SAMPLING IN CULTURAL RESOURCES MANAGEMENT

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Preface

Management of the cultural resources on 187 million acres of National Forest land nationwide has necessitated the use of sampling. The Southwestern and Intermountain Regions have been devoting considerable efforts toward the development and field testing of appropriate sampling strategies for the various cultural resource management activities which are undertaken in these regions. The papers in this volume reflect the efforts of both Forest Service personnel and an academically based archeologist working on National Forest lands in addressing situations in which sampling is an appropriate strategy. By publishing these papers we hope that the lessons we have learned may be useful to others who deal with sampling in a cultural resource context both within the Forest Service and within our sister agencies who have similar cultural resource problems and responsibilities. A paper by Landon D. Smith originally scheduled for inclusion in this volume is being delayed in order to include additional data.

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SAMPLING FOR CULTURAL RESOURCES INPUT TO LAND MANAGEMENT PLANNING

By Dee F. Green

Introduction

As a part of its land management mandate the Forest Service is involved in the preparation of Land Management Plans which need input on cultural resources. Land Management planning offers a systematic opportunity for doing cultural resources inventory that is not provided by project oriented activity. It also makes the most sense in terms of long range planning for the management of the cultural resource itself and for decision-making on how the cultural resource can and should be integrated with other Forest Service resource management programs. In addition to the above management considerations, archeologists can use data gathered in connection with land management plans to attack regional kinds of problems since large land areas are involved. Thus for both the land manager and the archeologist there is much to be gained from examining the cultural resources in connection with land management planning.

Current Forest Service Land Management Planning is governed by the provisions of The Forest and Rangeland Renewable Resources Planning Act of 1974, (88STAT. 476, ET. SEQ.) which was amended by the National Forest Management Act of 1976 (90 STAT. 2949, ET. SEQ.). Regulations governing the implementation of these statutes are found in 36 CFR 219.

Planning Levels

Three planning levels have been developed; national, regional, and forest. At the national level the Chief of the Forest Service is responsible for the development of a "Renewable Resource Assessment" and a "Renewable Resource Program." These documents set forth the policy, goals, and objectives for the forest and rangeland resource needs of the people of the United States. The program is then recommended by the Chief to the Secretary of Agriculture and the President for action by Congress.

The second planning level is regional. The basis for development of the regional plan is furnished by the national policy, goals and objectives. Regional plans are to address the "aggregated capabilities" of lands of the National Forests to supply goods and services to be used in developing the national program. The third and most fundamental level of planning is that at a National Forest. Forest plans are tied to national and regional policy, goals, and objectives but this level goes on to the location and scheduling of actions and presents standards, guidelines and requirements that govern those actions. Monitoring is also required in order to measure how well the actions meet the goals and objectives. Provision is made for amendment and update of Forest plans.

Completion dates have already been set for planning levels. The first regional plan will be completed by 1980 and will cover planning through 1985. Forest plans in Region 3 are scheduled for completion no later than 1983 which will allow the regional plan update scheduled for 1985 to be developed. Forest plans are to reviewed every five years and updated every 15 years.

Planning Process

The planning process is divided into three stages or categories; strategic, management control, and operational control. Strategic planning establishes the long term goals within the framework of such questions as: "How much goods and services can and should the land be producing?" "What are the environmental and other constraints placed on such production?" The management control level (tactical) establishes the long term objectives designed to achieve the goals. Objectives are structured in a time frame that may last anywhere from 10 to 40 years. Technical and coordinating standards are also established for governing the activities of the next level. Operational control is the third level of the process and involves the year by year implementation of the objectives. This level addresses such questions as: When is it going to happen? How much will it cost? Where is it going to be done? How will it actually be done? All planning levels should address the question of what is this going to do for the American people both now and in the future"?

Development of the plans themselves are the responsibility of the line officer at each planning level, using an interdiciplinary approach. The interdiciplinary team is to "work cooperatively to develop an understanding of the physical, biological, economic, and social considerations that enter into the resource planning process and not as advocates of a specific area of professional concern." The team may include individuals from outside the Forest Service, and provision is made for public review at all levels.

Additional Considerations

Several concepts associated with the planning will be of specific interest to cultural resource managers. The following quotes are provided from the regulations: "All resources should be considered to have important societal values and deserve equal consideration in assessment." "Interactions between various alternative plans and the physical, biological, economic, and social consequences must be evaluated and compared." In addition, specific provisions are made for the identification in a forest plan of research needs. At the national level an annual report will describe the status of research programs, highlight significant findings and address how those findings will be applied in National Forest System Management.

Forest plans are to identify the known cultural resources but locations are to be kept confidential and sites can appear on maps available to the public only with the express approval of the Regional Forester. In cases where a site or group of sites are being managed for recreational purposes such disclosure may be desirable.

Overviews

Currently, the Southwestern Region is generating a series of overview documents, whose purpose is to provide the Forests with a basis for input to Land Management Plans. In New Mexico, some of these overview documents are being written in cooperation with the Bureau of Land Management, especially in areas where land ownership patterns provide a rational for a single document. Similar arrangements may be made with the BLM in Arizona. Overviews are produced by scholars on the basis of literature, library, and file searches or where possible on the basis of sound sampling inventories. While the latter is the preferred approach, in order to meet the planning deadlines, the former has in some cases become necessary. However, as forest plans are updated through subsequent cycles in the next two decades we anticipate that sound sampling inventories will be available for all areas where complete inventories have not been conducted.

The objective of the Overview (BLM Class I inventory) is to, . . .summarize, compile, and bring up-to-date all previously recorded resource information on all known properties, investigations, evaluations, and publications" (FSM 2360). It should provide the starting point for future cultural resource investigations. The overview is the initial step not only in providing input to forest plans but in beginning the real decision making processes in cultural resource management i.e. resource allocation. By resource allocation I mean which sites are going to be preserved at all costs, which will be put into a sort of cultural data bank for future use, which have potential for development as recreation areas, which have no value and similar questions. While archeologists traditionally have not considered cultural sites in terms of their allocation for purposes other than their own immediate research interests that day is now past. The dawning of the conservation ethic (Lipe, 1974) and the involvement of federal land managing agencies in cultural resources management has made the notion of resource allocation a reality. For the Forest Service, the land management planning procedure is the vehicle through which the allocation will probably be accomplished.

Sampling

Because large land surfaces are involved in planning it is seldom possible for complete inventories of the resources to be accomplished prior to the production of the forest plan. Yet, the manager needs to have the resource characterized both as to its nature and extent. For best results, sampling is the obvious answer. But just any sample is not sufficient. Most areas have some kind of grab sample which can be gleaned from the archeological literature but such samples have unknown and uncontrolled biases which make them unreliable. Both the manager and the researcher need a sample that is representative of the total land surface encompassed by the planning unit if either are to make meaningful decisions about management or research. Thus, in urging input to land management plans we do so with the hope that wherever possible a stochastically based sampling design will be employed in order to derive maximum benefit from dollars spent. Sometimes a literature search is all that can be done within the time frame of the plan and dollar constraints. A literature search is preferable to no input at all but controlled representative sampling is much preferred. For a somewhat different view see Schiffer, Sullivan, and Klinger (in press).

Completed examples of stochastically based sampling for land use plans within the National Forest system are, at this writing (1978), few. The Apache-Sitgreaves National Forest in Region 3 has conducted two such studies and a third is in progress. Donaldson (1975) has reported on the White Mountain Planning Unit. In this study some 174 square miles of National Forest land were sampled using a stratified systematic design and a sample fraction of 1%. Sample unit employed was the transect. The sampling decisions were made affecting the placement of transects in Stage II. The strata employed were townships with six transects per township selected randomly from one of four compass bearings. Stage II sampling was done without replacement so that no Stage II transects would be located identical to Stage I. A map predicting site densities was generated from the data and Plog (personal communication) has estimated that the unit probably contains between 3500 and 4500 sites. In a subsequent study of the Little Colorado Planning Unit (Plog et al., 1978) essentially the same approach was used except that six rather than four compass bearings were used with similar results except that predicted sites densities are lower. Raab (1976) has outlined an approach for use on the Caddo Planning Unit, Ouachita National Forest in Region 8 which is also modeled on the White Mountain Planning Unit Study.

We are only aware of one case where complete coverage of a planning unit has been attempted. This was done on the Monticello Ranger District in the Intermountain Region. A series of crews recorded sites over a period of years from 1971 to 1974. Although the 330,000 acres within the unit were not completely covered, about 16% of the area has been looked at on an intensive basis and over 30% has been partially surveyed on a nonsystematic basis. Although the complete coverage was not achieved for the total land management plan some subareas within the plan have complete or nearly complete coverage. The data base allowed Green (n.d.) to write for the plan, a summary of the prehistory of the area plus provide more specific input to each of the management units defined in the plan.

We are aware of seven projects currently (1978) underway which involve sampling large land units on National Forest lands in the Southwest Region. Fred Plog is continuing with the sampling of the Apache-Sitgreaves Forest above the Mogollon Rim. The Cibola National Forest is sampling a portion of the Mountainair Ranger District using a design formulated by Landon D. Smith. James Hill is sampling an area around Los Alamos, New Mexico, involving the Santa Fe National Forest and other lands and the Tonto National Forest is conducting a sampling program on the Upper Salt River under the direction of Martin McAllister. On the Tusayan Ranger District of the Kaibab

National Forest, Arizona State University and Richard Effland are sampling the Ranger District, and Peter Pilles is directing the sampling of both the Cinderhills and Sedona-Oak Creek units on the Coconino National Forest. Thus, the number of such projects appears to be increasing and during the next decade the outlook is good for input based on sampling.

Designing the Sample

Given the very large land surfaces involved in unit plans a statistically based sample has much to recommend it. It is seldom possible to conduct a 100% inventory as was attempted on the Monticello District, nor for that matter even some fraction in excess of 40-50%. As with any project the precise sampling design used will vary, however, some general guidelines are provided below.

Sample Scheme -- While a stratified random sample is recommended over a simple random sample we do so only when there are good defensible reasons for the stratification. An a priori stratification simply because it is supposed to work better is not a sufficient justification for abandoning a simple random scheme. Actually some combination of the two schemes working as part of a multi-stage sampling procedure is the best approach. Stage I should employ a simple random sample scheme unless there are already overriding reasons for stratification. Based on Stage I, a stratification scheme can then be employed at Stage II and subsequently. It is important to remember that stratification criteria need not be archeological. Planning and/or potential project priorities should be considered along with the cultural resources themselves. For example, in connection with the Little Colorado Planning Unit, Plog's scheme included special attention to a particularly sensitive timber sale (Plog, Hantman, and Wood, 1976).

Sample Intensity -- As a general rule of thumb we have been recommending 1% simply because it seems initially reasonable. The 1% samples employed by Plog on the White Mountain and Little Colorado Planning Units have not been entirely evaluated by the Forest as to their usefulness and quality of predictability. Only additional time will demonstrate whether a 1% sample intensity will do the job.

What we already know is that areas of high site density can be readily identified but a large increase in sample intensity (say to 70%) may be necessary for defining areas of very low to no site densities. Obviously the detail which one wishes and/or can afford will influence the intensity level selected.

Sample Unit -- For land use planning generally we recommend transect sampling because it provides the greatest variability. However, there may be occasions, particularly at the later stages of a multiple-stage sampling scheme when quadrats or other block sampling may be appropriate. Also, since we clearly want to sample without replacement units should be chosen in such a manner that the same ground surface is not sampled more than once.

