew Interval Spacing (m)	(p-d/sq.mi.)	(p-d/sq.km.)	(p-d/ha.)	(p-d/acre)
5	80.4	31.04	0.31	0.12
10	40.2	15.52	0.15	0.06
15	26.8	10.35	0.1	0.04
20	20.1	7.76	0.08	0.03
25	16.08	6.21	0.06	0.02
30	13.4	5.17	0.05	0.02
35	11.49	4.44	0.04	0.02
40	10.05	3.88	0.04	0.02
45	8.93	3.45	0.03	0.01
50	8.04	3.1	0.03	0.01

Suppose that an installation requires that a 22 sq km training area be completely surveyed as part of a Base Realignment and Closure (BRAC) compliance process, and that a 15-m crew spacing has been established as the desired survey intensity based on known properties of the local archaeological record. Using Table 13, we can see that the survey tract would require a level-of-effort of approximately 10.35 person-days per square kilometer or a total effort of 227.7 person-days. Again, this assumes average survey conditions, reasonably good surface visibility, and a fairly low density of archaeological sites so that accessibility is largely unhindered and recording time is minimal. Should these conditions not prevail, then the estimate must be adjusted upward accordingly.

Previous knowledge of local landscape conditions and the regional and local archaeological record are thus indispensable in making accurate cost-estimates. As an example, on-going inventory survey at Fort Hood, TX, has provided installation archaeologists with a firm basis for estimating inventory costs in that region of the southern Great Plains. As Jackson et al. (1993:49) observe:

> On the average, the six-person field crew can walk a square km (247 acres) spaced 30 m apart in one working day. They can also record two archaeological sites in the process, by splitting into two recording teams at the end of the day. When the land is open and clear, the work will go much faster; on open prairie with good surface visibility the same crew could cover a 50 percent greater area, all things being equal. Because there are nearly always problems, vegetation, and more than two sites, the six person-days per square kilometer, or 25 person-days per 1000 acres is a good planning figure. If site density proves to be greater than 2 sites per

square kilometer, you may have to allow for an additional 8 to 10 person-hours per site. Site density will vary even within a region.

Using Jackson et al.'s estimates, it is interesting to compare their person-day per square mile figure with that obtained with the Schiffer and Wells (1982) formula presented earlier. According to their formula, a pedestrian survey carried out under normal conditions (reasonably good visibility, high accessibility, and low site density) at 30 meter crew spacing would yield an estimated level-of-effort of 13.4 p-d/sq mi (i.e., 402/30 = 13.4; see Table 13). On the other hand, Jackson et al.'s "planning figure" of 25 person-days per 1000 acres translates to an estimate of 16 p-d/sq mi, slightly higher than that of Schiffer and Wells. The comparison is useful for it demonstrates that the Schiffer/Wells formula should be considered a low-end or conservative cost-estimation guideline for pedestrian survey. Installation managers must always plan for these extenuating field circumstances, for in archaeological cost estimation, all things are rarely equal.

For purposes of evaluating the intensity of past surveys, the figures in Table 13 can also serve as a rough guide. As Schiffer (1987:348) has observed, "most modern, highly intensive surveys require between 10 and 100 person-days of effort per mi^2...Thus, if the reported level of effort falls below 10 person-days per mi^2, one is probably dealing with a survey of reduced intensity. Many early surveys, for example, had levels of effort of around .01 to .1 [person-days per mi^2]." Thus a crew spacing of 40 to 45 meters should probably be regarded as the maximum allowable interval size in contemporary archaeological surveys.

Cost Estimation for Shallow Subsurface Testing (SST) Survey

When surface visibility is greatly hindered due to dense vegetation or where geomorphic processes suggest that buried sites may exist, pedestrian survey must give way to some form of subsurface site discovery procedures, either shallow testing (usually between 25 and 100 cm in depth) or deep testing (greater that 100 cm in depth). McManamon (1984a) provides the most detailed discussion of cost estimation for shallow subsurface probes, including valuable comparative data derived from subsurface probing surveys conducted in the northeastern United States and elsewhere. His discussion centers on shovel test-pits but also includes data on other techniques such as shallow coring, and augering (see also Nicholson 1983; Stein 1986, 1991; Schuldenrein 1991; and Hoffman 1993). As mentioned in Chapter 3, shovel-tests can vary considerably in unit size, shape, depth, inspection time, and recording time, depending on the purposes of the investigation and/or the preferences and judgement of the archaeologist. This variability can make reliable cost estimation somewhat problematic.

McManamon (1984a:262) suggests two possible methods for calculating the time requirements or labor intensity of different subsurface probes:

> One is to calculate only the time required for excavating, inspecting, recording, and backfilling individual probes of different sizes. This is a basic cost that can be multiplied by the number of probes planned, and added to related costs such as the costs of setting up a test grid, moving between tests, and traveling between areas to be tested to calculate the total cost of tests. More commonly, the time needed to test a particular-size area is reported. Area coverage time estimates combine the time required for all the activities just listed above and are associated with a particular number and alignment or system of aligning the probes. Being linked to specific applications, these statements of time requirements are less easily compared than those for individual probes.

Data provided by McManamon (1984a:266, Table 4.11) from his survey at the Cape Cod National Seashore in Massachusetts show excavation rates for a series of shovel-tests placed at 25-m intervals, as well as comparative data on execution rates for soil cores and augers. These are given as number-of-tests/person-day. For the 40-cm-diameter shovel-tests, ranging from 25 to 75 cm in depth, the average excavation rate was 18 probes per person-day, with a range of 8 to 40 (Table 14). Some of this variability was due to the nature of the excavated deposits (i.e., whether they fell within a site or not) and to crew experience. Still the mean value of 18 probes per person-day is in line with estimates made by other archaeologists, given the size and depth of McManamon's probes. Lightfoot (1986:494), for example, estimates an excavation rate of 20 to 30 test probes per person-day for a probe size of 30 cm x 30 cm (Table 14). In contrast to these completion rates, Nicholson (1983) reports values at the low end of McManamon's (1984a) range. In a comparative experiment using several site discovery techniques in southern Manitoba, Canada (Nicholson 1983), shovel-testing resulted in an estimate of only 7 probes per person-day for a probe size of 50 cm in diameter and 40 cm in depth (Table 14). No screening was used, but thorough trowel sorting was carried out. Although these probes were slightly bigger than those excavated by McManamon (1984a), yielding 80,000 cu cm of sediment volume as opposed to 63,000 cu cm, it is unclear why the completion rate was so much lower, especially given the fact that McManamon's probes were all screened.

Table 14. Estimated completion rate per person-day and estimated volume of sediment extracted for four types of shallow subsurface testing (SST) procedures of a given size and depth.

SST TYPE	SIZE	DEPTH	COMPLETION RATE	RANGE	SEDIMENT VOLUME	SCREENED?	SOURCE
test-pit	100x100 cm	20 cm	1.5 probes/p-d	n/r	200000 cu cm	yes	Nicholson (1983)
test-pit	100x100 cm	50 cm?	2.5 probes/p-d	2 to 3	500000 cu cm?	yes	Spurling (1980)
shovel-test	40 cm diam	50 cm	18 probes/p-d	8 to 40	63000 cu cm	yes	McManamon (1984a)
shovel-test	30x30 cm	25-80 cm	25 probes/p-d	20 to 30	22500-72000 cu cm	yes	Lightfoot et al. (1987)
shovel-test	50 cm diam	40 cm	7 probes/p-d	n/r	80000 cu cm	no	Nicholson (1983)
posthole	15 cm diam	100 cm	10 probes/p-d	8 to 12	17600 cu cm	yes	Abbott and Neidig (1993)
posthole	20 cm diam	100 cm	4 probes/p-d	n/r	31415 cu cm	yes*	Nicholson (1983)
auger/core	10 cm diam	50 cm	46 probes/p-d	24 to 72	3900 cu cm	yes	McManamon (1984a)
auger/core	7.5 cm diam	60 cm**	25 probes/p-d	20 to 30	2650 cu cm	no	Whalen (1990)
auger/core	1.6 cm diam	26 cm	207 probes/p-d	n/r	52 cu cm	no	Hoffman (1993)

n/r = data not reportec
* = sediments were water-screened
** = average depth with range given as 10 - 150 cm deep

Using McManamon's *average rate* of rate of 18 probes/p-d as a reasonable approximation, and assuming a 40-cm-diameter probe size and 25 to 75 cm depth, we can calculate the Level of SST Survey Effort for shovel-testing as follows:

if # of probes/18 = # of person-days required,
then # of p-d/total area surveyed = Level of SST Survey Effort

For example, suppose we decide to intensively survey a 15-hectare tract of land by placing 100 shovel probes over each hectare in a staggered grid pattern with 10-m probe intervals. To calculate the level of effort required to complete this work, we first calculate the number of person-days required, as follows: 1500/18 = 83.3 p-d. Dividing this figure by the total area surveyed (in ha), we obtain the following: 83.3 p-d/15 ha = 5.55 p-d/ha. Converting this estimate to square miles, then, we arrive at a figure of 1437.45 p-d/sq mi.

This same algorithm can be used to arrive at level-of-effort estimates for Lightfoot, Kalin, and Moore's (1987; see also Lightfoot 1986) shovel-test survey on Shelter Island by substituting their value of 25 of probes per person-day (i.e., the median of their range estimate from 20 to 30 probes per person-day) when using unit sizes of 30 cm x 30 cm. They executed a total of 5523 shovel-tests within a 44-hectare study area. Thus, 5523/25 = 220.92 person-days. Dividing this figure by the total area surveyed (in ha), we obtain the following: 220.92/44 = 5.02 p-d/ha. or 1300.18 p-d/sq mi (see Lightfoot 1986:500 and Figure 8).

It is important to point out that the crucial values suggested by McManamon and Lightfoot for *number of completed probes per person-day* are by no means written in stone (as Nicholson's [1983] data demonstrate). They are both *averaged values* with associated ranges and they are both derived from large data sets gathered in two comprehensive SST survey projects in the Northeast. They should not be regarded as all-purpose "cookbook" recipes for rote use throughout the United States. Local archaeological experience should ultimately dictate the value used in a given case, but the McManamon and Lightfoot values still serve as useful points of reference. In cases where no prior experience exists, they can be used to make reasonable preliminary cost-estimates based upon published archaeological literature.

The above algorithm can be equally applied to other kinds of SST procedures such as postholing, augering, and shallow coring if you have reliable estimates of the number of probes completed per person-day. While the literature on this topic is not abundant, some data do exist. For example, in a recent summary article on posthole testing, Abbott and Neidig (1993:42) provide time estimates for the execution and thorough recording of an "average posthole test in a typical upland silt loam soil, if taken to a

1-m depth." Posthole diameter was 15 cm, yielding an estimated sediment volume of 17,600 cu cm. They suggest a completion time of 40 to 60 minutes, which roughly translates to 8 to 12 postholes per person-day (excluding grid set-up time, movement time between probes, etc.) or a median value of 10 probes/p-d (Table 14). This estimated completion rate is based on extensive field experience in the Midwest and includes screening of all fill in 10- cm levels as well as detailed soil/deposit descriptions (Abbott and Neidig 1993). It thus lies at the lower end of McManamon's suggested range for shovel-testing on Cape Cod (8 to 40 shovel-probes/p-d).

Even lower estimates of 4.9 and 4.0 postholes per person-day have been published by Wood (1976) and Nicholson (1983), respectively (see Table 14 for Nicholson's data). Wood's (1976:41) value of 4.9 postholes/person-day was derived from a subsurface testing program carried out in Georgia in which 354 postholes were executed in 72 person-days, although information on probe depths is incompletely reported. Although not explicitly stated, this lower figure may be due to the fact that some postholes were excavated to a depth of 150 cm (Wood 1976:39), rather than 100 cm as in Abbott and Neidig's study. In Nicholson's case, the postholes were excavated to 100 cm, but had a slightly larger diameter of 20 cm and thus yielded a larger volume of sediment (31,415 cu cm). In addition, all sediments were screened through one-quarter inch mesh "and a 1l [1 liter] sample was collected for water-screening from the screened soil" (Nicholson 1983:276) for the recovery of microremains (especially lithic debitage) (Table 14). Thus the added time required to excavate a slightly large volume of sediment, coupled with the time required to water-screen, would account for the lower completion rate in Nicholson's study.

Using the cost-estimation algorithm presented above, we can calculate the Level of SST Survey Effort used in Wood's subsurface sampling survey. According to Wood (1976), a total of 354 postholes was excavated within a 22-hectare study area and it took an average of 4.9 person-days to complete each posthole (including travel time and recording). Thus, 354/4.9 = 72.24 person-days. Dividing this value by the total area surveyed, we obtain: 72.24/22 = 3.28 person-days per hectare or 850.5 p-d/sq mi. This is a much lower level of effort than that reported by Lightfoot (1986) in his Shelter Island SST survey, but as expected, it is still considerably higher than the level-of-effort figures typically calculated for pedestrian surveys (e.g., Plog, Plog, and Wait 1978; Schiffer and Wells 1982). By substituting Abbott and Neidig's (1993) higher completion rate of 10 probes/p-d, we obtain a level-of-effort of 1.61 p-d/ha, or 416.75 p-d/sq mi for the same survey area.

Finally, the person-day costs for shallow coring and augering surveys can also be estimated using the above algorithm. Turning once again to McManamon's (1984a:266 and Table 4.11) Cape Cod data, shallow augering and coring (to depths of about 50 cm) were estimated to have an average completion rate of 46 probes per person-day, with a substantial range of 24 to 72 (Table 14). Sediment volume from each probe would be on the order of 3900 cu cm. Again, caution is warranted in using this average value as anything more than an approximation. Still it is interesting to note that 46 probes/p-d is some 2.5 times faster than the completion rate for a 40-cm-diameter shovel-test in McManamon's (1984a) study and over 4.5 times faster that the posthole completion rate estimated by Abbott and Neidig (1993). By substituting 1-m-deep augers for the 354 postholes in Wood's (1976) subsurface sampling scheme, we would obtain a level-of-effort of 0.35 p-d/ha or 90.65 p-d/sq mi.