Designing an appropriate approach to the sampling of a land management plan will involve the delicate balancing of the sample scheme, sample intensity, and sample unit. These all have implications not only for the quantity and quality of the data produced but for the cost of producing that data. Approaches should be designed appropriately, with sufficient lead time, and with some understanding of what can be expected from the results.

Summary

By the year 1983 we expect that overview documents, many of them based entirely or in part on stochastically derived samples, will be available for all National Forest System lands in Arizona and New Mexico. For land managers this will mean the establishment of a baseline for resource allocation. For archeologists there will be a summary body of data on the history and prehistory of the southwest virtually unparalleled. By 1985 when the regional summary is completed land managers and archeologists will have the best information base on cultural resources which has ever been available for the southwest. With the longterm planning goals currently envisioned, by the 1990's we may well have a complete sample of all National Forest System lands in the southwest and intensive survey over much of the land. Such a data base can only contribute immeasurably to both management and scientific concerns.

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SAMPLING STRATEGIES ON THE WHITE MOUNTAIN PLANNING UNIT, APACHE-SITGREAVES NATIONAL FOREST

By Fred Plog

The Natural Laboratory

The White Mountain Planning Unit is a region of about 226 square miles centered on Show Low, Arizona. One hundred seventy four of the 226 square miles are the property of the US Forest Service and are the subject of this report. The planning unit lies immediately to the north of the Mogollon Rim in east-central Arizona. The elevation of major land surfaces in the unit ranges from around 5,800 to about 7,000 feet. Vegetation varies from short-grass grassland along the northern edge of the unit to ponderosa pine forest along its southern limits, with the juniper pinyon woodland in between the two constituting the predominant vegetation cover in the area. Topography varies between open low mountains (high ridges separated by deep stream washes) at the southern and higher edge of the drainage to plains periodically interupted by deep valleys to the north. Soil variation within the planning unit is extremely complex. The three major soil groups consist of volcanic derived soils, sandstone derived soils, and quaternary gravel deposits.

Prior to the initiation of the project, little archaeological work had been done within the planning unit. Haury and Hargrave (1931) excavated at Show Low Ruin which lies on private land within the unit, principally in the vicinities of Rocky Arroyo and Show Low Lake. The Arizona State Museum has completed a number of contract projects to the south and to the east of Show Low. No major study focused on the interpretation of the prehistory of the unit or any area within it existed. Prior to this study, there were insufficient data for assessing any aspect of variation in cultural resources over the planning unit. The study itself has been described by Donaldson (1975).

Survey Goals

For purposes of discussion, the goals on which the survey of the planning unit focused can be broken into two groups; those involving the management of cultural resources and those involving the interpretation of the area's prehistory. I do not intend to suggest that these goal areas are incompatible; simply that each involves separate planning elements and planning issues in designing survey research.

The cultural resources aspects of the survey relate to the overall efforts of the US Forest Service to describe the resources of the

White Mountain Planning Unit and to identify means of planning for the wise use of these resources. Pertinent to the description and management of cultural resources, the following tasks were undertaken:

1) Initiation of an inventory of prehistoric and historic cultural resources on the planning unit.

2) Description at a preliminary level of variation in the density and distribution of archaeological sites on the planning unit.

3) Preliminary assessment of the impact of private ownership and access to sites on the cultural resources in the unit.

Goals pertinent to understanding the prehistory of the planning unit were identified on the basis of the research designs written to cover the activities of the Chevelon Archeological Research Project on USFS lands. The Chevelon Project began its studies in this area in the summer of 1971. At that time the geographical focus was limited to the Chevelon drainage on the Chevelon and Heber districts of the (then) Sitgreaves Forest. Since 1971 the activities of the project have shifted further eastward, the study under discussion representing the easternmost extent of the range expansion to date.

The research designs of the Chevelon Project concerned three major problem foci:

1) Understanding the nature of ceramic variation over the study area. Ceramic artifacts represent one of the very most critical data bases for southwestern archeologists. Sherds are used in making a variety of different inferences concerning the sites from which they are taken including: the dates of the site, functions carried out there, the nature of the social organization at the site, the nature of interaction between inhabitants of a given site and those of nearby sites. The project is attempting to clarify the effect of temporal, organizational, demographic, and environmental variation on variation in the kinds of ceramics made and used at specific sites (S. Plog 1976).

2) Understanding the nature of man-land relationships. A major focus of CARP research has been environmental-ecological in nature. The SARG research design (Plog and Hill 1971, 1972) has identified a number of important environmental variables that may effect the distribution of prehistoric population aggregates. Elements of the SARG design have been incorporated into CARP's research goals.

3) Understanding the social organization and demography of populations in the area. Intensive archeological efforts to under-

stand prehistoric social organization are relatively new. Yet, basic to understanding the occupation and use of any territory is an understanding of the manner in which prehistoric peoples organized to exploit the resources of that territory. Similarly, increases and decreases in the numbers of individuals within a given area provide important information on the success and failure of particular economic and social-organizational strategies.

It is with these goals in mind that the approach to surveying the White Mountain Planning Unit was defined.

Sampling Strategy

Considerations that must be taken into account in designing a sampling strategy for an area such as the White Mountain Planning Unit are only in part specific to the unit and the nature of the project carried out there. A variety of issues that were faced in designing this survey must be faced by any archeologist undertaking survey research. I will specifically address questions of: (1) intensity, (2) sample fraction and sample design, (3) unit size and shape, (4) sample design, and (5) the desired data base.

1. Intensity - I use the term intensity in reference to 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 unit. There is substantial variation in the intensity that is characteristic of archeological surveys that have been undertaken in the Southwestern United States. In the not too distant past, it was not atypical for a region to be surveyed by automobile, the investigator stopping periodically to check the likely location of sites or to check areas where local residents indicated sites would be found. Such surveys were very low in intensity - the proportion of the ground surface that the investigator neither saw nor inspected was quite high relative to what he did see and inspect. One archeologist has recently described a survey undertaken for the BLM in which teams of archeologists criss-crossed an area at distances of 50-150 yards from each other (Mueller 1975). (Actually, published data suggest that the 150 yard estimate was most typically employed.) While clearly more intense than the preceding surveys, such efforts are still relatively low in intensity. For the WMPU survey, we chose to survey using teams of individuals who were approximately 12 yards from each other; each individual was responsible for an area 6 yards to the left and 6 yards to the right of the line along which he was walking. While it is not possible to claim that 100% of the land surface is inspected when intensity is this high, it is the case that for most areas a relatively small number of sites, particularly very small sites will be missed. What is the justification for surveying at such a high level of intensity? Clearly intensity is costly and unless there is a good justification for keeping surveyors 12 yards from each other rather than 50 or 100 yards, much

more can be accomplished with a lower intensity survey.

Two pieces of evidence illustrate the problem with low intensity surveys. In our work on the Apache-Sitgreaves Forest, we have found that the average site is approximately 500 m^2 in area, or approximately 22 m X 22 m. Imagine employing a level of intensity requiring that each surveyor be 150 meters from each other surveyor. Allowing for minimal distance between sites could be present side by side at any one point between the lines being walked by the two surveyors. Even if the surveyors are 50 m apart, an average sized site can easily be missed. Average, in this instance, includes sites with architecture. Unless walls or at least a rubble mound stand well above the ground surface, it is unlikely that sites with habitation units will be seen from a distance of 100, 50, or even in some instances, 10 meters. Thus, 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.

A second important piece of evidence pertains to the characteristics of habitation sites that have been surveyed by us on the Apache-Sitgreaves Forest compared to surveys done in surrounding areas. Our efforts have located roughly 10 times as many sites per square kilometer as typical surveys done in surrounding areas. At the same time, the average number of rooms found on these sites is roughly 1/10 that of sites in surrounding areas. While there is an outside chance that these figures reflect simple differences in the nature of the prehistoric occupation of the areas in question, it is likely that it is variation in the intensity of the studies of the areas that is primarily responsible for such a difference. And the archeologist's interpretation of the prehistory of an area is going to vary drastically if he finds 2 as opposed to 20 sites per square kilometer, or 2 as opposed to 20 living units on the typical site.

We may summarize this situation overall simply by noting that previous archeological work in the area between Chevelon Creek and Show Low had identified no more than 50 archeological sites. The roughly 1 percent sample that we have done of the region in question has now resulted in records on over 1000 sites. Whether the Forest is managing 500 or 100,000 sites on the area in question clearly makes a big, big difference.

2. Sample fraction and sample size - Sample fraction refers to the percentage of some target population that is included in a sample. Sample size refer- to the number of observations that are made. The two are clearly different. One can imagine, for example, doing a 1% sample of the WMPU by surveying a single 1.74 mi^2 block. Alternatively, a 1% sample could be undertaken by surveying 1000 .00174 mi^2 square blocks. Balancing sample size and sample fraction in designing a survey is an important concern for a number of reasons.

First we should note that archeologists approach a sampling problem from a comparative disadvantage. When most scientists employing sampling techniques discuss a 1% sample, they refer to a sample that will encompass 1% of the entities in the target population (100 of 10,000 people, for example). But, in beginning a survey, we do not know how many entities (archeological sites) there will be or where they are. Our only option is to base the sampling fraction on the percentage of the land surface to be studied, recognizing that there is no guarantee that this will nearly correspond to the percentage of archeological sites in the target population.

Second, for most of the statistical techniques that are employed in making inferences about a target population on the basis of a sample, the sample size, the number of observations is critical. The probability that a particular inference can be accepted or rejected increases as the sample size increases. Yet, because increasing the sample size with the sampling fraction held constant means employing smaller and smaller areal units, the logistical problems increase drastically. The number of units that a crew or an investigator can survey in a day increases, and the needs for transportation from one sample locus to another rise dramatically as do transportation costs. Thus, logistical and statistical factors must be balanced.

Finally, it is important to note that inferences can successfully be made on the basis of very small sample fractions. Political polls are a good example - the sampling fraction is typical below a thousandth of a percent (while the sample size is quite high -1000s of individuals). Such samples are based, however, on an extremely precise understanding of critical characteristics of the target population. (Such samples are typically highly stratified, an issue that will be discussed shortly.) That archeologists have so substantial an understanding of their target populations and the variables influencing site distributions is doubtful. Nevertheless, important inferences about the prehistory of a given region can be supported on the basis of a 1% sample. And a 1% sample is about what typical levels of funding for large regional studies done at a high level of intensity will support.

3. Unit size and shape - Given a sample fraction and sample size, an investigator must next select a unit of a particular shape and size that will be used in drawing the sample. A number of studies have been undertaken on this issue (Plog 1976; Mueller 1975; Judge et al., 1975). The choice is typically between a quadrat or rectangular unit and a transect which can be thought of as either a long skinny rectangle, or a line. While the evidence is not conclusive, there is substantial indication that transects are the more effective of the units from a strictly statistical perspective. The one study done to date suggesting that quadrats are superior is based on a highly problematical data base that would inherently favor

quadrats. All of the studies done to date suggest that smaller units are more useful than larger ones, substantially because of the larger sample size.

But there are other considerations. The larger the unit, the larger the survey team needed to survey that unit. The smaller the unit, the greater the transportation cost of moving crews from one unit to another. The larger the unit, the greater the inferences that can be made about the relationship between sites - the tendency for smaller sites to occur around some central place, for example. The use of 1 mi x 50 yd transects on the White Mountain Planning Unit reflected our conclusion, based on substantial experience, that this unit is statistically as reliable and locationally and logistically preferable to larger or smaller units.

4. Sample design - There are three major design principles around which surveys strategies are developed: randomization, systematization, and stratification. Randomization involves selecting a sample according to a random numbers table or some other device that randomizes the location of particular sample units, that insures that the probability of a given unit being chosen is equal to the probability of other units being chosen. The advantage of randomization is that it reduces observer bias - the kinds of problems that arise archeologically, for example, when an investigator believes that he knows where sites will be located. Randomization also permits investigators to precisely state the biases that have occurred in the sample. Systematization involves locating sample units at equal distances from each other. This technique is useful for many sorts of mapping projects where an event distribution of data points over a study area is needed. Stratification typically involves breaking a target population or study area into units that will be sampled unequally - more observations will be made in some units than others - because of evidence indicating that the distribution of some important variable over the study area is in fact unequal. Stratification can also be areal - strata of equal area are defined and sampled equally - to guarantee some degree of systematization. As noted previously, sophisticated samples are typically based upon substantial stratification. Unfortunately, it is not clearly the case that our understanding of prehistoric site distributions is sufficient to permit meaningful stratification on any other than areal grounds. We will return to the adequacy of our understanding in this area later. Generally, studies to date have suggested that areally stratified samples provide statistically more precise and efficient information than either random or stratified samples.

5. Data base - Whatever the specific data base in question, there are important aspects of the archeological data base in general that effect sample designs. Most important concerns the relative desirability of finding out where sites are and where they aren't. For understanding prehistoric man-land relationships and

for a variety of cultural resource managemnt problems, it is as important to know where sites are not located as to know where they are located. Yet, understanding the prehistory of an area and managing its cultural resources necessitate some evidence concerning the sites that are there. This problem is typically overcome by employing a multistage sampling design. A first phase of sampling is done on random or areally stratified basis. A density map is constructed on the basis of this first phase and a second phase or stage of sampling is undertaken in which the proportion of new units done in each area varies with the previously observed density of sites in that area. More sample units containing archeological sites, are therefore likely to be surveyed in the second sample stage resulting in more data concerning the prehistory and archeological resources of the area in question.

The White Mountain Planning Unit Strategy

Based upon the issues discussed above the following sampling strategy was employed in the White Mountain Planning Unit:

Stage 1: Stratified random sample. The first stage of sampling involved the use of an areally stratified random sample employing transects 50 yards in width as the unit. Specifically, one sample unit was chosen in each six section unit of the planning unit, six transects in each township, or a total of 30 sample units. The specific procedure was as follows. One section out of every six sections was selected, using a random numbers table. A compass direction for each transect was selected randomly from one of four directions: N-S, E-W, NE-SW, NW-SE. N-S and E-W transects were 1 mile in length and 50 yards inwidth. NE-SW and NW-SE transects were 1.4 miles in length and 50 yards in width. While using transects of unequal length can introduce problems in the statistical inferences that can be based on the data, this variation can ultimately be controlled. And surveying from section corner to section corner creates a more desirable logistical situation in the field than attempting to stop and start transects in the middle of sections.

Stage 2: Stratified random sample. In this instance, stratification was done not on the basis of area but on the basis of the relative density of archeological sites in different portions of the drainage as indicated by the stage one sample. An additional 35 sample units were identified using this procedure.

Stage 3: Non-random blocks. In an effort to further clarify the patterning in the distribution of sites relative to other sites, a half-dozen non-random units in major site concentrations were examined.

It was on this data base that our conclusions concerning the study unit were based. Let me now turn to some of those conclusions.

Results: Cultural Resource Management

1. Density of sites. Projecting from the sample done of the White Mountain Planning Unit, I estimate that there are between 3500 and 4500 on USFS property within the planning unit. Clearly, these figures indicate the presence of a substantial management problem. The problem becomes more or less substantial as one interprets the existing legislation concerning the Forest Services responsibilities in regard to these sites. A comprehensive inventory of sites within the planning unit would be extremely expensive, involving several hundreds of thousands (if not over a million) dollars. Even if one bends the law to suggest that what is required is an "understanding of the information" rather than an inventory of every site, the cost in the long run of obtaining such an understanding will be substantial.

2. Distribution of sites. The relative distribution of sites over planning unit is shown in a site density or sensitivity map. This map was generated by SYMAP, a computer mapping procedure. Essentially, SYMAP provides a basis for inferring "zones" from points. The data points in this instance are the transect locations. The locations were used to generalize concerning the density of sites in their vicinity. It should be noted that what is measured by the map is relative density. Especially critical is recognizing that the sample employed is not sufficiently large to support the inference that there are no sites in the areas where no sites were found on transects. Rather, in these areas site density is inferred to be especially low. It is also critical to identify the purposes for which such a map should and should not be used. The map is useful as a planning tool - for estimating the magnitude of archeological resources in an area and the cost of studies that will need to be undertaken in conjunction with, for example, land clearance, land exchange activities. There is no sense in which the map is useable for concluding that a particular parcel of land should or should not be exchanged or cleared.

3. Past impacts. There is a statistically significant difference in the mean number of sites found on transects adjacent to private properties compared to the mean number of sites found on transects away from private property. The mean number of sites found on transects adjacent to private property is 1.4, while on transects away from private property it is 1.0. Thus, site densities in the planning unit areas away from private property average around 20 sites per square mile, while density in the vicinity of private land is 28 per square mile. Thus, there is reason to believe that the archeological record of the WMPU region has been effected by construction, farming, and ranching activities undertaken on this land. This problem is compounded when one considers the kinds of sites in question. The percentage of all sites that were large habitation units on transects in the vicinity of private land is 24%, while only 18% of sites on transects away from private

land are large habitation sites. Thus, the existence of private land effectively removes from federal protection both the lands within the unit where prehistoric human occupation was densest and the lands where the larger and more central settlements existed.

4. Vandalism. Initially, we had intended to assess the relative degree of vandalism occuring at archeological sites within this planning unit compared to areas within the Chevelon drainage to the west where access is poorer. However, the extent of vandalism was sufficient that no relative assessment was deemed necessary. It was rare to find a site within the White Mountain Planning Unit at which significant evidence of vandalism did not exist. In the Chevelon drainage, vandalism is relatively rare and slight in its effects.

Region Prehistory

While the primary purpose for undertaking the study was cultural resource management, the survey of the WMPU did contribute to understanding a number of different aspects of prehistoric behavior. Let me give two examples.

1) It is perhaps appropriate to begin with what we don't know rather than with what we do know. As mentioned earlier, one of the advantages of probability sampling is that it permits the investigator to state the biases of the sample in question. For this study the most important and obvious is the kinds of sites about which we probably have no information. If sites occurred with a frequency of less than one per square mile, then they were probably not picked up in the sample. These may be very important kinds of sites, early Paleo-Indian sites or ceremonial kivas, for example.

2) Prehistory. The area was apparently first occupied between 1500 BC and AD 500 by populations who lived in impermanent camps and villages of small pithouses. No ceramic materials were made at this time. Between AD 500 and AD 800, populations living in small pithouse villages and who made ceramics occupied the area. Between AD 900 and AD 1100, populations living sometimes in pithouse villages and sometimes in villages of unplanned surface structures were present in the drainage. The majority of the sites located on the survey date to the period AD 1100-1300. During this time populations occupied masonry pueblos that were on the average of about 6 rooms. Both larger and later sites are probably found within the planning unit, but on private rather than Forest Service property. Thus, the drainage is best considered as peripheral to populations living in the regions of which it was a part until around AD 1100. At this time, the drainage was briefly occupied, probably for a period of no more than 500 years, at which time it was abandoned.

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The Gentry Timber Sale: Archeological Sampling and Environmental Locational Models on the Tonto National Forest, Arizona

By
J. Scott Wood

Introduction

Sampling in archeological survey has seen increasing use in Forest Service cultural resource management in recent years. For large scale planning, it is a logistical necessity. It can also be viewed as necessary for smaller scale projects, such as timber sales, since these projects are usually large enough in area to put a considerable drain on the time and other resources of archeologists working at the Forest level.

The traditional role which sampling has played in this context has been to characterize large parcels of land on the basis of small samples and then to predict overall site densities for the larger area. It is felt that this approach relies too heavily on the common assumption that sites are distributed evenly across the landscape or in a statistically normal manner. Thus, the only information that such an approach can provide is data on a minimal number of sites, and a prediction of the total number of sites to be expected in the whole of the surveyed area. It cannot predict where within that area the sites will be located, nor can it describe the types of environmental situations associated with site placement. Information of this type would be valuable for the consideration of cultural resources in project planning.

One way to acquire this level of information is to construct an environmentally based site locational model for a project area which can be used to delineate areas of high and low sensitivity to cultural values. These sensitive areas can then be avoided or systematically and intensively surveyed, depending on the particular management needs of a project. For these reasons, an environmental locational model, developed from a settlement pattern analysis of transect sample data, was constructed for and tested on the Gentry Timber Sale, Pleasant Valley Ranger District, Tonto National Forest. This report describes the procedures used in constructing the survey samples, the model used, and the results obtained from the use of this approach. As such it presents a summary of the survey and analysis report (Wood, report in preparation).

The Gentry Timber Sale

The Gentry Timber Sale will take place in a large parcel (7800 acres) of National Forest land located in the dissected escarpment zone below the Mogollon Rim on the Pleasant Valley Ranger District in central Arizona (Fig. 1). This is a mountainous area characterized by rugged terrain and dense ponderosa pine forest grading into pinyon-juniper woodland and oak-juniper woodland and chaparral. The Gentry Timber Sale lies in the ponderosa zone just north of the ecotonal boundary of this zone with the pinyon-juniper-oak woodland. A number of small drainages headed by springs are found in this area and it receives considerable annual rainfall. One noteworthy aspect of the rainfall regime is that area experiences rather severe winters. These cold winters are magnified on the Gentry Sale, as the deep, narrow canyons there tend to hold snowfall for many days after it has melted out of nearby areas.

The Survey

As this area is to be sold for timber, Forest policy required at least a ten percent sample survey prior to assessment for archeological clearance. To accomplish this, a systematic transect plan was designed, utilizing transects 200 feet wide, oriented east-west across the boundaries of the sale. Transect interval was set at one quarter mile, with placement along surveyed quarter-section lines, to provide logistical efficiency and eliminate any bias relative to suspect archeological site locations. The 18 transects laid out in this manner (Fig. 2) covered a linear distance of 45 miles and provided an area of 1094 acres for a 14 percent sample of the entire sale. The total area surveyed for this sale was 1604 acres, slightly over 20 percent.

The transect survey was the initial stage of a two-stage sampling design. This stage was followed by a settlement pattern analysis of the transect information. This analysis was used to construct an environmental model of site location for the sale area. The predictions of this model formed the basis for the second stage of the sampling design.

The second stage of the sampling design identified areas within the sale which conformed or did not conform to the environmental parameters for settlement developed from the model. Those areas predicted to contain cultural resources by virtue of conforming to these parameters were designated "archeologically sensitive blocks." These blocks were then surveyed systematically and intensively (100 percent). In addition, the sale transportation system was surveyed in the same manner to test the effectiveness of the predictive model. The transportation system (roads and landings) was located almost entirely in areas defined by the model as being nonsensitive or containing no cultural values. The block survey parcels and sale transportation system are shown in Figure 3.