Intensive augering survey was used as an SST technique by Whalen (1990) for purposes on intrasite feature discovery in the Hueco Bolson area of west Texas. He recommends the use of a large diameter bucket auger, in this case measuring 7.5 cm in diameter with a 400 cc bucket capacity. His application, then, is one of site assessment rather than site discovery, but he does provide useful cost-estimation data on probe completion rates. For purposes of intrasite feature discovery, he placed auger holes systematically at 4-m intervals, with completed holes ranging from 10 to 150 cm deep and an average depth of only 60 cm (Whalen 1990). Augering was carried out in 10-cm levels (without screening) and field recording included notes on "soil color, artifact types, and artifact densities for each 10 cm level" (Whalen 1990:326). Whalen estimates that "a practiced operator was able to complete 20 to 30 holes per day" (Whalen 1990:326). In all, some 1480 auger holes were executed by a crew of three in a 4-week time period. Assuming a 5-day work week, these figures translate to an auger completion rate of 24.7 holes per person-day (including field recording) (Table 14). This is considerably lower than the augering rate reported by McManamon (1984a), a fact that is probably due to the greater depths attained in some of Whalen's probes.

It is useful to compare the preceding completion rates with the rate obtained by Hoffman (1993) for an intrasite "close-interval" core sampling program carried out in central southern New England. In this case, a small-diameter coring device (1.6 cm) was used to take for multiple cores at 1-m intervals for purposes of tracing soil discolorations across a single archaeological site (i.e., presence/absence of red earth). Thus there was no intention of locating cultural artifacts or features *per se*. Rather, the working hypothesis of the study was "that soil coring at close intervals is an accurate predictor of soil stain locations (and therefore of more intense concentrations of cultural materials) at buried archaeological sites" (Hoffman 1993:463). Core penetration was usually quite shallow; over 80 percent of the cores stopped at 26 cm below surface (1 tube length) and the remainder (19.8 percent) were only extended an additional tube length for a maximum depth of 52 cm (Hoffman 1993:464). Because of the shallow depth, small coring diameter, and close interval spacing between these probes, Hoffman's study resulted in a notably high probe completion rate of 207 probes per person day (Table 14). As such, it exemplifies the variable nature of completion rates for shallow coring and augering, depending on the specific purposes of the subsurface exploration. For purposes of areally extensive site discovery through shallow coring or augering, McManamon's (1984a) completion rate of 46 probes per person-day (with a range of 24 to 72) is probably the most reliable estimator (Table 14).

A final subsurface testing technique included here for comparison only is the 1-m x 1-m test-pit (Table 14). This technique is not widely used for purposes of site discovery in areally extensive survey tracts due to its very low completion rates and limitations on the depths that can be attained in a reasonable amount of time. Thus, it is more appropriately used as a site assessment technique in later phases of investigation where more modest numbers of pits would be excavated. Table 14 presents data on two survey projects where 1-m x 1-m test-pits have been used for purposes of site discovery. In Nicholson's (1983) comparative study in southern Manitoba, Canada, test-pits were excavated to a depth of 20 cm, yielding some 200,000 cu cm of screened sediment with an associated completion rate of 1.5 probes per person-day (Table 14). In another SST survey carried out in Canada, in this case northeastern British Columbia, Spurling (1980) reports a completion rate of about 2.5 probes per person day (range:2 to 3) for 1-m x 1-m test-pits (Table 14), but provides incomplete data on the depths attained (see discussion by McManamon 1984a:265). Judging from a single profile drawing (Spurling 1980: Figure 11), some pits apparently reached a depth of 50 cm, although it is unclear if all test-pits were routinely excavated to this depth. Sediment volume for a test-pit of these dimensions would be 500,000 cu cm (Table 14).

In choosing between test-pits, shovel-tests, postholes, and cores or augers, it is important to realize their relative advantages and disadvantages. Test-pits and shovel-tests afford a greater "inspection window" in that they normally retrieve a greater volume of sediment. Thus they generally have higher intersection and productivity probabilities associated with them, assuming that cultural materials are located in the top 50 cm or so of the landscape. Test-pits are extremely time-consuming , however, when compared to shovel-tests, and are not usually deemed practical as a site discovery technique. Postholes and augers/cores yield progressively lower amounts of sediment and are thus less likely to locate cultural materials unless they are extremely abundant and evenly distributed across the subsurface. The advantage they have over test-pits and shovel-tests, however, is the ability to penetrate more deeply into the subsurface (up to 1.25 or 1.50 m for postholes; up to 2.00 m for cores and augers) and yield comparatively more information about site-soil/deposit relationships (Abbott and Neidig 1993). Table 14 shows comparative data on *estimated completion rate per person-day* and on *estimated volume of sediment recovered* for the four techniques that may be useful in making cost-estimates for SST surveys.

Cost Estimation for Deep Subsurface Testing (DST) Survey

Of the three general types of site discovery techniques treated here, deep subsurface testing is perhaps the most difficult for making reliable cost-estimates due to the bewildering variety of devices (both manual and mechanized) that can be used and the associated logistical demands that they present in terms of transport, set-up, and execution time. The two principal techniques classified under the DST category are deep coring and deep backhoe trenching. The former is the more commonly used technique for purposes of site discovery (Stein 1986, 1991; Schuldenrein 1991). However, deep trenching by backhoe is gaining increasing acceptance as a site discovery tool in addition to its more common role in geomorphological exploration.

As a site discovery technique, deep coring is not always effective for the subsurface recovery of artifacts and features on archaeological sites due to the extremely small size of its "inspection window" (ranging anywhere from just over 1.0 up to 10 cm in diameter). However, it *is* an effective way to locate deeply buried soil formations that are likely to contain sites. In certain areas where deeply buried cultural deposits are thought to exist, geomorphological investigations based on deep coring become an indispensable preliminary step to archaeological inventory surveys (e.g., Muto and Gunn 1981; Britsch and Smith 1989; Bettis 1993), as they alert the investigators to high probability buried landscapes that can then be selectively tested through more labor-intensive excavation techniques where warranted. Cost estimation can be based either on the labor time required to complete a single core of a specified depth (e.g., number of 3-m cores/p-d), or alternatively on the total number of linear meters cored per person-day regardless of the number of individual cores this represents. The danger of using the latter estimate, however, is that it fails to consider the travel time and equipment set-up time necessary for the execution of each core.

Deep coring devices (i.e., greater than 1.00 m below surface) can be generally subdivided into manual corers and mechanical corers, both of which must be more or less portable for areally extensive site discovery applications in remote and often difficult terrain. At the Carlston Annis shell mound in western Kentucky, Stein used a 12.7-mm split-spoon soil probe for systematic coring at the intrasite level (Stein 1986; Marquardt and Watson 1983). She reports having executed 97 cores (to a maximum depth of 2 m) in 52 person-days. This gives a completion rate of 1.9 cores/p-d. If we assume that all cores attained a 2-m depth, an estimate for coring rate would be 3.7 linear meters/person-day (Table 15). Many variables are involved in these operations, however, so caution must be used in extending these rates to other situations. Stein's caveats are instructive in this regard:

> The time necessary to core a site depends on the depth of the deposit, the size of the site, the ease with which the site matrix is cored (a function of the concentration of obstructions such as impenetrable bones, rocks, or sherds, and the dryness and composition of the fine-grained matrix), the type of [soil] sampler used, and the precision desired by the researcher...When calculating the time needed to core a site, one must allow a sufficiently long period to adjust this technique to individual site conditions (Stein 1986:521).

Presumably the systematic coring of off-site areas would yield slightly higher completion rates due to the lesser amount of archaeologically relevant information that would be produced, as suggested by McManamon (1984a) with respect to shovel-testing on Cape Cod.

In Nicholson's (1983) comparative study, a hand auger was also used to collect core samples to a depth of 200 cm, yielding a completion rate of 1.8 probes per person-day or 3.6 linear meters per person-day (Table 15). These figures are remarkably close to those attained by Stein (1986) for the same depth and with comparable equipment. In Nicholson's case, completion rate was slowed considerably by sediment extraction and bagging in 10-cm increments, after which all bags were water-screened through graduated sieves of 2 mm, 1 mm, and 0.5 mm. "The fractions recovered from these screens were then examined for evidence of [lithic] microdebitage" (Nicholson 1994:277). Although more time consuming than the SST techniques he used in his comparative study, this technique proved to be the most successful at finding cultural material (45 successes out of 140 units), in spite of the smaller inspection window it provides (Nicholson 1994; p 277).

Schuldenrein (1991) has emphasized the particular utility of deep coring through manual devices as an aid in site discovery in CRM research. He argues as follows:

> In conjunction with systematic subsurface testing..., deep coring emerges as an efficient technique for site discovery, subsurface evaluation, and short- and long-term planning. Coring for site-discovery purposes is most useful as a supplement to systematic shovel testing, which provides a broader context of archaeological productivity (through intersection with artifact concentrations). In the discovery and evaluation stages, the key benefits of coring include recovery of artifacts and anthrosols and the relatively facile recognition of the thickness, extent, and composition of the archaeological strata (Schuldenrein 1991:133).

Schuldenrein advocates the use of a large diameter (4-inch or 102-mm) bucket auger for this purpose (cf. Stein 1991) as it is highly portable and inexpensive. Unfortunately he provides no data on time or labor requirements, so no comparisons can be made with Stein's or Nicholson's completion rates for intrasite coring.

Turning to mechanical devices, a diverse array of instruments has been used for site discovery purposes, usually in conjunction with off-site geomorphological investigations. Larger truck-mounted or trailer-pulled devices with wide-diameter coring tubes, such as the Giddens soil sampling machine (see Stein 1986), are not treated here as they are of limited utility for systematic areally extensive coring in survey tracts where roads do not exist. They are also prohibitively expensive to operate except perhaps in intrasite subsurface exploration and assessment where accessibility is not a problem. Three examples of more portable mechanical coring devices are briefly discussed below along with relevant cost-estimation data.

In their geoarchaeological study of the Terrebonne Marsh, Louisiana, Britsch and Smith (1989) report the successful use of a "vibracore sampler" for extracting 29 undisturbed cores with a standard diameter of 7.8 cm and an average length of 6.5 m. Vibracoring differs from other mechanical deep coring techniques, such as percussion samplers, hydraulic samplers, or rotary augers, etc., in that it uses the principle of liquefaction, rather than mechanical force, for penetration (Smith 1984). It was developed specifically for use in fluvial and deltaic sediments, and Britsch and Smith (1989) used it exclusively in unconsolidated, saturated deltaic sediments. Although they provide no data on time or labor requirements for the coring carried out in their study, Smith (1984:66) suggests that under the right conditions, "three persons can recover up to 100 m of core in one 8-hour day." This figure translates to approximately 33.3 linear meters per person-day. Thus if Britsch and Smith (1989) were extracting 6.5 m cores at approximately the same rate, then their completion rate would be on the order of 5 cores/person-day (Table 15). However, this estimate does not include transport time by boat to each coring location nor the time necessary to set-up and dismantle the equipment.

Another mechanical coring device is the Soiltest Hydraulic Porta-Sampler described by Johnson and Alexander (1975). While initially designed for augering, the authors modified the device for use as a tube sampler for core extraction at diameters ranging from 3.2 to 11.5 cm. They report extracting "a 3.7-m core in three undisturbed segments" in a total of 1.5 hours, including set-up and dismantling time (Johnson and Anderson 1975:135-136). In an 8-hour day, then, up to 27.75 linear meters of sediment could be extracted. Assuming a crew of two people, this results in a coring rate of 13.87 linear meters per person-day or 5 cores (3.7 m each) per person-day (Table 15).

Table 15. Estimated completion rate for five different type of deep subsurface testing (DST) procedures of a given size and depth.

DST TYPE	SIZE	DEPTH	COMPLETION RATE (# probes/p-d)	COMPLETION RATE (linear m/p-d)	SOURCE
split-spoon soil probe	1.27 cm	2.0 m	1.9	3.7	Stein (1986)
hand auger	n/r	2.0 m	1.8	3.6	Nicholson (1983)
vibracore sampler	7.8 cm	6.5 m	5	33.3	Britsch and Smith (1989)
hydraulic port-a-sampler	3.2-11.5 cm	3.7 m	5	13.9	Johnson and Alexander (1975)
split-spoon percussion sampler	3.5 cm	6.0 m	2	12	Alvarez et al. (n.d.)

In this case, the lower coring rate, when compared to the vibracorer, is largely due to differences in the consolidation and texture of the sampled sediments.

Finally, in a systematic intrasite coring operation at a large archaeological site in coastal Ecuador, Zeidler (1994) contracted for the extraction of 15 3.5-cm-diameter cores on a grid pattern across the site, using a Soiltest split-spoon percussion sampler. This unit uses a 6-m aluminum tripod with a central hammer assembly powered by a 5 horsepower Briggs and Stratton motor mounted on one leg of the tripod (Alvarez undated). The 15 cores were uniformly extended to a depth of 6 m through archaeological matrix and natural sediments consisting largely of silts, fine sands, and volcanic ash, although some gravelly sediments were also encountered. The extraction of these 15 cores required approximately 2.5 8-hour working days for three people, including transport time between cores (at about 100-m interval spacing) and set-up and dismantling time. This would give a completion rate of two 6-m cores per person-day or a coring rate of 12 linear meters per person-day (Table 15). This latter figure is remarkably close to the coring rate reported by Johnson and Alexander (1975), suggesting that 12 to 14 linear meters of core per person-day is a reasonable approximation of the coring rate for terrigenous sediments. This is *only* an approximation, however, and other variables should also be factored in, such as allowances for the difficulty of penetrating certain kinds of sediments, the properties of the core sampling device used, the extra travel time needed for larger core interval spacings, and the difficulty of transport within the survey tract due to remoteness, difficult terrain, dense vegetation, etc.