The choice of a systematic transect design as the initial stage was based on a previous assessment of the value of such a procedure for timber sale surveys (Plog, Hantman and Wood 1976) and on an experi-

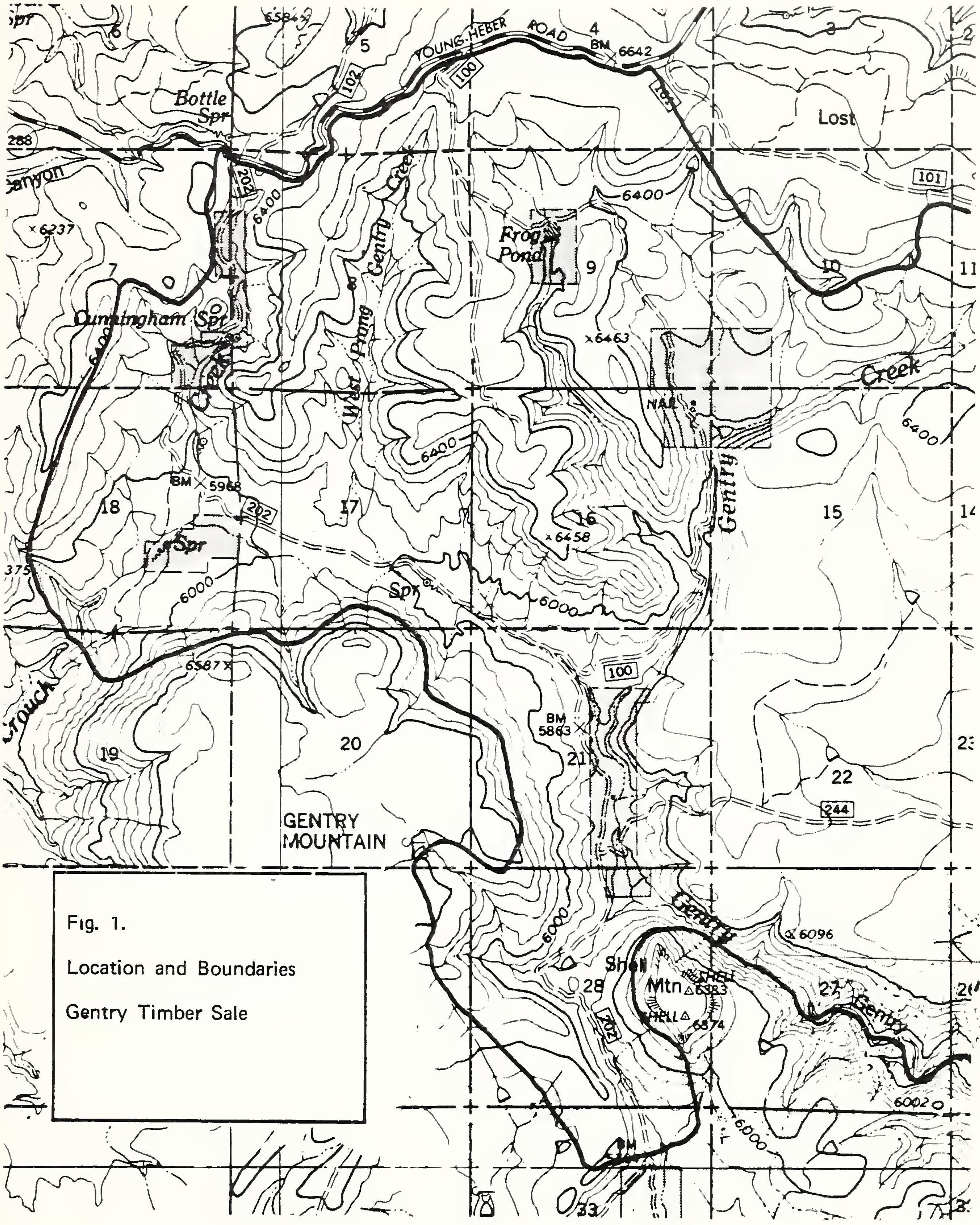


Fig. 1.

Location and Boundaries

Gentry Timber Sale

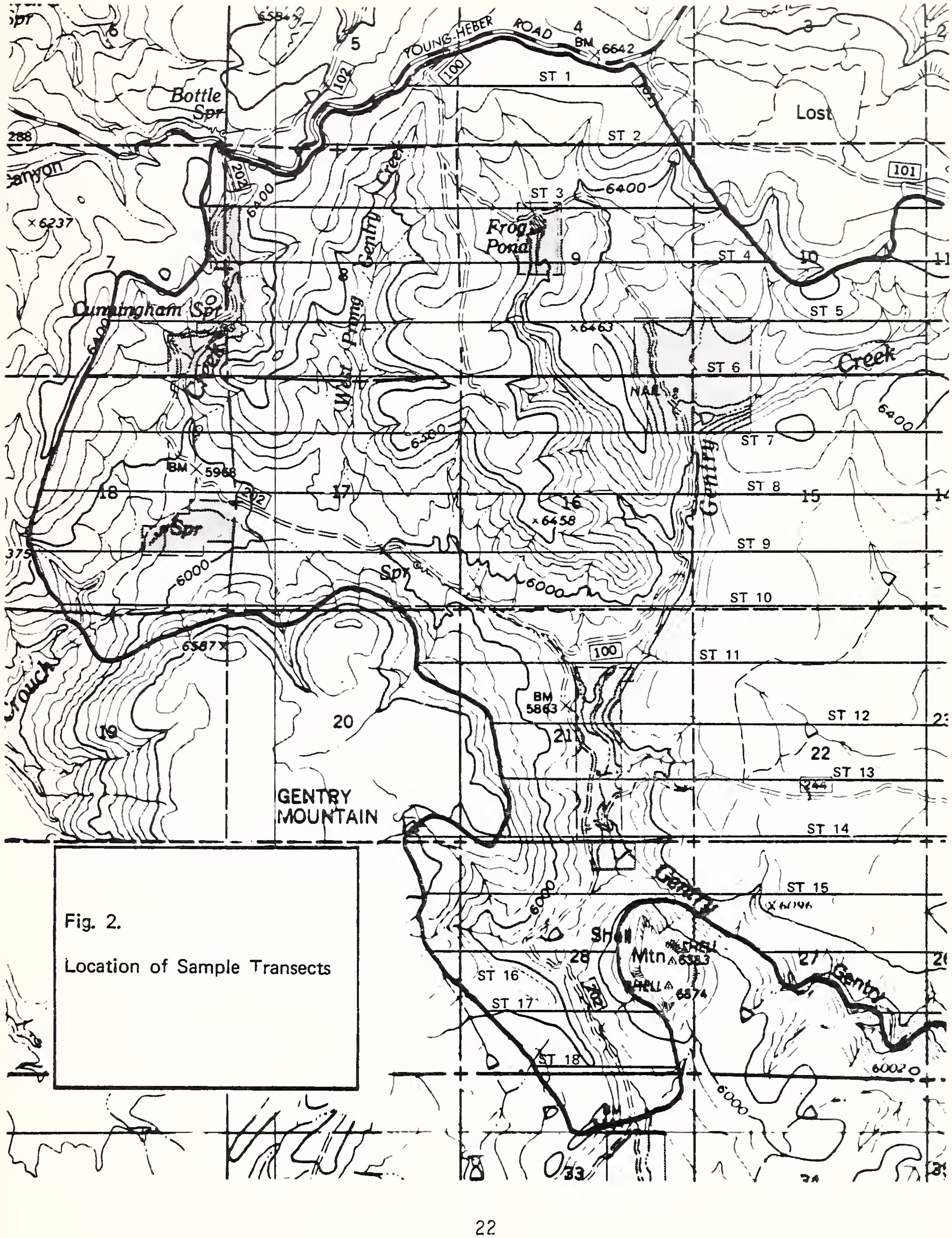


Fig. 2.

Location of Sample Transects

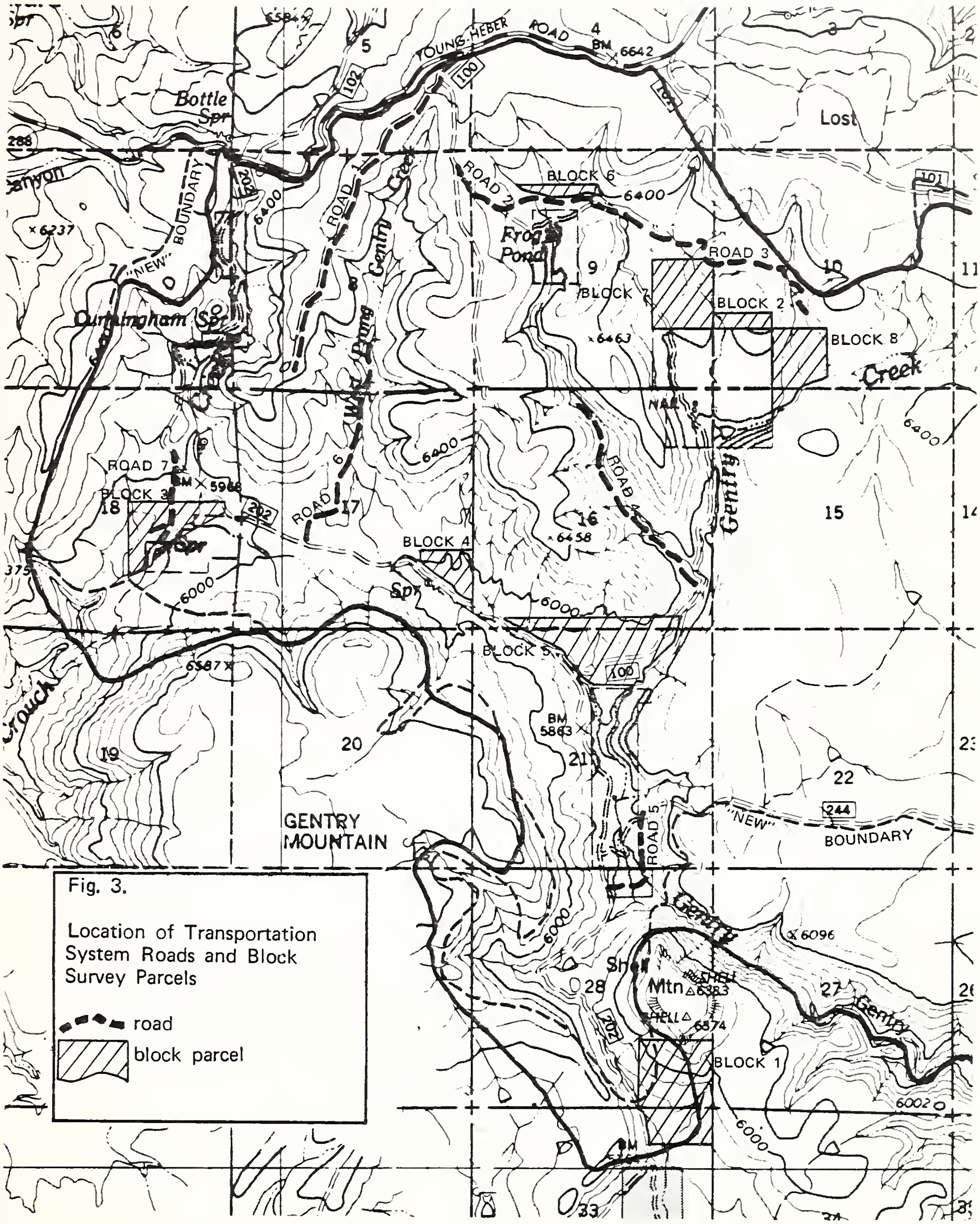


Fig. 3.