Another mechanized technique for deep subsurface testing (DST) is deep backhoe trenching. While it has been used for decades as a technique for deep intrasite investigation, backhoe trenching has become increasingly popular as a regional sampling technique for geomorphological investigations conducted in tandem with archaeological surveys (see, for example, Muto and Gunn 1981; Anschuetz 1990; Blair, Clark, and Wells 1990; and Bettis [1993]). As Anschuetz (1990) notes with regard to his off-site backhoe testing program in the southern Tularosa Basin, New Mexico, it is not an especially effective site discovery technique since its ability to systematically retrieve archaeological artifacts is very limited. This is even more problematic in places such as the Tularosa Basin where sites are typically represented by low-density lithic scatters. Off-site backhoe trenching can, however, be an effective search technique for locating buried soil horizons likely to contain archaeological site surfaces, especially when it is carried out in conjunction with pedestrian survey. His reasoning is as follows:

> Although the off-site archeological testing program represents a sizable work effort, we found that the use of backhoes was inappropriate as a "blind" search strategy

> for finding low-density buried cultural deposits because of the poor archeological visibility of artifacts and the high potential for sample error. On the other hand, our experience indicates that heavy equipment can be used successfully to identify the possible extent of buried cultural distributions in areas adjacent to surface site scatters or within loose spatial aggregations of isolated occurrences. We therefore believe that the selective use of backhoes in areas with relatively high probabilities of subsurface remains has direct application to long-term managerial concerns (Anschuetz 1990:166).

Again, for a given project or survey tract, the applicability of deep backhoe trenching would depend to a great extent on accessibility.

Regarding cost-estimation figures for deep backhoe trenching, Anschuetz (1990: Table 9.2) provides detailed data from his Tularosa Basin survey. He reports a total of 661 backhoe trenches completed (of varying size) for a total of 3886 linear meters of excavation and about 6206 cubic meters of fill. The labor time required for this undertaking is reported as "167 person-days and 35 backhoe days (including operator time)" (Anschuetz 1990:149). The person-day expenditures include cleaning and recording the trench profiles as well as occasional screening of the trench fill. The figure of 167 person-days should be reduced to 144 because 23 person-days were apparently lost to work stoppages caused by military testing (Anschuetz 1990; p 140). Using the 144 p-d figure, the deep trenching rate can be calculated variously as 6206 cu m/144 p-d = 43.10 cubic meters of trench fill excavated per person-day, or as 3886 linear m/144 p-d = 26.99 linear meters of trench excavated per person-day. These figures do not include the appreciable costs of backhoe rental, transport, and operation time, however. They do provide a useful point of reference for estimating general archaeological labor requirements. Two critical variables for making cost estimations for this type of subsurface testing are: (1) the degree of thoroughness with which the fill is to be sifted for systematic artifact retrieval; and (2) the degree of detail with which stratigraphic information from the trench sidewalls is to be recorded. These decisions, of course, depend on the specific objectives of the project as well as the preferences of the principal investigator.

Cost Estimation for Post-Field Analysis and Report-Generation

Developing standard cost-estimation procedures for the post-field analysis and write-up phases of an archaeological project is usually a difficult, if not impossible, task due to the highly variable objectives, scope, and intensity of the undertakings. One way to approach the issue of post-field cost estimation is by constructing "...some more or less standard ratio between field and non-field costs..." (Dr. Thomas F. King, CEHP Incorporated, personal communication, 1993). This procedure is notoriously spurious, however, for archaeological projects involving intensive site-specific excavations or even systematic subsurface testing. While many archaeologists automatically assume that the "field work" to "post-field analysis" cost ratio would be heavily skewed toward the latter, such is not always the case. In fact, variability seems to be the more common. For example, in the Lubbub Creek Project in west central Alabama, Peebles' (1983:Table 19) cost estimation data for intensive excavation and field recording (32,921 person-hours) and post-field laboratory analysis (10,142 person-hours) indicate a 3.2:1 ratio in favor of the former. This ratio is far from standard. In a cost analysis of archaeological excavations conducted at eight sites in the southeastern United States (Carnes et al.1986), the ratio of person-hours dedicated to field and nonfield activities varied widely from site to site. Three sites ranged from 1.4:1 to 1.6:1 in favor of field activities, four sites ranged from 1:1.2 to 1:6.0 in favor of post-field analysis and report preparation, while one site showed an even 1:1 ratio between both activities.

The degree to which this variability affects archaeological survey projects is difficult to assess. For pedestrian survey, Jackson et al. (1993:50) suggest the following field/nonfield cost estimation ratio for archaeological survey projects on the Fort Hood military reservation:

> A good rule of thumb is to allow about 2.5 to 4 person-days of analysis and write-up time for every calendar-day of field time. There are economies of scale to be realized. There is a minimum start-up cost for the smallest field-work project which grows only slightly as the size of the project grows. The same applies to reports covering ten sites or 200. Bigger projects will be closer to 2.5 person-days and smaller projects may go to 3.5 or even 4.

This estimate does not account for the use of SST and DST techniques, however. It is valid only for pedestrian surveys in which "the only excavation done is limited to a few shovel probes to establish site boundaries and find a shallowly buried component...If [intensive] shovel testing is included, costs can vary tremendously depending on the type and amount of heavy equipment involved" (Jackson et al. 1993:50). It is likely, then, that in cases where pedestrian inspection techniques give way to repetitive subsurface testing and sediment screening, field costs begin to rise systematically above laboratory analysis and report-generation costs, especially where large numbers of probes do not encounter cultural materials or where labor-intensive field processing techniques such as water-screening are used.

In summary, then, the rule of thumb suggested by Jackson et al. (1993) provides a reasonable field/nonfield cost ratio for pedestrian survey under ideal landscape conditions. However, where subsurface testing, test excavations, or specialized deep coring or backhoe trenching studies are required, standard ratios of field to nonfield labor costs become problematic. As Jackson et al. (1993;p 50) note, "recent [field] costs at four different Army installations varied from $27 to $673 per acre" depending on the amount of subsurface testing that was required and the corresponding field to non-field cost ratios no doubt varied accordingly.

Recommendations

In light of the preceding discussions of the contracting process and the issue of cost estimation for archaeological surveys, the following five policy recommendations are proposed.

1. Development of Multi-Phase Contracting Mechanisms

The multi-stage nature and logistical complexities of archaeological field work and analysis should be adequately reflected in DoD Requests-for-Proposals and in Scopes-of-Work for specific contracts. These documents should be prepared with the active input of an experienced archaeologist or cultural resource specialist acting in an official capacity as the Contracting Officer's Technical Representative. If a given installation does not have the personnel capable of fulfilling that role, then arrangements should be made with other DoD agencies directly involved in cultural resource management (such as the U.S. Army Corps of Engineers), so that appropriate contracting procedures can be put into place.

The multi-stage project design should minimally include separate task items for the following sequential activities:

1. an initial regional overview of previous historic and prehistoric baseline data for the installation that includes all pertinent environmental (especially geomorphological) and cultural background research.
2. development of a comprehensive research design for intensive archaeological survey based on data gathered though background research.
3. performance of the intensive archaeological survey and related data analysis and data compilation.
4. final report of survey results, including all NRHP eligibility evaluations and recommendations;
5. after appropriate report evaluation by agency archaeologists and other interested parties (i.e., the corresponding SHPO), performance of additional field work (continued survey and/or site testing) *where necessary* in order to make additional NRHP eligibility determinations.

This kind of project design, if implemented with detailed scopes-of-work for each phase of the research, will ensure that a "good faith" effort will be made to locate and identify all archaeological sites according to both the letter and intent of historic preservation law. DoD contracting officers and installation cultural resource managers should explore ways to implement these comprehensive multi-phase projects either within the context of a modified Firm Fixed Price contracting format, or more appropriately, through the Cost Reimbursement contracting format, as it is within the Interagency Archeological Service of the Department of the Interior (Butler 1978, 1979). Alternatively, the Indefinite Delivery/Indefinite Quantity contracting format should be used where possible so that separate RFP/Contract cycles can be established for each phase of the project within a larger contractual arrangement with a single archaeological contractor. This format permits a greater amount of flexibility for the agency archaeologist in scheduling individual project tasks as well as for rapidly responding to unforeseen "emergencies" requiring timely field visits and managerial decisionmaking. It also permits a closer working relationship between the two contracting parties that is mutually beneficial (Minor 1992).

2. Incremental Dispersal of Funds by Project Phase or Task

The multi-phase contracting mechanism should also include a provision to allow for incremental dispersal of research funds to the contractor at the successful completion of each phase of the research. Separate dispersal of funds should also be considered for ancillary studies related to archaeological survey and site-testing phases, such as separate or subcontracted geomorphological studies, radiocarbon analyses, pollen/phytolith analyses, etc. as stipulated in the scope-of-work. This will prevent fiscal "bottlenecks" in the progress of the overall research endeavor. As a common example, archaeological surveys are very often completed well in advance of a radiocarbon analysis on charcoal samples recovered in the survey. Yet because the two research tasks are bound together in the same FFP contract, the archaeological survey cannot be considered completed (and the contractor cannot be paid for his or her services) until the radiocarbon results are also completed. Since the radiocarbon laboratory is a separate entity with its own research priorities and scheduling problems, the contractor has no control over the timely completion of laboratory results, yet in a sense is held accountable for this delay. This is largely a scheduling problem that could be effectively addressed through the separate "tasking" of these ancillary research activities and the incremental dispersal of funds to pay for them within the FFP, CR, or ID/IQ contracting formats.

3. Specification of 80 Percent Confidence Threshold for Site Discovery Probability

Requests-for-Proposals as well as contractual Scopes-of-Work should stipulate that confidence estimates of 80 percent or higher be attained for site discovery probability at a given level-of-effort, a given crew/probe interval spacing, and a minimum targeted site size. Each of these last three variables should be specified by the agency archaeologist or cultural resource specialist in the RFPs scope-of-work before awarding of the contract. It is then the contractor's obligation to comply with the 80 percent confidence threshold and make "good faith" estimates of the kinds of archaeological resources that may not have been recovered in the survey. Final survey reports should routinely include a section on *bias assessment* where these confidence estimates are explicitly treated. This will ensure a greater degree of comparability between different survey results within an installation, within a given archaeological region, and within the DoD generally.

4. Routine Use in Cost Estimation of Previous Survey Metadata Pertaining to Level-of-Effort Expended

Requests-for-Proposals and contract specifications for archaeological surveys should require a full recording of survey intensity and level-of-effort expended. These include, respectively, the crew interval spacing or subsurface test spacing used, and the number of person-days expended per unit area surveyed. Routine recording of this metadata will greatly facilitate the evaluation of project effectiveness and permit a greater level of comparability with other DoD projects for which similar data exist.

5. Separate Cost-Estimation Procedures in Accordance with Site Discovery Techniques and Level-of-Effort Used

Reliable cost estimation for archaeological inventory surveys should be closely tied to the site discovery techniques deemed appropriate for a given project and for specified levels-of-effort. Labor costs cannot be calculated in the same way for pedestrian surveys, shovel-test surveys, or deep coring surveys. If combinations of these techniques must be used within the same project, cost estimation should be carried out for each survey tract using a different technique. Some general guidelines for making these cost-estimates have been presented above based on published archaeological literature. They should not be used uncritically, however, and installation archaeologists and land managers are encouraged to consult local and regional archaeological literature for comparable data on labor time requirements for different discovery techniques so that appropriate adjustments can be made for local landscape conditions, local archaeological resources, and labor and equipment costs. Much of this information may seem trivial for some DoD archaeologists or cultural resource specialists with ample research experience in a given locality or region. However, for other archaeologists and land managers charged with RFP and SOW development, contract monitoring, budgetary decisions, etc., these guidelines will hopefully provide a useful point of reference.

Management Implications

The principal management implication of the preceding policy recommendations has to do with the long-term planning and scheduling of archaeological inventory surveys. Installation managers should, first and foremost, develop effective, long-range Historic Preservation Plans or more precisely, Cultural Resource Management Plans (CRMPs) as required within the Department of Defense. Each service branch has regulations in place that govern the implementation of CRMPs.

For the Department of the Army, HPP's are mandated by Army Regulation (AR) 420-40, *Historic Preservation* (April, 1984). This regulation will soon be superseded by AR 200-4, which is still under development. In the meantime, interim guidance for the preparation of Cultural Resource Management Plans is provided by the Headquarters, Department of the Army (HQDA) Memorandum (dated 7 April 1994) entitled *Responsibilities and Staffing Procedures for Cultural Resources Compliance Actions* (M. Woods, personal communication, 1994). For the Department of the Navy and the United States Marine Corps, NAVFACINST 11010.70A, *Guidance for Preparing Historic & Archeological Resources Protection Plans at United States Navy Installations* (June, 1990), serves this function, while for the Department of the Air Force, it is Air Force Instruction (AFI) 32-7065, *Cultural Resources Management* (June 1994), especially Attachment 3 entitled "Preparing Cultural Resources Management Plans." More broadly, the DoD's Legacy Resource Management Program also contains recommendations for the development of comprehensive CRMPs at the installation level. Under the first legislative purpose of the Legacy Resource Management Program, the DoD is specifically directed "to establish a strategy, plan, and priority list for identifying and managing significant biological, geophysical, *cultural, and historical resources* existing on, or involving, all Secretary of Defense lands, facilities, and property (U.S. Department of Defense 1991:2; emphasis added). The extent to which this task has been carried out in the DoD is highly variable, however. As Neumann, Warren-Findley, and King (1991:10; see also King and Drucker 1993) have observed:

> A number of installations have "historic preservation plans" or "cultural resources management plans"...but there are serious questions about their effectiveness. Some apparently languish on shelves, unattended to; others do not work because they are not effectively integrated with environmental or installation master

planning; others are misinterpreted by poorly trained staff or are forgotten during staff rotations. Still others are not implemented for lack of funding.