Location of Transportation System Roads and Block Survey Parcels

mental assessment of the procedures described in the Gentry Timber Sale report (Wood, in preparation). The systematic transect design is used on the Tonto National Forest primarily because it guarantees each portion of a survey area an equivalent degree of coverage. In this way, the systematic design has an advantage over strictly random transect designs and is, in addition, more logistically efficient than simple or stratified random designs. Most important for the purposes of this study, systematic transect designs allow prediction of variations in site density over an area, owing to the even coverage they provide.

Twenty-one archeological sites were recorded during the survey (Figure 4). Nine were located on the transect sample, ten were identified in the block survey, and two were located fortuituously outside the sale boundary. Of these 21 sites, 13 were prehistoric habitations, one was a prehistorically occupied rock shelter, six were prehistoric artifact scatters, and one was a historic mining settlement of indeterminate age. These sites are described in Table One.

On the basis of the predictive analysis and subsequent block survey, it is felt that this inventory represents at least 80 percent inventory of all cultural materials and more than 90 percent of the habitation sites from the sale area.

The cultural manifestation identified in the sale area appears to be a locally developed derivative of Mogollon with an early Hohokam admixture. This population has been termed the Vosberg Mogollon (Wood, in preparation), after the larger population center just south of the sale (Cartledge 1976a, 1976b; Chenhall 1971). The Gentry occupation appears to be a marginal manifestation of this larger population and represents its northermost, highest elevation occupation (Tjaden, 1977; Wood, in preparation; 1977a).

Environmental Settlement Pattern Analysis

The construction of the environmental predictive model used here was based on procedures described for a similar model developed for the Little Colorado Planning Unit, Apache-Sitgreaves National Forest (Wood, in Plog, 1977; Wood, 1977b). These procedures involve the correlation of site placement with the presence of environmental variables having particular characteristics seen as functionally adaptive for a prehistoric population. The goal was to develop a small-scale or local model, since such models are more accurate and specific than Region-sized models.

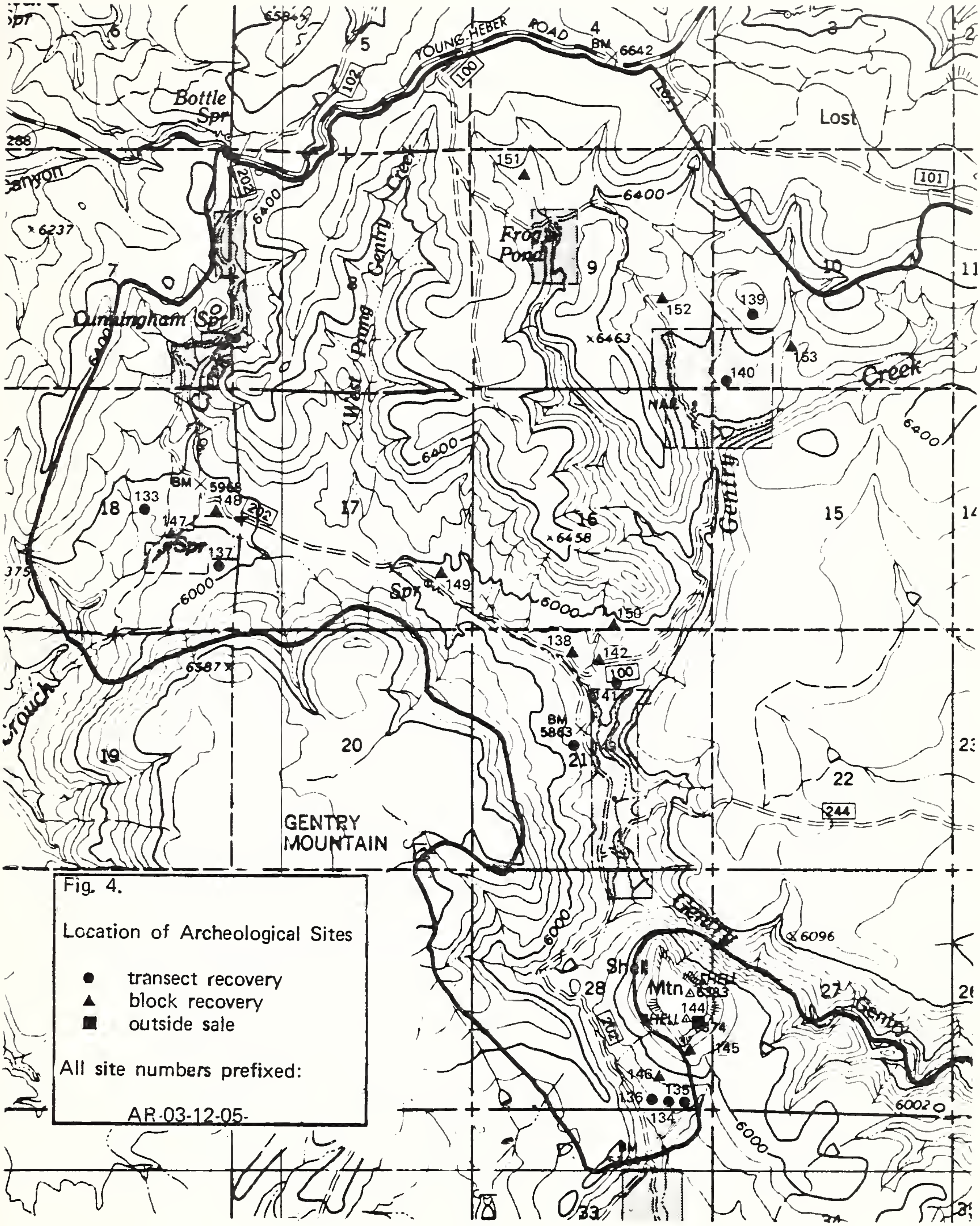


Fig. 4.

Location of Archeological Sites

● transect recovery
▲ block recovery
■ outside sale

All site numbers prefixed:

AR-03-12-05-

TABLE ONE

SITES LOCATED ON TRANSECT SAMPLE

Habitation		Limited Activity	
133	Masonry-Jacal	136	Ceramic/Lithic
134	Masonry	137	Ceramic/Lithic
135	Masonry-Jacal	143	Lithic/Ceramic
139	Masonry		
141	Masonry-Jacal		
142	Historic		

SITES LOCATED IN BLOCK SURVEY

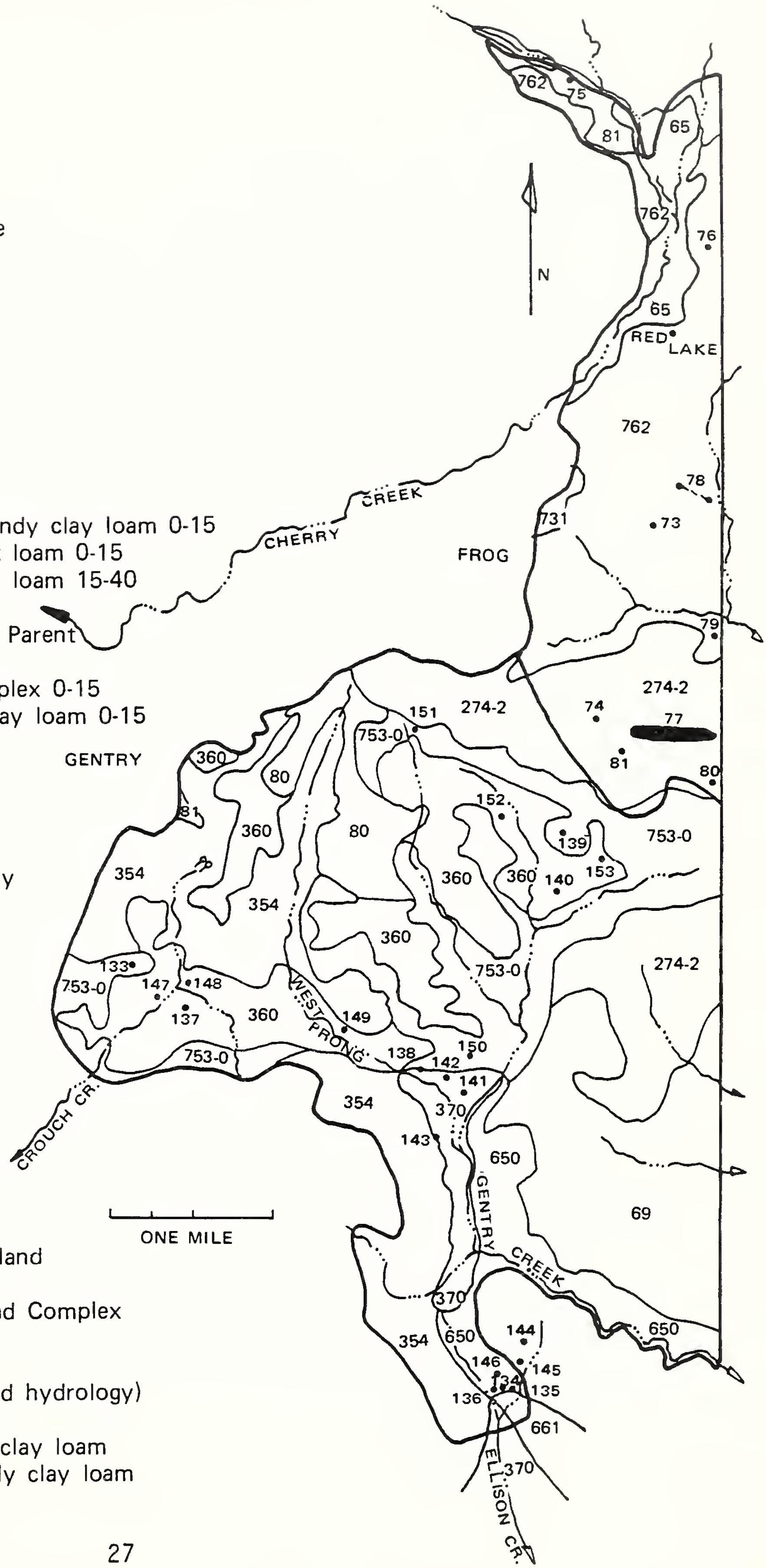
Habitation		Limited Activity	
138	Masonry-Jacal	151	Lithic
145	Jacal	153	Lithic
146	Jacal		
147	Masonry-Jacal		
148	Jacal		
149	Masonry		
150	Jacal		
152	Jacal		

SITES LOCATED OUTSIDE SURVEY AREA

Habitation		Limited Activity	
144	Cave/Rock Shelter	140	Ceramic/Lithic

Fig. 5.

Gentry Timber Sale
Soil and Drainage Map



Soil Units

Alluvial Parent

65 - Pyeatt Loam 0-5
69 - Showlow ext. cobbly sandy clay loam 0-15
80 - Colcord very cobbly silt loam 0-15
81 - Colcord very cobbly silt loam 15-40

Sandstone/Siltstone/Quartzite Parent

271-2 - Jack's - Crouch Complex 0-15
274-2 - Cherry Creek silty clay loam 0-15

Diabase Parent

354 - Jayarr ext. stony sandy clay loam 30-60
360 - Workman gravelly sandy clay loam 0-15
370 - Queare gravelly sandy clay loam 0-15

Sandstone/Quartzite Parent

650 - Rockland 10-100+
661 - Telephone ext. stony fine sandy loam

Shale/Siltstone/limestone Parent

753-0 Steep Sandstone Rockland 30-90
762 - Diamond Rim Rockland Complex 10-40

Arable Soils (by structure and hydrology)

370 - Queare gravelly sandy clay loam
360 - Workman gravelly sandy clay loam (valley subunit)

Fig. 6.

Gentry Timber Sale
Vegetation Map

MAP UNITS

1 - Ponderosa Forest

2 - Ponderosa, A. Juniper, Gambel Oak, Manzanita, Shrub Live Oak

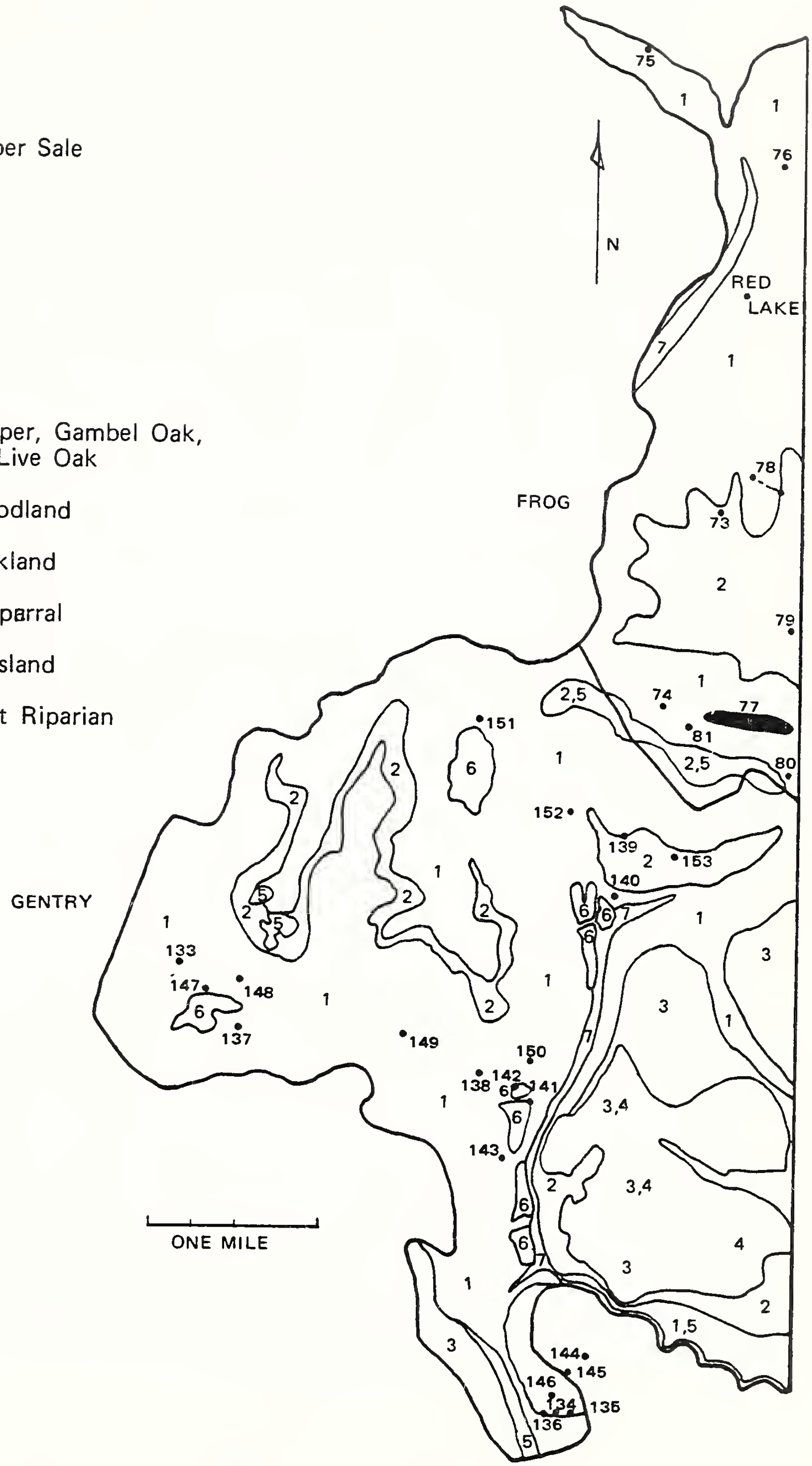
3 - Pinyon-Juniper Woodland

4 - Pinyon-Juniper Parkland

5 - Oak-Manzanita Chaparral

6 - Grama-Galleta Grassland

7 - Walnut-Alder-Locust Riparian



Four environmental variables relevant to the assessment of settlement patterning within the context of this sale were selected on the basis of differentially available natural resources. These four variables are soils, vegetation, water and topography. The model describes correlations between these four variables and sites located in the transect sample, in which these variables were independent of sample unit selection. The selection of these variables as critical is based on several established premises of Southwestern archeology and ethnology. These are that the sedentary populations of this region (those utilizing permanent architectural habitation structures) were involved in a mixed economy of agriculture and the hunting and gathering of wild foods, that housing constructed of native materials is perishable, and that architectural designs utilized reflect certain social and ecological factors. Following these assumptions, agriculture is dependent upon the presence of arable soils and gathering on available plant resources, while both require available water. Housing locations should have provided drainage in wet seasons to protect these structures from waterlogging and collapse. Another consideration should have been exposure to the sun in a manner compatible with maximum comfort during the winters. Based on these assumptions, the hypothesis of the model is that habitation sites are located in close proximity to arable land, economic plant associations, and permanent water, and also in association with topographic features providing both adequate relief for drainage and maximum exposure to solar radiation to offset the effects of cold, snowbound winters.

Soils

Only two of the local soils, the Workman and Queare loams, are considered arable in the context discussed above (Broderick 1971). Within these two soils, only the deeper valley floor portions meet the criteria of structure, composition, and depth commonly accepted for soil arability (Wood, in Plog, 1977; Wood, 1977b). As is shown in Figure 5, nearly all sites located in the sale area are found on or within 150 meters of the valley floor expressions of these two soils. The only exceptions are -145 (300 meters away) and -144 (500 meters away). This association supports the hypothesis.

Vegetation

Little is available here in terms of economic plant species associated with arable land. Economically useful plant species are available but are concentrated in the dry uplands of Gentry Mesa, well away from any arable land parcel. All sites in the sale are located within mixed or nearly pure stands of ponderosa (Figure 6), probably because this is the vegetation most commonly encountered around the arable land parcels and in most of the sale area. The association most economically useful (the pinyon-juniper woodland of Gentry Mesa) was found to contain no cultural material. It would seem from this that the gathering of plant resources

was less important in terms of site location than was the use of arable land. Thus, the hypothesis is not supported in this instance.

Water

Water appears to play an important role in site location for the sale area, since all sites are found within 400 meters of seasonal to semi-permanent or perennial streams or springs. However, this resource is rather widely distributed within the sale area and may not actually be a determining factor. Thus, its relationship to the hypothesis is suggestive, but not clear.

Topography

Topography in the sale area is highly variable. Site situations vary as to type of landform and relative relief but nearly all reflect some relief. Placement was on low ridges, slope bases, low rises in valleys, and low knolls. There are several exceptions to this selection for low raised areas. One site (a scatter) was located in a shallow drainage, the cave site is located on a cliff face, and two sites were situated on high, steep ridge crests.

The more deterministic aspect of topography appears not to be landform type, but exposure. All sites from the Gentry assemblage, except for two small scatter sites, are found on generally to abruptly southwest to southeast facing slopes. Thus, a south slope exposure on a landform of some relief was a major locational parameter for habitation sites in the sale area. This parameter does not appear to have affected limited activity or scatter site placement greatly, since those sites have no particular orientation.

The Model

The most important environmental parameters for the prediction of habitation site location appear to be the presence of valley floor Workmans or Queare loam soils and low to medium relief topography situations providing a southern exposure. The model, therefore is that habitations are located in those portions of the sale where these two parameters are met simultaneously. It should also predict where limited activity site exploiting the same resources as habitation sites, or associated with them in other ways, will be found. Other limited activity sites not involved in the same environmental relationships, will not be predicted by this model.

Testing The Model

The model presented above was developed from the transect sample and tested by means of additional survey within the sale. The first part of this test was to systematically and intensively survey a series of block parcels which fit the environmental parameters of the model. The block parcels shown in Figure 3 represent all those areas within the sale which appeared on the basis of the soil, vegetation, and topographic maps presented here (Figures 1, 5, and 6) to meet the criteria of the model. They may not account for each microlocational situation compatible with the model, but they do account for all such areas recognizable from presently available geographic information. The second part of the test was a survey of the sale transportation system, which was, with the exception of part of a single road (Road No. 7 - Figure 3), located in areas which did not conform to the parameters of the model.

The block surveys all produced additional archeological sites and materials, though at much lower densities than initially predicted from the transect survey. While this supports the locational predictions of the model, it suggests a major problem with using raw density figures for predicting the quantity of a cultural resource for an area from a sample.

No archeological sites were located on any of the six "non-sensitive" roads. Cultural material was encountered along Road No. 7 on that portion which crossed block no. 3 as the road intercepted part of the extended artifact scatter surrounding site -147. Thus, to the extent that it is valid, the transportation system survey establishes that sites are not found in areas not conforming to the environmental parameters of the model, and supports the predictions made from the transect survey. Overall, then, the model is supported by dependent testing and appears to be valid at a high level of probability for the area of the sale.

Conclusions

The locational model described here has been shown to be useful in predicting the environmental situations where cultural values are located. Clearly, such information is valuable for cultural resource management. It also facilitates the assessment of cultural properties contained within large project areas. It is valuable as well for the design of sampling strategies for that assessment, as it can be used to direct sampling or inventory of those areas most sensitive to the presence of cultural values.

The two stage procedure presented here is similar in many respects to stratification sampling designs which have been used in the past. However, this procedure is felt to represent a refinement of that approach, as it is able to specify particular locations for predicted cultural materials, identified by the coincidence of interacting environmental locations parameters. By utilizing this predictive ability to delineate sensitive areas, a large parcel of land can be broken down by means of a low-level sample into smaller blocks requiring further investigation or predetermined avoidance. A much better picture of the nature and distribution of cultural resources is obtained by utilizing this procedure than by simply relying on the generalized overall density projections of most small samples. As a byproduct, this procedure also negates the need to systematically and intensively survey the whole of very large land parcels, such as are involved in timber sales, when the site density overall is indicated to be too high for a No Effect determination. Thus, it is felt that this procedure provides a useful and valuable tool for the management of cultural resources by Federal land-holding agencies.

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PROJECT SAMPLING IN THE INTERMOUNTAIN REGION USDA FOREST SERVICE

By
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Introduction

Man's knowledge about the reality which surrounds him is based entirely upon that portion of reality with which he has had experience. Man experiences only a few of the total relationships possible in the universe and gains a view of reality from them. It is inevitable that he acts upon that which he observes and assimilates from his total cultural and physical environment. In one way or another, all human behavior expresses the biases and limitations resulting from endlessly variable samples of reality.