Successful archaeological inventory surveys on DoD installations can only be efficiently planned, contracted, and executed within the larger framework of a well-conceived and proactive CRMP. Intensive archaeological surveys, like other kinds of cultural resource studies and surveys (Derry et al. 1985), should be planned and budgeted from the perspective of an installation "master plan." In this way the specific projects can be correctly carried out in an orderly multi-stage manner in accordance with the long-term monitoring and quality control aspects of the typical HPP or CRMP (Figure 1). As King and Drucker (1993:5) note with respect to cultural resources generally, "...it is not necessary to identify all cultural resources at an installation before preparing a CRMP. The plan itself may provide for ongoing identification. It should define appropriate approaches to developing information on resources and specify how to select among different approaches." In this regard, the present document has attempted to define "appropriate approaches" to the identification of archaeological resources.

General guidance on the development of CRMPs within the DoD can be found in a recent document of the Legacy Resource Management Program entitled *Principles of Cultural Resource Management Planning in the Department of Defense* (draft) by King and Drucker (1993). It contains helpful discussions on the purpose, scope, content, and implementation process of an installation CRMP. For the Department of the Army, a detailed "how-to" treatment on the implementation of installation CRMPs can be found in Jackson et al. (1993:27-71). This discussion is particularly useful in that it covers a wide range of issues normally encompassed by an installation CRMP such as the various players and their roles, basic elements of the CRMP, its integration into installation decisionmaking and master planning, funding, staffing, and training requirements, contracting, integration of the CRMP with the National Environmental Policy Act (NEPA) process, etc.

Several case studies of successful CRMPs or HPPs are also available for consultation, only a few of which can be mentioned here. Zier et al. (1987) provide a comprehensive Historic Preservation Plan for the Fort Carson Military Reservation, Colorado, which is currently being used as a model for HPPs at other DoD installations (e.g., Kirtland Air Force Base, NM). Anderson and Wilson (1987) developed a comprehensive four-volume Historic Preservation Plan for Fort Polk, Louisiana, and a useful overview of this plan can be found in Anderson et al. (1989). Finally, Jackson et al. (1993: Volume 3) provide an instructive example of a highly effective Cultural Resource Management Plan for Fort Hood, Texas, corresponding to the years 1990-1994. Together, the three HPPs provide interesting contrasts in terms of physiographic environment and landscape conditions, relative complexity of the archaeological record, amount of previous archaeological survey, and differences in their military mission and impacts on the landscape. Installation cultural resource managers contemplating their own multi-year CRMP would do well to consult the Fort Carson, Fort Polk, and Fort Hood documents. Such foresight and planning will avoid the problem of piecemeal and haphazard contracting for archaeological surveys, or any other cultural resource surveys. It will also avoid the problem of unnecessarily short "turn-around" times between contract awards and the completion of field work, which inevitably result in hasty, least-effort research. In the context of an effective CRMP, multi-phase contracting mechanisms and the incremental dispersal of funds would provide the installation manager with greater flexibility in contract specification and a greater degree of control in project monitoring and evaluation.

6 Summary and Recommendations

Summary

The preceding chapters are intended as points of reference for evaluating the interrelated problems of site definition, survey intensity, and cost estimation in archaeological inventory surveys. It should be reiterated that the present study is a working document for the establishment of official DoD policy regarding intensive archaeological survey. The detailed treatment of these issues herein has attempted to point out their implications for future inventory surveys on DoD lands and to establish a tentative series of recommendations for discussion and evaluation among archaeologists, cultural resource specialists, installation managers, and other interested parties within and outside of the Department of Defense.

The comprehensive treatment given to the issue of site definition was a by-product of the initial investigation into survey intensity, and brings into sharp focus the justification for a standardized definition of this central concept. Likewise the multiregional data gathered on archaeological survey designs and site discovery procedures has provided quantifiable measures of regional trends in the survey methodologies and site discovery procedures commonly employed by U.S. archaeologists. The effects on these trends of different landscape conditions and temporal changes in cultural complexity have also been examined through comparative study of the eastern region of the Great Basin culture area and the Illinois region of the Northeast culture area. These two contrastive regions serve as useful examples of the fundamental differences in eastern United States and western United States archaeology, in terms of the effects of variable surface visibility on site discovery probabilities, as well as different disciplinary conventions for studying the archaeological record.

Specific methods for calculating site discovery probabilities were also explored as a means of promoting greater attention toward bias assessment and quality control. Finally, our extensive literature review of archaeological survey monographs has provided a useful corpus of data relating to the issue of cost estimation, the third component of the present project. The treatment of cost estimation has included guidelines and specific algorithms for a range of survey methods and site discovery techniques pertinent to different landscape conditions. These include conventional pedestrian survey in areas of moderate-to-high surface visibility, subsurface test-pit, shovel-probe, posthole, or augering surveys in areas with low-to-nonexistent surface visibility, and deep coring programs in areas where geomorphological processes have resulted in deeply buried archaeological sites.

A related issue is the contracting process through which inventory surveys are planned and executed. Recommendations have been made to permit the archaeological contractor more flexibility in developing and implementing research designs and in field logistics at the same time that DoD contracting agencies are permitted a greater flexibility in the dispersal of payments and in monitoring of the field work as it proceeds. The dual issues of site definition and survey intensity, of course, are intimately related to cost estimation and the efficient planning and execution of archaeological inventory surveys. Thus the cost-estimation guidelines developed in this project take into consideration the recommendations adopted for standardization of site definition and for greater rigor in the definition of survey intensity.

Recommendations

The principal recommendations are listed below under the three basic topical issues treated in this document:

Site Definition

- The definition of an archaeological site should follow that of Tainter (1983: p 132; emphasis original) in which a site is "*any location where human behavior has resulted in the deposition of at least two different artifacts in close proximity, or other evidence of purposive behavior.*"

Survey Intensity and Site Discovery Procedures

- Assessment of regional landscape conditions by the installation manager. Specification of anticipated archaeological resource targets and predictive models of archaeological sensitivity across the landscape by the installation manager.
- Routine calculation of discovery probabilities through Monte Carlo simulation by the installation manager.
- Specification of sampling design, site discovery procedures, and pertinent logistical "metadata" by the archaeological contractor.
- Specification of survey intensity by the archaeological contractor.

Contracting and Cost Estimation

- Development of multi-phase contracting mechanisms.
- Incremental dispersal of funds by research phase or task.
- Specification of 80 percent confidence threshold for site discovery probability.
- Routine use in cost estimation of previous survey metadata pertaining to level-of-effort expended.
- Use of separate cost-estimation procedures in accordance with site discovery techniques and level-of-effort used.

It is intended that specific DoD policy recommendations can be implemented in the near future. Of the recommendations suggested herein, perhaps the most important are those relating to the issues of survey intensity and detailed recordkeeping of metadata pertaining to level-of-effort expended. There is a special need to achieve greater quantitative rigor in determining survey intensities appropriate for a given circumstance (i.e., landscape conditions, nature and complexity of local archaeological record, etc.), and in calculating confidence estimates for the site discovery procedures selected in a given case. The overall goal is to make the implementation of these recommendations both a fiscal and a logistical reality for cultural resource managers on DoD installations. Since the recommendations clearly imply a greater labor-intensity and analytical rigor in the design and execution of inventory surveys, it is imperative that the DoD ensure that managers are provided with sufficient fiscal resources and the analytical tools and techniques necessary for their successful implementation. By the same token, however, it is incumbent upon installation managers to develop long-range, pro-active Cultural Resource Management Plans within which archaeological inventory surveys can be effectively planned and executed.

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Appendix A: Site Definitions from Regional Archaeological Literature in the Continental United States

SURVDATA: site definitons, page 1

1
Keyname: Raab 1982
Sort Key: Plains (southern region)
Site Definition: Two kinds of archaeological resources or manifestations are discussed: 'sites' and 'localities'. The latter are defined 'as isolated finds, streambank faunal deposits, or small scatters of artifacts' (p.27). 'Sites' are not explicitly defined but had several properties of interest including 'depth, horizontal dimensions, and artifact content' and 'potentially contained features, assemblages of artifacts, and other significant data' (p.27).

2
Keyname: Marmaduke and Conway 1984
Sort Key: Southwest (Hohokam region)
Site Definition: The 'site' concept is rejected in this monograph, and the concept of 'cultural acreage' is utilized instead as a means of documenting archaeological manifestations within given spatial sampling units (quadrats). The authors state that: 'In keeping with the basic project goal of characterizing the acreage rather than identifying site boundaries, there was no minimum density for defining a site or for recordation. When densities extended beyong unit boundaries, no attempt was made to determine their extent. Isolated artifacts were plotted on the unit maps. The surface densities of artifacts in ranges of light (1-9/9 sq m), moderate (10-30/9 sq m), and high (>30/9 sq m), were recorded with hatchuring' (p.99). However, shaded areas on quadrat maps indicating artifact densities greater than one item per 9 sq m could be used as a rough proxy for an archaeological 'site'. A thorough discussion of the justification for employing the 'cultural acres' concept is provided in pp.6-11.

3
Keyname: Lightfoot et al 1987
Sort Key: Northeast (coastal region)
Site Definition: 'Sites' were defined largely through subsurface sampling (shovel-probe testing). The term 'archaeological manifestations' is used generically to refer to a) isolated finds, b) low density scatters, and c) high density scatters. Only the latter two seem to qualify as 'sites' in the conventioanl sense of the term. All three are defined in terms of three criteria: (1) spatial dimensions; (2) percentage of positive shovel probes; and (3) artifact density. See pp.41-42 for quantitative limits separating the three types.

4
Keyname: Waselkov 1980
Sort Key: Southeast (coastal plain region, piedmont region, and Appalachian highlands region)
Site Definition: 'For this survey and interpretation, the concept of 'site' is defined as 'a location of artifacts.' Artifacts may in turn be defined as 'any material or object modified in form or context by past human activity.' Thus a site is potentially informative about past cultural behavior and organization' (p.136).

5
Keyname: Tipps 1988
Sort Key: Great Basin (eastern region) and Southwest (western Anasazi region)
Site Definition: Sites and isolated finds were termed 'cultural resources' and 'were defined as identifiable loci of historic and prehistoric human activity. When a cultural resource was found, the crew chief determined whether it should be recorded as a site or an isolated find. If features, rock art, or at least five artifacts in a 10- by 10m area were present, the locus was recorded as a site, Otherwise, the materials were recorded as an isolated find' (pp.35-36).

6
Keyname: Kane et al 1986
Sort Key: Southwest (western Anasazi region)
Site Definition: Explicit site definition criteria are given only for one probabililistic survey tract of the larger study area, which is treated in Chapter 9 (pp.379-433). The authors (Schlanger and Harden) note that site definition criteria changed slightly between two field seasons (1979/1980). 'In 1979, sites were defined by the presence of artifact clusters or by areas of human alteration of the terrain that had enough spatial discreteness and integrity to be easily defined. No arbitrary limits were imposed on artifact presence or density when defining what was or was not a site (although density rules were used to determine site limits)' (p.386). 'In 1980, sites were defined as any locus of past human activity that had at least 20 artifacts (flakes, sherds, tools) within an area of approximately 30 by 30 m, or which had surficial evidence of structures, cists, or other such features...Site limits were determined by absolute

distribution of artifacts. That is, site boundaries were extended to include any artifact that could reasonably be thought to have at one time been affiliated with the general site occupation' (p.386). 'Isolated finds' were recorded for both field seasons and 'consist of the following: (1) any tool or 'finished' artifact (presumably used) such as a biface, mano, or core; (2) any diagnostic artifact (for cultural/temporal assignment purposes) such as certain ceramic sherds; or (3) a small collection of flakes or sherds or other such items. The latter criterion was made more specific in 1980 and defined an isolated find as a collection of between 10 and 20 flakes or sherds or other such items contained in an area of less than 30 by 30 m.' (p.386).

7
Keyname: Lafferty et al 1981
Sort Key: Southeast (Ozark-Ouachita highlands region)
Site Definition: None given

8
Keyname: O'Brien et al 1982
Sort Key: Northeast (Illinois region)
Site Definition: A 'probabilistic site' (i.e., a site found in probabilistic survey) '...is defined as any isolable aggregate of five or more surface artifacts having a spatial midpoint that occurs inside a sample quadrat' (pp.339-340 in Chapter 16: Prehistoric Settlement Patterns by Robert E. Warren)

9
Keyname: Taylor & Smith 1978
Sort Key: Southeast (piedmont region)
Site Definition: None given, but authors follow Glassow (1977) in use of the term 'archaeological resource' instead if 'site'. He defines three categories of archaeological resources: items, deposits, and surfaces. Beyond these three categories, resources are also described in terms of five 'properties', as follows: variety, quantity, clarity, integrity, and environmental context. (See discussion pp.155-157). No minimal criteria are given for site definition, however.

10
Keyname: MacManamon 1984a, 1984b
Sort Key: Northeast (coastal region)
Site Definition: "Site' was used in this study to refer to a bounded area within which artifacts occur. The discovery of a single artifact as well as the discovery of thousands indicated the existence of a site. Site boundaries were set along contour lines of artifact density, interpolated from shovel test and excavation unit data, beyond which artifacts were not expected to occur, i.e., the zero isopleth. In the context of this study, then, sites were contiguous areas that contained a veneer of deposits with a density of at least one artifact per shovel test' (pp.49-50).

11
Keyname: Fuller et al 1976
Sort Key: Southwest (Hohokam region)
Site Definition: In general, the three criteria of the Arizona State Museum Site Survey Manual (AZM 1974:3) were utilized in the definition of any site : '(1) it must exhibit definable limits in time and space; (2) it must contain more than one definable locus of past human activity; and (3) it should have an artifact density of more than five per square meter' (p.68). In this project, however, only the first two criteria were strictly employed and it was 'suggested that artifact density criteria...be field tested at the earliest stage of any project to see if it is , indeed, functional. If so, an estimation of density threshold should be determined on the basis of locally specific cultural manifestations' (p.68).