Archeologists face the same situation in describing or characterizing prehistoric pheonomena. All data gathered by archeologists are in one way or another only samples of a larger population of data. Excavation of an archeological site recovers only a portion of all the data available. The archeologist makes decisions as to which data are relevant to his purposes and discards other data. Some data are not collected because they have yet to be recognized as relevant or else they await new techniques which will allow their recovery. Rarely, in fact, are all data known to be relevant and recoverable actually collected from a site.

When one is faced with the task of explicating large populations of sites, artifacts, or attributes, it is readily apparent that complete enumeration will require the commitment of immense amounts of time and money. If any description and analysis of large collections of materials is to occur, one is forced to limit his investigations to some portion of the total population. For years, statisticians have extolled the advantages of sampling over complete enumeration in such instances. Taking a sample of a large body of data for analysis may have a number of advantages over an attempt at complete enumeration, even when it is possible. First, it requires less time and hence, less money to obtain and analyze a sample. This is important when deadlines exist for the use of information. Second, properly collected and designed samples can, in many cases, increase the accuracy of the data collected by allowing the utilization of personnel and techniques more highly specialized than could be afforded otherwise.

Sampling is not a novelty. Archeologists have been taking "samples" for decades and have been inferring from these samples certain properties of the total population. What is a novelty in archeology is the application of statistically sound and explicitly formulated sampling designed. Two points are apparent in many reports: 1) every site selected for investigation is in some undefined way "typical" or "representative" of an area, a time period, or a class, and 2) it is assumed that other archeologists know implicitly what is meant by "important" and "significant" sites, and sites that are "representative" and "typical."

It is probably safe to conclude that most archeologists are interested in collection information about prehistoric populations that is reliable and "representative" of the total population. This collection process must, at the same time, be kept within the limits of time and money allocated to the project. This is practically the definition of the aims of modern sampling procedures (Binford 1972:139). Sampling does not mean the substitution of partial coverage for total coverage. Sampling is the science of controlling and measuring the reliability of data through the theory of probability (Deming 1950:2). It is the only known means of accomplishing coverage of the archeological phenomena so that the results can be evaluated as to their reliability and from which inferences can be drawn for the total population.

Sampling Cultural Resources

One of the most obvious and pressing problems faced in cultural resource management is providing the data on cultural resources necessary for project decision making. Hundreds of projects are planned and executed annually that require some evaluation of the cultural resource and the impact of the project upon it. These projects range from planning units including several hundred thousands of acres, to stockponds a fraction of an acre in size. Some have no effect upon the cultural resources and, hence, require little more than a statement to that regard. Others may directly or indirectly impact this resource and will require an evaluation of that impact. Since an evaluation must be preceded by an inventory, we are frequently faced with a data collecting problem. How many and how important are the cultural resources? Can we mitigate any adverse impacts and how much is it going to cost? Is the project feasible, will it require extensive modification or, perhaps, should it be canceled? These are the questions to which the land manager needs answers.

For many small projects the answers are obtained by inventorying and evaluating all cultural resources present. But what about the big project? How do we evaluate the consequences of our planned actions upon the prehistoric and historic resources of the large area? Sampling is essentially a compromise between inventorying all sites in an area and not inventorying any. Our choices are these, 1) delay the project until all sites have been inventoried and evaluated, 2) cancel the project or proceed without doing any inventory or evaluation, or 3) sample the area.

The first alternative would mean the delay of projects for months or even years and the investment of thousands of dollars in systematic inventory work. Even after all this, the most feasible and prudent alternative may be to drop the project. This can easily occur with projects of low unit-worth, i.e., land exchanges, range revegetation, etc. A 20 percent increase in the cost of a project due to cultural resource inventory may reverse a positive cost-benefit ratio and result in a different decision altogether.

The second alternative is not the least costly of the three by any means; it is the most risky. An ever increasing list of examples could be given as an argument against carrying out projects without adequate consideration of the cultural resources. A road project scheduled for 1974 may begin during the summer of 1977 now that the Forest has complied with the court's decision to consider the cultural resources of the project. After spending $10,000 preparing appraisals and other administrative costs, a land exchange was canceled when a large prehistoric village complex was accidently discovered on the selected lands. Inventory cost estimates of $120 to examine the parcel were previously considered "too high." Canceling projects because we can't find funds to conduct any cultural resource evaluation is equally impractical.

It appears that for many large projects, sampling is a practical alternative to doing nothing. We must, however, keep in mind the limitations of sampling with regards to the legislative regulations effecting cultural resources on public lands.

In the course of cultural resource management, there frequently arises the question of importance. Inventories result in three categories of sites initially, important, and questionable. Although many projects may be able to proceed and management decisions can be made with this level of data, frequently additional investigation of a site or group of sites is required to evaluate this importance. Sampling can be an efficient means of accomplishing this evaluation with a minimal outlay of money and manpower.

As in sampling surveys, sampling as a means of site evaluation can both reduce the resources needed to accomplish the job and permit a more intensive examination of that sample than would be possible otherwise. As with area investigations, the limitations of sampling with regard to the requirements for project clearance must be kept in mind.

Limitations

Different projects will require various data levels. This need is dependent upon a number of variables; 1) project effect, 2) cost-benefit analysis, 3) planning status, and environmental factors.

The first question to be answered is one of project effect. Will the project directly or indirectly impact cultural resources that may be present? If the answer is no, there is no project-related need to pursue the issue further. This "no" must, however, be due to the nature of the project and not a "no, because we don't know of any cultural resources in the area." If the answer is "yes," the next step is to determine what the effect will be. This means inventory data will need to be gathered if it has not already been done. How much data to gather can vary with the extent of the impact, and degree of commitment to the project. If we are talking about project feasibility, a low level inventory may be sufficient to provide planning information. If the project must be carried out essentially as planned, we might just as well get on with the inventory and evaluation of all cultural resources to be impacted. Land-disturbing projects cannot proceed until all sites which are eligible for inclusion in the National Register, i.e., are scientifically important have been identified, and an agreed upon mitigation plan has been signed by the Forest Service, the SHPO, and the Advisory Council.

In order to meet these various needs, we have defined four levels of inventory in the Intermountain Region. Each will meet certain specifications and needs of the land manager.

These levels are:

Level I -- Overview

This level of inventory consists of the accumulation of data about an area through a systematic search of existing records. Some of the records that should be consulted included: National Register Of Historic Places, state archeological and historical files, local university and college files, published archeological and historical journals and reports, Forest and District files, archeological and historical files kept by other Federal agencies, etc.

An overview will assemble all known cultural resource data for a project and will permit various interpretations depending how extensive these data are. If sufficient data are found, some statements as to the potential of an area may be made as well as statements as to the expected impacts from a proposed project.

An overview inventory will not meet the requirement of EO #11593 to identify all eligible National Register sites in an area. It can be beneficial to land use planning if sufficient data exist for the planning unit. It is a necessary first step in all other levels of inventory.

An overview inventory is not sufficient to allow a determination of effect to be made for a project which involves land-disturbance and, hence, will not be adequate for project clearance. In a rare instance, however, a project might be planned in an area where a Level IV survey has previously taken place for other purposes. In this case the overview would be sufficient. An overview inventory might also be of value in directing project planning into areas where low densities of cultural resources appear to occur. An overview might be sufficient to cancel, modify, or move a proposed project at a minimal cost for cultural resource work.

Level II -- Reconnaissance Survey

This level of inventory involves on-the-ground search for cultural resources. It is not a systematic, thorough, or probability sampling of an area, but a "grab" sample for a quick assessment of potential or to verify sites reported in the Level I overview. The area is quickly covered using a "best-guess" approach to locate some of the cultural resources if present.

A reconnaissance is best used to check data gathered during the Level I inventory. Field checking to determine present condition, eligibility for National Register nomination, etc., are carried out in the Level II inventory.

A reconnaissance survey will not meet the requirements of EO #11593 and cannot provide the necessary data to prepare a determination of effect for a project. It also will not permit statistical projections of an area's cultural resource potential as will a Level III survey.

A Level II inventory may be useful in some cases where a quick check of a proposed project is needed to provide verification of previously reported cultural resources or when the presence of any cultural resources may be sufficient to allow the land manager to make a decision.

Reconnaissance surveys should be carefully considered since they have a rather limited usefulness. In most cases a low intensity Level III inventory will provide more useful data for the same dollar cost.

Level III-- Sample Survey

This level of inventory involves a statistically valid sampling of a proposed project area to provide predictions of the cultural resources present. The intensities of the sample are varied to fit the need for accuracy. Level III surveys are extremely useful in projecting total resource values, estimating project impacts, and designing projects at a minimal cost. Level III inventories are useful in most land use planning both to permit projections of cultural resource values and to direct project planning into areas of low cultural resource potential.

Preproject sample surveys at low intensity can quickly establish the feasibility of a project in relation to the number, importance, and required mitigation of cultural resources present. Sample surveys will generally permit determinations of effect on cultural resources to be made, but will usually be inadequate to meet EO #11593 requirements. They will provide data sufficient to determine what mitigation action will be required but will not provide sufficient data to permit the formulation of specific mitigation plans. Level III surveys are not usually sufficient for project clearance under existing regulations, but are far more useful as a planning tool than Level II inventories.

In some projects a combination of Level III and Level IV inventories will be acceptable for project clearance. These kinds of projects are characterized by dispersed impacts in difficult to survey types of terrain. Timber sales in heavy forest types can generally be cleared with a combination of intensive survey of identifiable land-disturbing activity areas and sample surveys of the remaining project area.

Level IV -- Intensive Survey

This type of inventory is characterized by a 100% coverage of a proposed project to locate every eligible National Register site. It thus meets the requirements of EO #11953 and provides all necessary data to allow a determination of effect, mitigation proposal design, and final clearance of a project to be carried out.

The intensity of the inventory will, in reality, vary in response to variations in terrain, ground cover, site size, weather conditions, etc. The accepted total survey technique consists of a pedestrian survey by an archeological team. Individuals walk over the ground in parallel routes spaced according to the dictates of the environment. This distance may vary from 10 feet to 100 feet or more. The survey is designed to locate all eligible National Register sites in that area. Open ground will allow wider spacing and quicker coverage than heavily vegetated locations.

This level of inventory is the minimum permissible in most projects where impacts to the cultural resources will be wide spread. Land exchanges, pinyon-juniper removal by chaining, road construction, land leveling, reservoir construction, etc., are examples of such projects. As a rule any area of land which will be disturbed by a project or a project activity, will require a Level IV inventory for clearance.

All four levels of inventory are designed to obtain cultural resource data. For projects having different land disturbing impacts, different levels of inventory may be adequate for clearance decisions. The aim of a cultural resource inventory program is to provide data necessary to meet requirements, make determinations, of effect, obtain comments of state historic preservation officers and the President's Advisory Council, design adequate mitigation measures where necessary, and meet production targets. All this should be done as efficiently and economically as possible. Analyzing the project type, expected impacts, and environment are necessary steps to selecting the most effective level of inventory for each project. Level III surveys should not be conducted if Level IV surveys are required for project clearance. Level IV surveys are the most costly and may not be necessary in many cases.