12
Keyname: Coombs 1979
Sort Key: Great Basin (southwestern region)
Site Definition: Following the BLM Site Classification System given in Appendix I (p.141), 'an archaeological site is defined as a locus of prehistoric activities which can be delineated specifically by the cultural remains present and can be separated by distance and/or observable geomorphic features from other loci of prehistoric activities. The cultural materials that constitute a site are basically artifacts and/or cultural featurtes.'

SURVDATA: site definitons, page 3

13
Keyname: Lebo & Brown 1990
Sort Key: Plains (southern region)
Site Definition: 'A site is defined as the locus of past human activities that can be delineated by the presence of cultural features (e.g., houses, storage oits, hearths, ditches, mounds,etc.), and/or cultural artifacts (e.g., stone tools, chipping debris, pottery, etc.)' (p.18).

14
Keyname: Rodeffer & Galm 1985
Sort Key: California (north coast ranges region)
Site Definition: 'Four categories of material remains were recorded during the survey: isolated finds, scatters, clusters, and sites. 'Isolated finds' were defined as portable artifacts not associated with other artifacts or features. Quantitatively, single items discovered more than 50 m from another artifact were identified as isolated finds. A 'scatter' was defined as an area containing single artifacts distributed approximately 25 to 50 m apart. The category 'cluster' was characterized by an area more or less 15 m in diameter which contained between two to 10 artifacts. The criteria used to define an archaeological cluster, that is, the area and number of artifacts, was established arbitrarily and employed as a distinguishing characteristic for site designation. A 'site' was defined as an area 15 m in diameter which contained a minimum of 11 artifacts or a feature. A 'feature' was defined as a phenomenon reflecting past activities through the fortuitous accumulation of materials and/or the production or construction of a faciltiy (e.g., hearth, talus pit, hunting blind, cairn)' (p.48).

15
Keyname: Hartman 1985
Sort Key: Plateau (middle Columbia River region)
Site Definition: 'Four categories of prehistoric cultural materials were recognozed in the course of the field investigations: isolated finds, low density scatters, high density scatters, and isolated features. Low density scatters were defined as fewer than five artifacts per 100 square meters and were recorded as isolated finds. Scatters with high densities of artifacts were recorded as sites, as were any isolated features. Features were defined as recognizable groups of objects, such as cairns, hearths, or other discrete associations, resulting from cultural activity' (p.58).

16
Keyname: Larralde & Chandler 1981
Sort Key: Great Basin (eastern region)
Site Definition: 'A site was defined as a locus of features or artifacts eesulting from some definable human activity that took place at least 50 years ago. Sites were distinguished from isolated finds on the basis of artifact density and discernible site function. In all prehistoric locales, this distinction was clear cut and all isolated finds consist of fewer than four artifacts' (p.41).

17
Keyname: Sussenbach & Lewis 1987
Sort Key: Southeast (interior low plateau region)
Site Definition: None given.

18
Keyname: Butler et al 1981
Sort Key: Southeast (interior low plateau region)
Site Definition: None given. Isolated finds are defined as 'the loci of single or, in some cases, multiple items of archaeological material for which it is not possible or appropriate to define a bounded area or speak of an occupation in any menaingful sense' (p.23).

19
Keyname: Biella & Chapman 1977
Sort Key: Southwest (eastern Anasazi region)
Site Definition: 'Sites are generally defined as relatively high density clusters of architectural and/or artifactual remains occurring within definable spatial limits, which are presumed to represent loci of high intensity or long

SURVDATA: site definitons, page 4

duration of human activities' (p.173). The authors go on to distinguish between 'isolated occurrences' and 'site locations'. The former 'are defined as single occurences of artifacts or features, or low density scatters of artifactual remains over very broad areas of landscape. These units of observation are differentiated from 'site locations' in that they provide information about subsistence or settlement behavior primarily through analysis at a regional rather than locus-specific scale' (p.174) The latter 'are defined as clusters of artifactual and/or architectural features which can be delimited spatially to a particular locale upon the landscape. Site locations are felt to represent spatial locales which potentially provide information about locus-specific subsistence pursuits through intrasite analysis of material remains. Site locations are thus differentiated from isolated occurrences as units of observation because they exhibit artifactual and/or architectural variability indicative of greater intensity, diversity or duration of behavior within definable spatial boundaries' (p.174). See extended discussion of these definitions on p.174.

20
Keyname: Schiffer & House 1975
Sort Key: Southeast (Ozark-Ouchita highlands region)
Site Definition: 'The definition of archaeological sites used by the Cache Project was 'any area with observable evidence of past cultural behavior'' (p.47). 'The minimal criterion used for site designations was suggested by Dan Morse: A site had to yield at least a double hand-full of cultural material. Locations of cultural material not meeting this criterion were not designated as sites but were recorded. In areas of continuous distribution of material, any observable concentrations were mapped as separate sites. Some large areas of uniformly scattered material, however, were designated single sites' (p.48).

21
Keyname: Oetting 1989
Sort Key: Great Basin (northern region)
Site Definition: 'Sites were determined pragmatically, based on the amount and density of materials observed and the conditions of observation. No inflexible site criteria were employed, rather, sites were identified as those areas with local concentrations of artifacts, suggesting more than merely passing human occupation (Aikens and Minor 1977:4), 'a locus of human activity which can be delineated specifically by observable cultural remains (artifacts or features) and can be separated by distance and/or by distinct geomorphic features from other such loci (Oetting and Pettigrew 1985:19)'' (p.36).

22
Keyname: Cheatham 1988
Sort Key: Northwest Coast (lower Columbia River/Willamette Basin region)
Site Definition: None given.

23
Keyname: Cook & Fulmer 1981
Sort Key: California (southern coastal region)
Site Definition: 'Site boundaries were defined on the basis of topography and a fifty-meter artifact interval rule, corresponding to a theoretical reduction in density to less than .0001/m. In some areas,...the density of isolated flakes or sherds appeared to be higher than this arbitrary figure, and the density value was adjusted. Sites were initially classified under BLM codes [see Coombs 1979:141-148], with emphasis of site description on estimating the range of artifact types, variablility within these categories, and the overall density of materials' (p.50).

24
Keyname: Reher 1977
Sort Key: Southwest (eastern Anasazi region)
Site Definition: None given; however, sites are clearly distinguished from 'isolated finds'. 'Isolated artifacts and other 'non-site' finds were collected and assigned a 'locality' number as opposed to a site number...An occasional isolated artifact, a scatter od several sherds ot flakes with no apparent locus, was designated by a locality number' (p.15).

25
Keyname: Chapman & Kimball 1935

SURVDATA: site definitons, page 5

Sort Key: Southeast (Applachian highlands region)
Site Definition: Sites are equated with 'archaeological resources', broadly defined. 'As used in this analysis, archaeological resources are items, deposits, and surfaces which exhibit discrete spatial parameters. Items include manufactured (artifacts) and unmodified objects (chert nodules, animal bone, etc.). Deposits are buried strata, middens, or the fill of features. Surfaces comprise features such as architecture, fish weirs, rock fire pits, etc...The discrete spatial clustering of these material elements define an archaeological resource or site' (p.6). '...any number of artifacts could be used to define an archaeological resource...As it turned out, very few sites produced less than ten items...' (p.8).

Appendix B: Statement-of-Work Guidelines

- Statement-of-Work Checklist
- Statement-of-Work Format
- Helpful Hints for Statement-of-Work Preparation
- Sample Scope-of-Works

  Preparation of Historic and Prehistoric Archeological Survey of Poinsette Range, South Carolina

  Indefinite Delivery Contract for Cultural Resource Investigations

STATEMENT OF WORK
CHECKLIST

There is no mandatory format for a Statement of Work (SOW); however the following provides guidance in developing the SOW and provides a standard format for use at USACERL.

The Statement of Work should be recognized as not only the technical document it is, but, perhaps as importantly, as the sole contractual communication between the Government and the Contractor. As such, it must be understood by all with as little interpretation as possible, since the greater the degree of interpretation, the greater the likelihood of misunderstanding and undesirable performance. With this caution in mind, the SOW must have the following characteristics:

(1) It must be complete and legally sufficient.

(2) It must be compatible with the procedures and capabilities of contract administration.

(3) It must be organized to allow for cost estimating.

(4) It must contain a method for measuring, reporting, and correcting performance.

The following checklist should be used to review all Statements of Work prior to submission:

___ 1. Ensure background information is adequate to provide a clear understanding of the requirement.

___ 2. Use definitive work statements which precisely identify work to be done, in clear and understandable terms. Use words such as analyze, install, develop, remove, update, review. Avoid the use of words such as assist, as required, as necessary, or as directed. Ensure that the SOW defines a product or non-personal service.

___ 3. Use a Uniform format and ensure that grammar and sencence structure are correct. Ensure that all acronyms and abbreviations are defined.

___ 4. Ensure that the SOW defines the Government's minimum needs.

___ 5. Define Government Furnished Property (information, materials, etc) and identify timeframe when it will be supplied to the contractor.

___ 6. Identify the use of facilities.

___ 7. Identify all applicable documents.

___ 8. Define all estimated travel requirements, to include the number of trips, location and duration.

___ 9. Identify inspection criteria, if applicable.

___ 10. Define the point of Inspection and acceptance.

___ 11. Define packaging and shipping requirements, if applicable.

___ 12. Identify the place of performance, if not at the contractor's facility.

___ 13. Identify the period of performance.

___ 14. Ensure the delivery schedule is realistic.

___ 15. Ensure consistency between deliverables, travel requirements, meetings, and specific tasks.

___ 16. Ensure that the SOW for the basic contract defines all anticipated work tasks which may be required under the individual delivery order.

___ 17. Ensure that the scope of the effort is clearly defined.

___ 18. Ensure that the SOW does not specify inherent Government functions, i.e. program/personnel management decisions; inspection and acceptance, financial management; supervision of Government employees.

___ 19. Ensure the SOW is prepared independently by the Government.

___ 20. Ensure the tasks will not direct or supervise a contractor.

___ 21. Review the SOW for clarity, consistency, and connection to the overall requirements.

___ 22. Ensure no conflict of interest concerns exist.

STATEMENT OF WORK
FORMAT

1. INTRODUCTION/BACKGROUND:

   a. Introduction of the effort.

   b. Reasons why effort is required now.

   c. Summary of prior research conducted in this area.

2. OBJECTIVE:

   a. Brief description of the overall objectives of the work being contracted.

   b. Concise statement of what is to be achieved and a clear description of expected product.

3. MAJOR REQUIREMENTS:

   a. Starting Paragraph: In order for the Contractor to accomplish the work under this delivery order, it shall be necessary for the Contractor to complete the following tasks:"

   b. Provide further breakdown of work into definable tasks, each beginning with an active verb.

4. GOVERNMENT FURNISHED INFORMATION OR MATERIAL:

   a. List information, materials, facilities, etc. to be provided to the contractor by the Government.

   b. Identify disposition of those materials, etc., after completion of the contract.

   c. State when items will be available to contractor if not on the date of award.

5. REPORTS/DELIVERABLES:

   a. List specific reports/deliverables required of the Contractor either in satisfaction of the task definition or to enable the Principal Investigator to manage the contract.

   b. Include types, frequency or timetable, contents of reports and other data, and quantities.

   c. Monthly progress reports must be included as a deliverable in order to properly monitor the contract or delivery order.

6. MEETINGS AND REVIEWS:

List required meetings/reviews, purpose, location and time schedule.

7. TRAVEL REQUIREMENTS:

a. List number of trips, location, number of days per trip, number of people the Government expects to travel.

b. State whether the Government will issue travel orders or the Contractor is solely responsible for costs.

8. CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE (COTR):

a. Identify the Government personnel and phone number who will be the technical representative under the contract or delivery order.

b. Include the following paragraph: "No Government personnel, other than the Contracting Officer, have the authority to change or alter these requirements. The COTR can clarify technical points or supply relevant technical information, but no requirements in this scope of work may be altered as a sole result of such verbal clarification."

9. PERIOD OF SERVICE:

Specify a time by which all work to be performed under the order will be completed. This can be stated as a date or in terms of days or months from the date of award of the order.

10. CONTRACTOR QUALIFICATIONS:

When appropriate, list the qualifications that are deemed to be required in order to perform the services adequately.

STATEMENT OF WORK PREPARATION
HELPFUL HINTS

1. TITLE PAGE AND TABLE OF CONTENTS: For lengthy, complicated SOWs, a title page should be provided. It should identify the SOW by title, date, and organizational affiliation. A table of contents should be used following the title page when a SOW exceeds five pages.

2. LANGUAGE: The language of a SOW must be exact and concise. Every effort should be made to use the simplest words, phrases, and sentences possible, so that anyone who reads it will understand its meaning.

3. AMBIGUITY: Perhaps the most frequent cause of disagreement in a SOW between the Government and the Contractor is the use of indefinite, ambiguous terms and words with double meaning. If ambiguity is present, the court generally holds the party that drew up the contract responsible.

4. USE OF "SHALL" AND "WILL": The term "shall" is used to specify that a provision is binding. Throughout the SOW when describing an action the Contractor is to perform, the word "shall" is always used. For example, "The contractor shall analyze the results.....". When describing an action the Government is to perform, the word "will" is always used. For example, "The Government will evaluate the preliminary submittal and return it within....".

5. USE ACTIVE RATHER THAN PASSIVE VOICE: For example, write "The Contractor shall establish a program...," rather than "A program shall be established...". Choose verbs that identify work effort and task performance.

6. DO NOT USE "ANY", "EITHER", "AND/OR": These words imply a choice that the Contractor may make. It is better to avoid them unless a choice is to be made.

7. DO NOT USE "ASSIST" OR PARTICIPATE": "Assist" or "participate" suggests personal services. It implies working side-by-side and being subject to supervision. The words are totally undefined as to the type, range, and depth of the work to be performed by the Contractor.

8. DO NOT USE "AS REQUIRED", "AS APPLICABLE", "AS NECESSARY": These words constitute a work condition undefined. If the Government does not know what is required, necessary, or applicable, it must not leave the unsettled issue to the Contractor. Because these words do not express the Government's minimum needs, their use could lead to a debatable condition as to whether the Contractor has complied with the contract. A SOW should clearly state the Government's requirements with Contractor compliance.

9. DO NOT USE "AS DIRECTED": These words also imply a personal services situation. The Contractor will place itself under the supervision of the work directions of the Government and individuals may be prone to continue directing the work generally without benefit of a task being written as part of the contract requirements.

10. WHEN USING THE WORD "SUPPORT": Without an explicit statement in a SOW of exactly what support is needed, the meaning is ambiguous.

11. USE OF PRONOUNS: Pronouns should be avoided in a SOW. It is better to repeat the noun and avoid misinterpretation.

12. CONSISTENT TERMINOLOGY: When referring to a particular item, use the same word or phrase throughout the SOW. This is especially true when referring to technical terms and items.

13. NUMERALS: When numerals are used on drawings and illustrations, and the numerals are part of the discussion in the SOW; rather than spell out the numbers keep them numerals.

14. ABBREVIATIONS AND ACRONYMS: The first time an abbreviation or acronym is used in the SOW, show it in parentheses immediately after the spelled-out word or phrase.

SCOPE OF WORK
PREPARATION OF HISTORIC AND PREHISTORIC ARCHEOLOGICAL SURVEY OF POINSETTE RANGE
SOUTH CAROLINA

1. THE PROJECT:

The Air Combat Command has requested the assistance of Tri-services Cultural Resources Research Center of the U.S. Army Construction Engineering Research Laboratories (USACERL) in conducting a Phase 1 archeological survey of Poinsette Air Force Range, South Carolina. The completion of this survey will provide the baseline inventory of historic and prehistoric archeological sites. These sites will then be evaluated for potential inclusion in the National Register of Historic Places.

2. AUTHORITIES:

Federal law (NHPA Sec. 106) requires that land managing agencies take into account the effect of their undertakings on historic properties on or eligible for National Register of Historic Places, including archeological sites. To support these efforts cultural resource management compliance processes have been codified under such laws and regulations as the National Historic Preservation Act of 1966, as amended, and Air Force Regulation 126-7. Military land managers are the stewards of millions of acres of land and the archeological resources on them. In order to comply with the Archeological Resources Protection Act and the NHPA Sec. 110, they must develop installation-wide inventories of archeological sites.

The work outlined is to be conducted in accordance with and in partial fulfillment of the U.S. Air Combat Command (ACC) obligations under the National Historical Preservation Act of 1966, as amended (PL-96-515), the Archeological and Historical Preservation Act of 1974, as amended (PL-93-291), the National Environmental Policy Act of 1969 (PL-90-190), Air Force Regulation 126-7, and Executive Order #11593, "Protection and Enhancement of the Cultural Environment". Applicable Air Force regulations replace Army regulations in the base contract.

3. CONTRACTOR RESPONSIBILITIES:

The Contractor shall provide full cooperation with the Shaw Air Force Base point of contact (AFB POC), Captain John Akers, Deputy Environmental Flight Chief and other officials appointed by the USACERL or the Air Force base. The Contractor shall participate in interaction concerning the AFB with representatives of the Advisory Council for Historic Preservation

(ACHP) or State Historic Preservation Officer (SHPO) only upon the direction of the AFB POC and authorized representatives of the ACC and USACERL. The USACERL Technical Representative, Dr. John Isaacson, is the only contact for direction on technical matters and the USACERL Contracting Officer (CO) or Authorized Representative of the Contracting Officer (COR) are the only responsible parties for contractual matters. Consequently, the Contractor shall not take any action relating to this contract at the direction of any other party. Persons working under this contract are considered to be carrying out official agency duties under the Federal land manager's direction, associated with the management of archeological resources. No permit is issued under the Archeological Resources Protection Act (ARPA). However, the Contractor shall meet all requirements necessary to carry out archeological investigations under ARPA. These requirements include: professional qualifications, research design, research strategy, recording standards, reporting, and curation.

4. OBJECTIVES. There are two objectives of the work to be performed under this delivery order:

A. The development of an archeological OVERVIEW and RESEARCH DESIGN for the Phase 1 archeological survey of 7,500 acres of Poinsette Range, South Carolina.

B. The Phase 1 archeological survey of 7,500 acres of Poinsette Range, South Carolina. A Phase 1 survey is a systematic field inspection done by or under the supervision of professional archaeologists, and/or other appropriate specialists. The purpose of an intensive archeological survey is to locate, identify, define, and evaluate the NRHP potential of all prehistoric/historic archeological resources within a given area.

C. All archeological materials and features encountered during the course of the fieldwork shall be recorded. The focus of the work is on historic and prehistoric archeological materials.

Activities conducted under this task shall follow the standards and guidelines outlined in the Secretary of the Interiors Standards and Guidelines for Archeological Investigations (1983). Documentation of archeological sites shall be provided on the appropriate South Carolina archeological site inventory form. All sites encountered shall be recorded in duplicate 35mm black and white photographs, and color slides. These shall be indexed, bound in loose leaf binders and provided to USACERL after acceptance of the draft final report. The photographic recording form shall include information on the site number, survey quadrat, photograph orientation, a brief caption, date and film number.

It is expected that within the survey areas some land will have been previously disturbed. These locales shall be identified in the field through visual verification, or if necessary by shovel or auger testing, and excluded from survey. Documentation of the extent of these disturbances shall be made and incorporated into the final report.

Poinsette Range also contains a number of threatened and endangered species of plants and animals. Archeological survey work must be coordinated with ongoing natural resources surveys and monitoring efforts at the installation. To facilitate this coordination, survey teams shall be required to become familiar with the visual identification of the sensitive species in question and avoid damaging them. Assistance in this effort shall be provided by the AFB POC.

5. MAJOR REQUIREMENTS. In order for the contractor to accomplish the work under this delivery order, it will be necessary for the Contractor to complete the following tasks:

A. Task 1. The contractor shall produce an historic and prehistoric archeological OVERVIEW. This OVERVIEW shall include historic and prehistoric archeological baseline data and an historic context for Poinsette Air Force Range. The goal of the OVERVIEW is to gather, analyze, and report the data necessary to provide an historic and prehistoric context from which to build a set of research questions to be addressed in the phase 1 survey design. This archeological context will also serve as a tool for the significance evaluation of archeological sites discovered in the survey.

The OVERVIEW shall incorporate Geomorphology/Geology data and shall utilize published maps, published studies and field observations to characterize the various categories of soil deposits at the installation, to arrive at relevant conclusions in reference to the location of archeological sites, their depth below the present soil surface, and their potential state of preservation. Areas of erosion and deposition shall be identified and the potential for the presence of archeological sites should be evaluated. The OVERVIEW shall address in particular the question of prehistoric archeological site distributions in relationship to the Carolina Bay formations. The OVERVIEW shall include a set of trial conclusions based on this information. A preliminary site visit should be scheduled.

The OVERVIEW shall include archival investigations covering the entire AFB area and shall fully utilize existing studies, publications, pertinent maps, records, and other sources to obtain necessary information on prehistorical and historical use of the AFB area. Early records pertaining to the area shall receive priority in the study. The product shall include an identification of all known historical and prehistoric archeological resources, a statement of their significance, their eligibility status for inclusion in the National Register of Historic Places (NRHP), the deed/title/probate inventory study of known historic sites, and a categorization of records and sources checked for individual sites.

This task also requires development of the following maps: (1) landforms; (2) updated disturbance areas not requiring survey; (3) areas previously surveyed and excluded from survey; (4) known site locations; and (5) archeological sensitivity areas. The Contractor shall, during development of the OVERVIEW, research and provide documentation to support their findings. The OVERVIEW shall include recommendations that justify exclusion of areas from survey as appropriate. The Contractor shall list resources for which eligibility has been determined, and those needing additional investigations (and the nature of these investigations) before eligibility can be determined. The OVERVIEW shall complete the baseline database and historic context necessary to make determinations of eligibility, according to 36 CFR 60, with recommendations for additional field work specified.

B. Task 2. The Contractor shall develop an archeological survey RESEARCH DESIGN for the purpose of locating prehistoric and historic archeological sites based on the OVERVIEW developed under Task 1, above. A consideration in the RESEARCH DESIGN shall be the depth of potential impacts on archeological sites in the proposed target ranges. The archeological survey RESEARCH DESIGN shall produce a bias assessment for the discovery of archeological sites, with justification based on site size and artifact density gleaned from the archeological literature for the area. It shall include, but not be limited to discussion of the following topics:

Definition of Study Area and Targeted Archaeological Resources: The survey study area should be determined in accordance with the installation's overall mission, its past impact on the landscape, and its probable future impact on the landscape and associated cultural resources. Prior to the initiation of survey activities, the study area should be "stratified" into different archaeological sensitivity zones based on a predictive model developed from existing archaeological data. These zones should include areas of high, and low probability of site discovery. The predictive model should also specify the anticipated archaeological resource targets that the inventory survey is intended to find. Such targets would typically include sites of a minimum size (e.g., 10, 20, or 30 m. in diameter), but could also include sites of a given size which also exhibit surface or subsurface artifact densities of a specified magnitude (e.g., 0.1, 1, 5, 10, or 50 artifacts per sq. m.). In short, the archaeologist shall make a good faith effort to specify the minimal kinds of archaeological resources that the survey is likely to find at a given level of survey intensity and observational acuity. Conversely, known archaeological resources that are likely to be missed by a given set of survey procedures should also be specified.

Site Discovery Techniques: Site discovery technique(s) to be employed in the survey should be determined on the basis of prior geomorphological research and landscape analysis in order to assess the relative degree of surface visibility within the study area and the likelihood of buried archaeological sites. Where surface visibility is at least 25% and where buried sites are not expected to exist, standard pedestrian survey techniques should be employed. In general a no-collection strategy should be maintained for this phase of the research and surface materials should be left in situ. However, enough diagnostic material should be collected for chronological placement of the site and the limits of the artifact distributions should be recorded on a detailed map of the site.

Where surface visibility is less than 25% due to dense vegetation cover, or where pedogenic/geomorphic processes may have buried site surfaces at relatively shallow depths, some form of shallow subsurface testing (SST) procedure (i.e., < 3.0 m.b.s.) should be employed, preferably shovel-testing, postholing, or bucket augering. These specific instrument to be used should be determined by the depth of the probe required to locate the targeted archaeological resources (i.e., 0.50, 1.0, or 3.0 m.b.s.). Shovel tests are suitable to a depth of about 0.50 m.b.s. and provide stratigraphic sections and a larger volume of fill for visual inspection. Shovel tests can be square or circular in shape and should measure 40 cm across in either case. Standard size and shape should be maintained throughout the duration of the survey so that fill volume remains constant. Postholing is suitable to depths of up to 1.0 m.b.s., but provides less fill for visual inspection. Sidewalls are not visible for detailed recording, but careful inspection of the fill at varying depths will provide useful stratigraphic information. Bucket augering will attain depths of up to 3.0 m.b.s. but provides even less fill for visual inspection. All probe fill should be screened minimally through 1/4" hardware cloth and all artifactual material should be collected and catalogued for subsequent laboratory analysis and description.

In areas where archaeological sites are thought to be deeply buried (i.e., > 3 m.b.s.), based on prior geomorphological and/or archaeological evidence, some form of deep subsurface testing (DST) should be employed, such as coring or, in limited situations, backhoe testing. These procedures should only be conducted in collaboration with a professional geomorphologist and only in situations where proposed impacts will affect these resources.

Based on the archaeological site characteristics revealed in the overview phase of the project, the research design of the archaeological field survey should stipulate the level of survey intensity to be carried out, so that confidence estimates can assigned to the likelihood of finding targeted archaeological sites of a minimum size and internal artifact density. In no case, however, should crew spacing or shallow subsurface probe (SST) interval exceed 40 m. For a rapid assessment of survey adequacy, the reader is referred to Sundstrom (1993). For subsurface testing adequacy, see Krakker et al. (1983), Nance and Ball (1986), and Kintigh (1988).

Site Definition: Site definition should follow the minimal criteria outlined by Joseph Tainter (1983). An *archaeological site* is defined as "any location where human behavior has resulted in the deposition of at least two different artifacts in close proximity, or other evidence of purposive behavior" (ibid.:132), such as cultural features, architectural remains, etc. Contextual integrity is also a crucial criterion as implied by the term "deposition...in close proximity." *Isolated finds* are thus defined as occurrences of a single artifact only, or two artifacts of an identical nature (e.g., two conjoinable pieces of pottery, etc.). As a tool for cultural resource management, this definition will ensure that "...when an area is investigated for archaeological remains, all evidence of intentional past behavior...[is] inventoried" (ibid.) in a good faith effort, so that appropriate assessment can be made with regard to significance determination, potential National Register eligibility, and future protection and management.

Metadata Reporting: The contractor shall include in his final report of the Phase 1 archeological survey information pertaining to the level of effort expended in the field reconnaissance, calculated as person-days per unit area surveyed. Other pertinent logistical metadata to be discussed in the final report include accessibility, obtrusiveness of archeological remains, degree of surface visibility, etc.

C. Task 3. The Phase 1 archeological survey of 7500 acres of Poinsette Range, South Carolina

D. Task 4. Record all encountered archeological sites and features and collect a sample of temporally and functionally diagnostic archeological materials with proper provenience data, and define the spatial limits of all archeological sites encountered in the survey. Black and white photographs of all archeological sites and features shall be taken. Photographic logs noting the survey area, site, and photograph orientation will be maintained. All diagnostic artifacts shall be documented with good quality black and white photographs which includes a size scale or technical scaled line drawings.

Sites located in the field shall be delineated on USGS 1:24000 scale maps and professional quality site maps shall be made for each site located under this contract. All site maps shall be scaled drawings utilizing adequate land surveying techniques. This will minimally require use of a surveyors compass and metric tape or preferably transit and metric stadia. All survey datums shall be referenced to a permanent survey marker where possible; otherwise, the datum shall be referenced to some well-defined permanent feature. Rough sketch maps not drawn to scale are not acceptable.

E. Task 5. Compile all field information and descriptions of artifacts and features into a final report detailing the location of, and areal extent of all archeological sites. Describe in detail all recovered artifacts and when possible, interpret diagnostic materials as to cultural affiliation and date. Provide an assessment and written discussion of the applicability and adequacy of the survey model and recommendations for any necessary refinements.

F. Task 6. Provide National Register of Historic Places evaluations and recommendations for all sites located under this survey (36CFR800). If additional testing is recommended the contractor shall specifically address what additional information is required for a determination of eligibility to the National Register of Historic Places and why the initial field survey methods were judged inadequate to provide this data.

The following are detailed steps required to complete Tasks 1 and 2:

A. Notification of the SHPO of intent to undertake the Phase 1 archeological survey.

B. Prepare map to document the extent, depth, and nature of ground disturbances at Poinsette Air Force Range and account for those areas contaminated to the extent that they are unsafe for archeological survey. Information regarding contaminated areas on Poinsette Air Force Range should be available at Shaw Air Force Base.

C. Consult with Dr. Lucy Whalley, the USACERL Native American Consultation Coordinator and obtain information on sensitive areas that may contain properties of cultural and/or religious significance in accordance with the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, the Archeological Resources Protection Act and Air Force Regulation 126-7, Historic Preservation and the Air Force Guidelines for Consultation with Native Americans in the Context of Program Planning and Impact Assessment.

D. Prepare maps specifying the locations of all known archeologically significant sites and Native American traditional cultural properties. These shall include documentation which describes the rationale for including a site or traditional property.

E. Prepare an archeological sensitivity map based upon landform type and collected knowledge of archeological settlement patterns in the region.

F. Prepare a map of the potential depths of cultural deposits based upon existing soils, geomorphological and geological information.

G. Submit a complete draft OVERVIEW and RESEARCH DESIGN in loose leaf binders for approval by the AFB POC, ACC, and the USACERL before initiation of Tasks 3 through 6. The Contractor must address the comments submitted by the AFB POC, ACC, and USACERL before the phase will be complete.

TASKS 3 through 6:

A. After the approval of the draft OVERVIEW and RESEARCH DESIGN and with the approval of the AFBPOC, the Contractor shall undertake an archeological field survey to locate prehistoric and historic sites. Archaeological survey methods should follow the guidelines and recommendations found in *Archaeological Inventory Survey Standards and Cost-Estimating System for the Department of Defense: A Draft Final Report* (Zeidler 1994) prepared in cooperation with the Tri-Services Cultural Resources Research Center at USACERL (Champaign, IL).

6. GOVERNMENT FURNISHED MATERIALS AND SUPPORT. The government will furnish the following information and support:

A. A geographical information system (GIS) database containing soils maps, hydrology, roads, installation boundary, location of proposed targets, elevation, known archeological sites.

B. Survey reports and associated maps from previous archeological studies and Poinsette Range.

C. GIS support for the production of geomorphological, archeological probability, and modern disturbance areas data layers, based on the Contractors data.

D. Copies of the EIS and archeological survey reports from previous investigations at Poinsette Range.

E. Draft copy of the historic overview of Poinsette Range prepared by USACERL. This draft will require augmentation for inclusion in the Task 1, OVERVIEW.

F. The necessary permission to enter and conduct the survey at Poinsette Range, South Carolina.

G. USACERL Inhouse Standards for Submission of Archeological Collections.

H. The U.S. Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1 Revised Oct. 1987).

I. A copy of , Archaeological Inventory Survey Standards and Cost-Estimating System for the Department of Defense: A Draft Final Report (Zeidler 1994) prepared in cooperation with the Tri-Services Cultural Resources Research Center at USACERL (Champaign, IL).

6. MEETINGS

The Contractor and the USACERL/AFB/ACC shall meet as needed, including a pre-field meeting and a post-field meeting for each phase of the project. These meetings are designed to promote understanding of the Poinsette Air Force Range needs and requirements. The USACERL may arrange meetings with the

Poinsette Air Force Range staff periodically which shall include the Contractor's Principal Investigator (P.I.). The USACERL may, with the approval of the ACC and the Poinsette Air Force Range POC, also arrange meetings with the SHPO and ACHP that may also include the Contractor's P.I. The Contractor may request a meeting at any time with the USACERL Archeologist, the COR, the Poinsette Air Force Range POC.

7. SUPERVISION

The Technical Representative from the Tri-Services Cultural Resources Research Center at USACERL, the ACC, and the Poinsette Air Force Range POC will review the Contractor's work by the quality of the delivered products and the success of this program. The draft and final deliverables serve as partial evidence of performance and final deliverables are the items that will also represent the work to the professional community at large if applicable.

8. GENERAL PROVISIONS:

Potential eligibility to the National Register of Historic Places (NRHP) shall be discussed on discovered cultural resources and determined if such criteria can be discerned during the survey. Eligibility recommendations shall include three categories: (1) unusual sites that the contractor recommends for eligibility based upon survey data; (2) sites in which contractor cannot make recommendations without more information (unknown); and (3) sites contractor recommends as ineligible based upon the information gathered during survey. Archeological site evaluations and recommendations for any additional work, if necessary, will be made by the Contractor based upon information derived from the methods outlined within this Scope of Work. A South Carolina State Site Form will also be prepared on all archeological site loci recorded for completion of this Delivery Order. The State Site Form will provide a current and easily used reference of cultural resources with the survey area.

The Contractor is required to obtain all necessary rights-of-way and shall verify with the USACERL that such rights-of-way have been obtained prior to visiting the project area.

Official trinomial site identification numbers will be used on all site forms, index forms, maps, charts, tables, graphs, and reports.

Neither the Contractor nor their representative shall release or publish any sketch, photograph, report, or other material of any nature derived or prepared under this Delivery Order without specific written permission of the USACERL Technical Representative except as is specifically provided for in this Scope of Work.

Copyright will not be claimed by the Contractor for any materials produced under this Delivery Order. All such materials are to remain within the public domain.

The Contractor and those in his/her employ may, during the term of this agreement, present reports of research from this project to various professional societies and publications. Abstracts and copies of these reports, presentations, or articles utilizing work sponsored by the USACERL will be provided to the USACERL Technical Representative for approval prior to publication or presentation.

In the event the Contractor encounters problems in fulfilling performance requirements, or when difficulties are anticipated in complying with the Delivery Order schedule or dates, or whenever the Contractor has knowledge that any actual or potential situation is delaying or threatening to delay timely performance of tasks, the Contractor shall immediately notify the USACERL Technical Representative in by telephone communication and in writing noting all relevant details. However, this material will be informational in character and this provision shall not be construed as a waiver by the U.S. Government of any delivery schedule or date, rights, or remedies provided by law or under this Delivery Order.

9. COORDINATION

The USACERL archeologist will be the Technical Representative and will be responsible for the coordination of the project, however, the contractor shall schedule field campaigns with the AFB POC and notify the USACERL Technical Representative in writing the planned periods of fieldwork.

10. TRAVEL REQUIREMENTS

Travel anticipated under this contract shall consist of travel to Poinsette Air Force Range, South Carolina to complete the tasks outlined above. Travel costs shall be the sole responsibility of the Contractor.

11. SAFETY

The Contractor will at all times conduct operations in a safe manner and in accordance with the USACERL safety plan. The U.S. Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1 Revised Oct. 1987) will be followed for all work.

12. INSPECTION OF WORK IN PROGRESS

The USACERL Technical Representative reserves the right to periodically inspect all phases of work in progress or after completion of the project, or any portion thereof, to insure that the work is performed in compliance with the terms of this Delivery Order and Contract. If the USACERL Technical

Representative determines that the work is not being conducted in accordance with these specifications, the USACERL Technical Representative reserves the right to require that the work be corrected of deficiencies or to be redone if corrections cannot be made acceptable. Time spent making corrections or redoing the work will be absorbed by the Contractor with no additional expense to the U.S. Government. All work related records will be available at all times for examination by the USACERL Technical Representative.

13. REPORTS/DELIVERABLES

The Contractor shall provide to the USACERL and to the Poinsette Air Force Range POC monthly progress reports documenting the phase(s) upon which the Contractor is working, the percentage of the phase and component completed, the expected completion time of the phase and the component, any discoveries worthy of note, and any problems. With regard to archeological sites, the Contractor shall prepare reports to meet relevant professional standards in addition to the applicable contractual requirements. All reports and drafts are to be delivered in the quantities specified in this Scope of Work and submitted to the USACERL at: USA Construction Engineering Research Laboratories, ECC, ATTN: Dr. John Isaacson, P.O.Box 9005, Champaign, IL 61826-9005.

The Contractor shall submit the following reports/deliverables to the government:

A. A Monthly Report. Two (2) copies of a progress report every thirty (30) calendar days for the duration of the delivery order. These reports shall document the progress of the work and any anticipated problems or delays which may impact deliverables.

B. Five (5) copies of the draft OVERVIEW and RESEARCH DESIGN One calendar months (thirty days) after award of the contract for review and comment prior to the initiation of the archeological fieldwork.

C. A Manager's Report. Two (2) copies of a Manager's Report summarizing the results of the field survey shall be submitted within one (1) month of completion of fieldwork. This interim report will allow the project managers to continue the Section 106 process prior to the submission of the final report.

D. A Final Report. Five (5) copies of the final report detailing field methods employed, provenience data, descriptions of recovered materials, and maps indicating the location of all archeological sites and isolated artifacts recovered in the survey shall be submitted within sixty (60) calendar days of the completion of the fieldwork. The report should be professional in appearance and style and should follow as closely as possible the format for reports in the <u>American Antiquity</u> style guide. The report shall include, but shall not be limited to, the following sections:

(1) Report Documentation Page, DD Form 1473. Complete all but sections 2 and 3.

(2) Title Page. The study type, location (project name and counties), report date, name of Contractor, author/ Principal Investigator, and Corps of Engineers contract number.

(3) Abstract. A brief synopsis of the work conducted, number and types of cultural resources identified, overall significance, and an overview of the management recommendations, which shall not exceed 150 words.

(4) Introduction. Identify the Sponsor and Contractor, the purpose for the investigation, discuss the type of investigation performed, the location, indicate the disposition of the artifacts, and original records or other data. Discuss the report organization.

(5) OVERVIEW which may be divided into logical subsections including, but not limited to the following:

Baseline data and the historic context of the Poinsette Air Force Range. The OVERVIEW shall include a detailed description of the survey area including physical features and terrain, past and present vegetation and fauna, field conditions and past and present land uses.

A detailed discussion of previous work including an enumeration and description of all previous cultural resources investigations conducted within the reconnaissance area, names of principal investigators, dates of the studies, study results, and an assessment of the general adequacy and deficiencies of the past work. This discussion shall include the historic and prehistoric context statements from which the research questions addressed in the phase 1 survey design were developed.This archeological context will also serve as a tool for the significance evaluation of archeological sites discovered in the survey.

Geomorphology/Geology data utilizing published maps, published studies and field observations which briefly characterize the various categories of deposits at the installation, and arrive at relevant conclusions in reference to the location of archeological sites, their depth below the present soil surface, and their potential state of preservation. Areas of erosion and deposition should be identified and the potential for the presence of archeological sites should be evaluated. The OVERVIEW shall address in particular the question of prehistoric archeological site distributions in relationship to the Carolina Bay formations. The age of these formations and their stability shall be discussed and integrated into the research design. The OVERVIEW shall include a set of trial conclusions based on this information.

(6) Research Orientation. Develop and present theoretical and/or substantive goals and the methodology used in achieving them. Address problems and testable hypotheses as iterated in the probability model.

(7) Methodology. Present the field procedures used to accomplish the research design. Discuss how the field work was organized, scheduled, and undertaken with data on the level of effort (person-days/area surveyed) synopsized in tabular form . Detail the laboratory procedures and the methods used to analyze artifacts and other data recovered from the field.

(8) Inventory. Address all cultural resources or potential cultural resources identified by the field investigation. The information provided in this section for cultural resources located during the course of the field investigation shall include, but shall not be limited to: site name (if any); site number; County; State; site type (lithic scatter, farmstead, mound, etc.); component(s) or probable component(s); elevation; description of the topographic position of the site size (or presumed size); strata and depth (if known); present vegetation; ground vegetation and surface visibility at time of field investigation (in percent, 10-20%, 20-30%, etc.); nearest water (name and distance and elevation); condition (address current, projected, or past known impacts); if collections were made, by whom and when; a review of artifacts collected; a description of any previous investigations at the site, location, and artifacts collected; and site specific recommendations, and remarks. The site

specific recommendations shall include, but shall not be limited to, any recommendations for testing for National Register eligibility, if needed. The exact meaning of the recommended testing shall be indicated; e.g., to determine a site's aerial extent or depth, to verify or determine components present, to assess research potential and/or to determine site integrity. The recommendations section shall also include any interim measures which should be taken to preserve the resource until it can be tested for National Register significance (stop cultivation, fence, etc.).

(9) Study Area Recommendations. Synopses of the recommendations offered for individual resources within the study area.

(10) References. Use the American Antiquity format for every publication, work, or interview cited in the report.

(11) Appendices. State of South Carolina site forms and field notes, maps, photographs, and a list of all artifacts collected. All locational data shall be restricted to state site forms which will be bound separately.

USACERL personnel will review and provide comments on the draft OVERVIEW and RESEARCH DESIGN within seven (7) calendar days after receipt. Comments and revisions must be addressed within fifteen (15) calendar days after receipt so that fieldwork can proceed without long delays.

USACERL personnel will review and provide comments, if any, within thirty (30) calendar days after receipt of the final draft report. Two final reports and a camera ready copy will be submitted, incorporating Government comments, if any, within (30) calendar days after receipt of comments. A copy of the manuscript will be submitted on electronic media in MSDOS and Wordperfect 5.1 or higher word processing format.

D. All sites will be recorded on State of South Carolina Archeological inventory forms. Two copies of each site form will be delivered to USACERL at the time of final report submission. The contractor will be responsible for obtaining site numbers from the South Carolina State Historic Preservation Office.

E. All artifacts recovered during the course of the field survey are the property of the United States Government per 36CFR79. The contractor shall recommend a curation facility, in the event that one is necessary, through USACERL for the AFB POC approval. The Contractor shall also make a recommendation of materials to be curated in accordance with the Native American Graves Protection and Repatriation Act. The Contractor shall prepare the materials so they meet the requirements of the AFB, USACERL and ACC. In the event that the AFB chooses to curate their own materials, the Contractor shall only charge the USACERL for preparation of the materials. All artifacts retained shall be carefully washed, cataloged, recorded, and stored during the field investigation.

F. All field notes, photographs, photographic logs, and negatives, maps and drawings will be labeled appropriately and delivered to USACERL at the time of final report submission.

Final reports shall be accompanied by a camera-ready-original, one copy Wordperfect 5.1 (or comparable) MS-DOS compatible 5.5 and 3.5 inch diskettes and a National Technical Information Services (NTIS) factsheet.

The OVERVIEW and RESEARCH DESIGN shall be reported in draft and then in final form after receipt of the USACERL/ACC/AFB POC technical comments. These documents will conform to the standard requirements of the profession and the draft documents will be double-spaced, contain all relevant maps, charts, figures, and references as required. The final documents will be of letter quality, single-spaced, bound and on 8.5 by 11 inch paper. Each copy of the final documents shall include, as the first page, DD Form 1473, the Report Documentation Page (provided by the USACERL).

Two copies of site forms will be provided to the USACERL Technical Representative with the draft documents.

14. SCHEDULE OF DELIVERABLES

1. Draft OVERVIEW and RESEARCH DESIGN for review thirty (30) days after award of contract.

2. Revised draft of OVERVIEW and RESEARCH DESIGN fifteen (15) days after receipt of comments.

3. Completed Fieldwork One hundred twenty (120) days after submission of revised drafts of the OVERVIEW and RESEARCH DESIGN.

4. MANAGER'S REPORT thirty (30) days after completion of fieldwork.

5. Draft FINAL REPORT sixty (60) days after completion of fieldwork.

6. FINAL REPORT thirty (30) days after receipt of comments on draft report.

Indefinite Delivery Contract for Cultural Resource Investigations

1. GENERAL:

a. Purpose: The U.S. Army Corps of Engineers Construction Engineering Research Laboratories (USACERL) Tri-Services Cultural Resources Research Center seeks proposals under the terms of a one-year indefinite delivery contract, with an option to extend for one additional year, to conduct a broad range of cultural resource investigations within the United States and Trust Territories. Topic areas shall include but shall not be limited to: Historic Preservation Compliance, Historic Preservation Planning, Technical Transfer, Archeological and Architectural Survey and Evaluation, and Predictive Modeling. Services shall be provided on a delivery order basis, and each delivery order shall contain its own specific Statement of Work, budget, and time schedule.

b. Personnel: The contractor shall provide all the necessary personnel at the rates specified in Schedule B to perform and document assigned studies as identified on each individual delivery order. Only personnel acceptable to the USACERL Contracting Officer shall be utilized in providing services under this contract, including senior staff, technical consultants, hourly assistants, and all supporting staff. Any staff members, other than support staff and hourly assistants, replaced by the Contractor under any delivery order issued, may do so only upon the expressed approval of the Contracting Officer.

c. Travel expenses: For each delivery order, USACERL will, at its option, either (1) provide U.S. Government Travel orders and direct reimbursment to Contractor employees required to travel under this contract or (2) will provide funds as other direct costs to the Contractor as negotiated under each specific delivery order. Travel costs provided to the Contractor will be at the current rates set forth in the U.S. Government Joint Travel Regulations (JTR) at the time of the execution of the delivery order or at rates approved by the Contracting Officer. U.S. Government travel orders provided under this contract shall be used exclusively for the tasks, services, and requirements specified in each individual Statement of Work.

d. Materials and other expenses: For each delivery order, USACERL will provide at its option, either, (1) required supplies, reference materials, communications equipment, printing, etc., or (2) funds for these items as other direct costs specified and negotiated under each individual delivery order.

2. STATEMENT OF WORK: The Contractor shall perform services as

specified on each individual delivery order. Typical activities may include, but are not limited to, work in Historic Preservation Compliance, Historic Preservation Planning, Technical Transfer, Archeological and Architectural Survey and Evaluation, and Predictive Modeling. Examples of work to be requested may include, but are not limited to, the following:

a. Archeological Services:

(1) Perform background research of courthouse records, historical and archival literature, professional journals; and production of overview studies, bibliographies, synopses, and National Register Nomination forms. These shall be in support of work conducted to provide contexts for the evaluation of archeological sites in terms of the National Register of Historic Places Criteria and preparation of National Register Nominations as identified in Paragraph 3.

(2) Perform archeologically oriented geomorphology and environmental reconstruction as it applies to the location and interpretation of prehistoric archeological sites, including but not limited to: soils pedology, sedimentology, fluvial geomorphology, palynology and archeobotany.

(3) Perform archeological reconnaissance and testing surveys to include but not be limited to: Archeological inventory, preparation of archeological survey research designs, pedestrian archeological survey and sampling survey including subsurface (shovel probe) testing, large equipment excavation, and archeological test excavations.

b. Architectural Services:

(1) Perform background research of courthouse records, historical and archival literature, professional journals; and production of overview studies, bibliographies, synopses, and National Register Nomination forms. These shall be in support of work conducted to provide contexts for the evaluation of historic architectural sites in terms of the National Register of Historic Places Criteria for Evaluation and preparation of National Register Nominations as identified in Paragraph 3.

(2) Architectural Survey and Assessment of Historic Military Buildings and Engineering Structures to the standards of the Historic American Building Survey/Historic American Engineering Record (HABS/HAER) as identified in Paragraph 3.

3. STANDARDS: Delivery orders may require a combination of the above skills or tasks. All work completed under this contract shall satisfy current scientific standards for data collection, analysis, and reporting, as well as the requirements of each specific Statement of Work. All work shall be performed within the context of an approved, detailed research design which pairs

data collection techniques with specific research problems relevant to the designated project area. All data shall be analyzed, described, and integrated into scientific reports of findings.

a. National Register of Historic Places Criteria: The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(1) That are associated with events that have made a significant contribution to the broad patterns of our history; or

(2) That are associated with the lives of persons significant in our past; or

(3) That embody the distinctive characteristics of a type, period, or method of construction, that represent the work of a master, that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(4) That have yielded, or may be likely to yield, information important in prehistory or history.

b. National Register Nomination Form: National Register Nomination Form means (1) National Register Nomination Form NPS 10-900, with accompanying continuation sheets (where necessary), Form NPS 10-900a, maps and photographs or (2) for Federal nominations, Form No. 10-306, with continuation sheets (where necessary), Form No. 10-300A, maps and photographs. Such nomination forms shall be "adequately documented" and "technically and professionally correct and sufficient." To meet these requirements, the forms and accompanying maps and photographs shall be completed in accordance with requirements and guidance in the NPS publication, "How to Complete National Register Forms" and other NPS technical publications on this subject. Descriptions and statements of significance shall be prepared in accordance with standards generally accepted by academic historians, architectural historians and archaeologists.

The nomination form is a legal document and reference for historical, architectural, and archeological data upon which the protections for listed and eligible properties are founded.

c. HABS/HAER Levels of Documentation:

(1) Level I Documentation:

Drawings: A full set of measured drawings depicting existing or historic conditions. Photocopies with large-

format negatives of select existing drawings or historic views where available;
Photographs: Photographs with large-format negatives of exterior and interior views;
Written Data: Extensive history and description.

(2) Level II Documentation:

Drawings: Select existing drawings, where available, shall be photographed with large-format negatives or photographically reproduced on Mylar;
Photographs: Photographs with large-format negatives of exterior and interior views, or historic views where available;
Written Data: Extensive history and description.

(3) Level III Documentation:

Drawings: Sketch plan;
Photographs: Photographs with large-format negatives or exterior and interior views;
Written Data: Architectural data form (A one page HABS form intended to provide identifying information for accompanying HABS documentation).

(4) Level IV Documentation:

HABS/HAER Inventory Cards: A one-page form which includes written data, a sketched site plan and a 35mm contact print drymounted on the form. The negative with a separate contact sheet and index shall be included with the inventory card.

4. DELIVERY ORDER REQUIREMENTS:

a. To order services under this contract, a Request for Quotation, SF 18, will be forwarded to the Contractor identifying the specific requirements of the individual order. The Contractor shall prepare and submit an itemized budget for the work requested based on the fully burdened rates negotiated in Schedule B of this contract and any direct materials, travel or other significant costs applicable to the particular services requested. Any variations to the negotiated labor rates will not be accepted without the prior written approval of the Contracting Officer. Following negotiation of each individual requirement, the Contracting Officer shall issue a written delivery order for supplies and services on a DD Form 1155. All delivery orders shall be issued on a firm fixed-price basis.

b. For each delivery order, one (1) copy of all paper deliverable items, including but not limited to, proposals, reports of progress, draft and final reports, shall be delivered to the USACERL Contracting Officer, P. O. Box 9005, Champaign, Illinois 61826-9005. Additional deliverables shall be as specified in each individual delivery order.

c. Delivery Orders may be issued at any time during the contract period. Multiple delivery orders may be in force at any given time. Conversely, there may be periods when no delivery orders are in force. No compensation will be provided to the Contractor during such periods of non-work.

d. Performance of Delivery Order. The Contractor shall be required to commence work on each approved Delivery Order within ten (10) calendar days of the date of issuance. The Contractor shall perform the necessary work on each assignment continuously as working conditions permit. If it becomes necessary for the Government to stop work on any assignment because of unforeseeable circumstances which are beyond the control of the Contractor, the Contractor Officer or his representative will give the Contractor a minimum notice of five (5) calendar days.

e. To perform the required work, the Contractor shall provide all professional staff, support staff, and specialists necessary to plan, supervise, perform and report the required work. The Contractor shall furnish all labor, plant, transportation, fuel, equipment, and material necessary to perform the services required by each delivery order. The Contractor shall also provide adequate professional supervision to assure the accuracy, quality, and completeness of all work required under this contract.

f. Reports. All data collected under the auspices of this contract shall be recorded, analyzed, and reported using currently acceptable scientific methods. The Contractor shall catalog all artifacts, samples, specimens, photographs, drawings, etc. The Contractor shall integrate all observations and results of data collection and analyses into a written, comprehensive, and graphically illustrated report of investigation. The types of reports, number of copies and delivery schedules for all reports required shall be as specified in each delivery order.

g. Research Design. When a delivery order specifies multiple phases of work, the Contractor may be required to synthesize the results of previous investigations or initial phases of work and integrate those results into a research design for subsequent phases. The research design shall be submitted to the USACERL Contracting Officer or his representative for review and approval before subsequent phases may commence.

h. State Site Forms. For any delivery order requiring survey and inventory of cultural resources, the Contractor shall complete the appropriate State inventory forms and submit them to the State Historic Preservation Officer with a request for site numbers prior to submitting the draft report of investigations for review. State assigned site numbers shall be used in all draft and final reports rather than field numbers. In cases where delivery orders require the testing or excavation of previously recorded sites, the Contractor shall submit two (2) copies of an updated State site form to the COR with the draft report. The updated site form shall correct all previous observations about the extent and results of the work completed under this contract.

i. Accident Prevention Plan (APP): The offeror shall submit two (2) copies of a draft APP (LMV Forms 358-R and 359-R) for each delivery order as requested which is specific to the requirements of that delivery order. The reference for preparation of the APP is EM 385-1-1, April 1981 as updated. Specific Safety requirements shall include the following as appropriate:

(1) Each field crew must contain at least two persons with current cardiopulmonary resuscitation (CPR) and Basic First Aid training,

(2) any person performing fieldwork alone in remote areas must be certified in CPR and Basic First Aid,

(3) local hospital and ambulance arrangements are required for all fieldwork, and

(4) all APP's are required to address the organization's policies and procedures for the prevention of alcohol/drug abuse.

j. Disposal of Records and Artifacts. All records, photographs, artifacts and other material data recovered under the terms of each delivery order shall be recorded and catalogue in a manner compatible with those systems utilized by the Army and by State and Federal agencies which store archeological data.

They shall be held and maintained by the Contractor until completion of the delivery order. Final disposition of the artifacts and records shall be in accordance with applicable Federal laws. The Contractor shall be responsible for delivery of the analyzed archeological materials to the repository designated by the Government following acceptance of the final report. The Contractor shall inform the Government in writing when the transfer of data has been completed and shall forward a catalog of items entered into curation. The location of any notes, photographs or artifacts which are separated from the main collections shall be documented in the catalog. All artifacts to be permanently curated shall be cleaned, stabilized, labeled, catalogued, and placed in sturdy bags and boxes labeled with site, excavation unit or survey collection unit provenience.

5. RESPONSIBILITY OF THE CONTRACTOR: The Contractor shall provide a safe working environment for key consultants and all persons in his employ as prescribed by Engineering Manual (EM) 385-1-1, "General Safety Requirements". The Contractor shall be responsible for all damages to persons and property which occur

in connection with the work and service under this contract, without recourse against the Government. The Contractor shall provide maximum protection, take every reasonable means, and exercise care to prevent unnecessary damage to existing historic structures, contemporary structures, landscape plantings, natural features, roads, utilities, an other public or private facilities. Special attention shall be given to historic structures, natural and landscape features of the areas to protect these elements and their surroundings.

6. PUBLICITY: Except with prior approval from the Contracting Officer, neitner the Contractor or any of his employees or consultants shall release for publication or any other use (including student thesis or professional journals) any sketch, photograph, report, or other material of any nature pertaining to any matters for which services are performed under the terms of this contract. The provisions of this paragraph shall extend also to the release of any such material to any person, including the public media and the professional community without the expressed written approval of the Contracting Officer.

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