One of the goals of a cultural resource management program is to "clear" projects that may have an effect on such resources. This process involves the adherence to procedural steps outlined in 36 CFR 800. Basically, these steps require the answers to questions concerning the potential impact of the proposed project, the presence or absence of cultural resources, and the degree or significance or importance of these resources. These questions require different types of analysis and information in order to provide satisfactory answers. The first requires data concerning the proposed project and its potential land-disturbing impacts. Cultural resource evaluations of any project are likely to be either inadequate or in some cases, unnecessary if details of the project are not furnished at the beginning of the process.

The second question can be answered only through inventory. The level of inventory is dependent more on the answers needed than any other consideration. In many cases, the cost of obtaining the required data makes the project prohibitively expensive. If one has only $.50 per acre to spend on inventory and he cannot meet the minimally required inventory level for less than $2.00 per acre, the project cannot legally proceed. Even if a high percentage sample can be funded with available monies, the failure to meet minimal legislated requirements means the project must remain at the beginning of the 36 CFR 800 procedures.

Because of the differences between the various kinds of Forest Service projects and the impacts they generate, inventory levels and unit-costs will vary significantly. Dispersed impacts from a timber sale that results in thinning a timber stand requires less intensive inventory than a clear-cutting operation. Some type of sampling approach may be acceptable in reducing the risks in the first type of project and unacceptable in the second type. Land transfers from public to private ownership, because they involve a total impact on the cultural resource, are not suitable for sampling approaches in an attempt to meet requirements. I do not mean to say that sampling is not of any usefulness in a Federal land exchange program, but sampling cannot satisfy the data requirements necessary to proceed with the transfer of public lands to private ownership.

The third question involved in project "clearance" is one of the significance of the cultural resource in the project area. This is possibly the most difficult question of the three to answer. It involves more than mere presence and absence and frequently requires data from outside the project limits. Often the costs required to determine significance of individual sites are directly related to the degree of difficulty required to reach a judgement.

Couching the issue of significance in terms of "have yielded or are likely to yield" important scientific data means that a considerable number of sites will require near total excavation before their significance is known. The only alternative results in the placement of most, if not all, prehistoric sites in the category of potentially significant. These philosophies are reflected in the prevalent views of the National Register of Historic Places being to one group a total inventory of the Nation's cultural resources and to another an honor role of highly important sites. In reviewing sites listed on the Register, it is possible to find examples of both extremes in terms of significance. Since the determination of significance is, at the present time, a joint opinion of the Forest Service professionals and the State Historic Preservation Officer, it is expected that the dividing line will fluctuate with time and individuals.

Project clearance will require more intensive site investigations to settle issues of significance than outlined in the four levels of inventory above. It is in these investigations that sampling should find considerable use. Exploring the potential of a site or a group of sites, is a sampling problem not a salvage problem.

When it comes to project approval, the decision makers need to know that the minimal legal requirements have been met. With some exceptions, these requirements preclude the use of sampling strategies alone. Determining the significance of sites in question is one area that sampling should and is finding great applicability.

Another area where sampling schemes are being and will be used extensively, is land use planning (see Green, this volume). Although sampling surveys may not be adequate to allow a project to proceed, they can provide vital data with which projects can be planned to minimize impacts on the cultural resources and reduce the costs of meeting cultural resource procedures. Everyone can see the value in designing a project to avoid significant cultural resources. Sampling can quickly locate areas of varying site densities, for example, and the project can then be designed to avoid high resource values and sensitive areas. Sampling areas potentially useful in future land exchange proposals can segregate those lands in varying categories of sensitivity. In general, sampling data provided early in the planning process allows the decision maker a broader list of alternatives, reduces the possibility of conflicts with cultural resources, and helps avoid delays in projects. Sampling is far more useful in planning and project design than it is in project "clearance".

The question of when is sampling appropriate must be answered in terms of the required information. If the intent is to provide data upon which planning decisions can be made, sampling will always be appropriate. If project "clearance" is needed, sampling will generally fall short of meeting the legal requirements of 35 CFR 800.

Reliability and Validity in Cultural Resource Samples

The questions of reliability and validity of projections based upon sample data are addressed by a number of authors (Chenhall 1972; DeBloois 1975; Mueller 1974; S. Plog 1972). The testing of sampling designs has been and is an important part of Forest Service cultural resource management programs. Simulated sampling of inventoried areas has been carried out to test a number of the parameters of sampling designs. What has resulted thus far is a verification of sampling approaches to the management of cultural resources in the Forest Service.

As the use of sampling increases in land management programs, the hard evidence for its validity will continue to accumulate. Some archeologists, who presently regard sampling with distrust and disdane, will be converted to its usefulness.

Sampling Strategies in Region 4

The application of sampling strategies in the Intermountain Region of the Forest Service follows those limitations discussed. Sampling is used in various phases of management work from project "clearance" to planning to determinations of site significance. Three typical projects employing sampling are summarized below to illustrate in some detail how it can assist the land manager in his task.

South Paradox Pinyon-Juniper Removal Project

In July 1975, 2000 acres of pinyon-juniper forest were scheduled for revegetation by removing tree cover and reseeding with grasses. A level III inventory was requested to estimate the density and significance of the cultural resources. Also desired were estimates of man-days of work required and total costs of a level IV inventory if required.

A five percent sampling was carried out, stratifying the area by topographic features since the vegetation type was uniform over the project area. All sites (defined as an artifact cluster of 10 or more items) and isolated artifacts (less than 10 items) were located on aerial photographs for the units sampled. A total of six sites and five isolated artifacts were found in the 100 acre sample. (Six man-days were spent in conducting the sampling operation.) Four of the six sites located were lithic scatters of varying size, two contained slab-lined structures and other evidence of architecture.

From these results, site densities were projected as 38.4 per square mile.

$$6 + .05 = 120 \text{ sites in } 2000 \text{ acres}$$

$$120 \div 2000 \times 640 = 38.4 \text{ sites per mile}^2$$

It is estimated that 13 out of the 38 sites will contain architecture although this projection is less reliable based on earlier work (DeBloois 1975). No particular concentrations of sites were identified although all sites with architecture were located on south-facing slopes at the heads of small drainages.

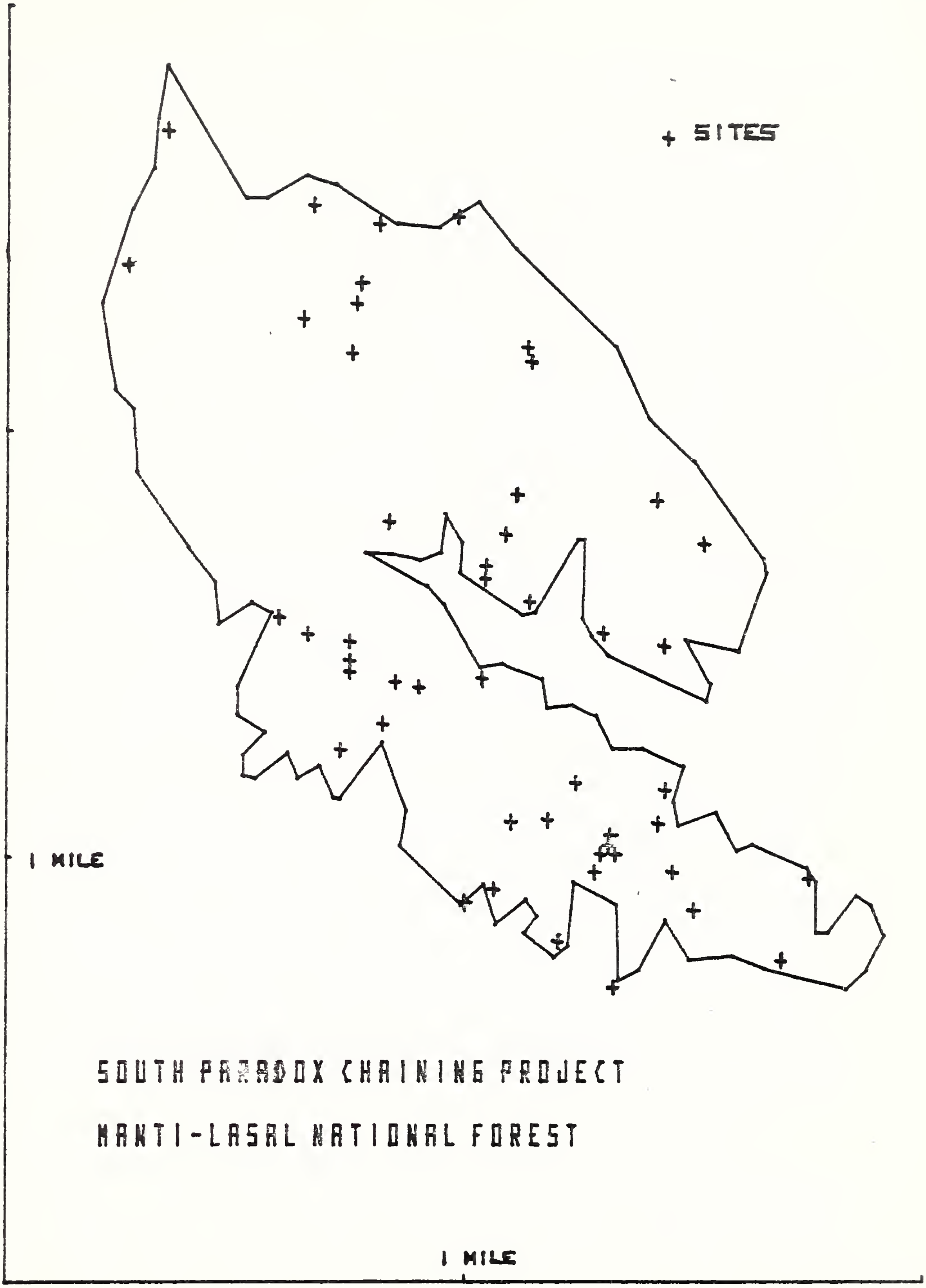
Estimates of workload based upon the 16.7 acres per man-day covered during the sampling inventory are more difficult. Considerable travel to the project was involved. The coverage could be increased by 75 percent during an intensive survey to a total of 30 acres per man-day.

The question of significance is based upon site attributes and projections for simple random samples have been shown to be less reliable than site numbers (DeBloois 1975). We can, therefore, estimate that approximately 83 percent of all sites found will meet National Register criteria. This equals 32 sites per section or 100 sites for the project.

The preliminary results of Level IV inventory show the usefulness of these estimates. By October 1975, 220 acres of the project had been inventoried. The results were as expected; 15 archeological sites located for a total of 43.6 sites per square mile. Eleven percent of the total area had been covered and the difference in the initial estimate of 38.4 sites per section and the new prediction of 43.6 sites per section is an error of only 14 percent, well within that predicted for a 5 percent sample.

Seven and one half man-days were spent in covering 220 acres, an average of 29.3 acres per man-day. Ten of the 15 sites appear to meet the eligibility criteria for the National Register; 67 percent of all sites. This is 16 percent less than expected but still within the error expected for the size of sample conducted.

At the completion of the project, a total of 1030 acres were inventoried for treatment. This is only 51.5 percent of the original proposed project area. Refiguring the original sample data to match this reduction in project area, we would expect the results to be: 62 sites found, 20 with architecture, 51 eligible for nomination


+ SITES
1 MILE
SOUTH PARADOX CHAINING PROJECT
MANTI-LASAL NATIONAL FOREST
1 MILE

to the National Register, and 34 man-days of fieldwork consumed. The actual results are: 50 sites located, 4 with architecture, 20 thought to be eligible, and no report on total man-days used.

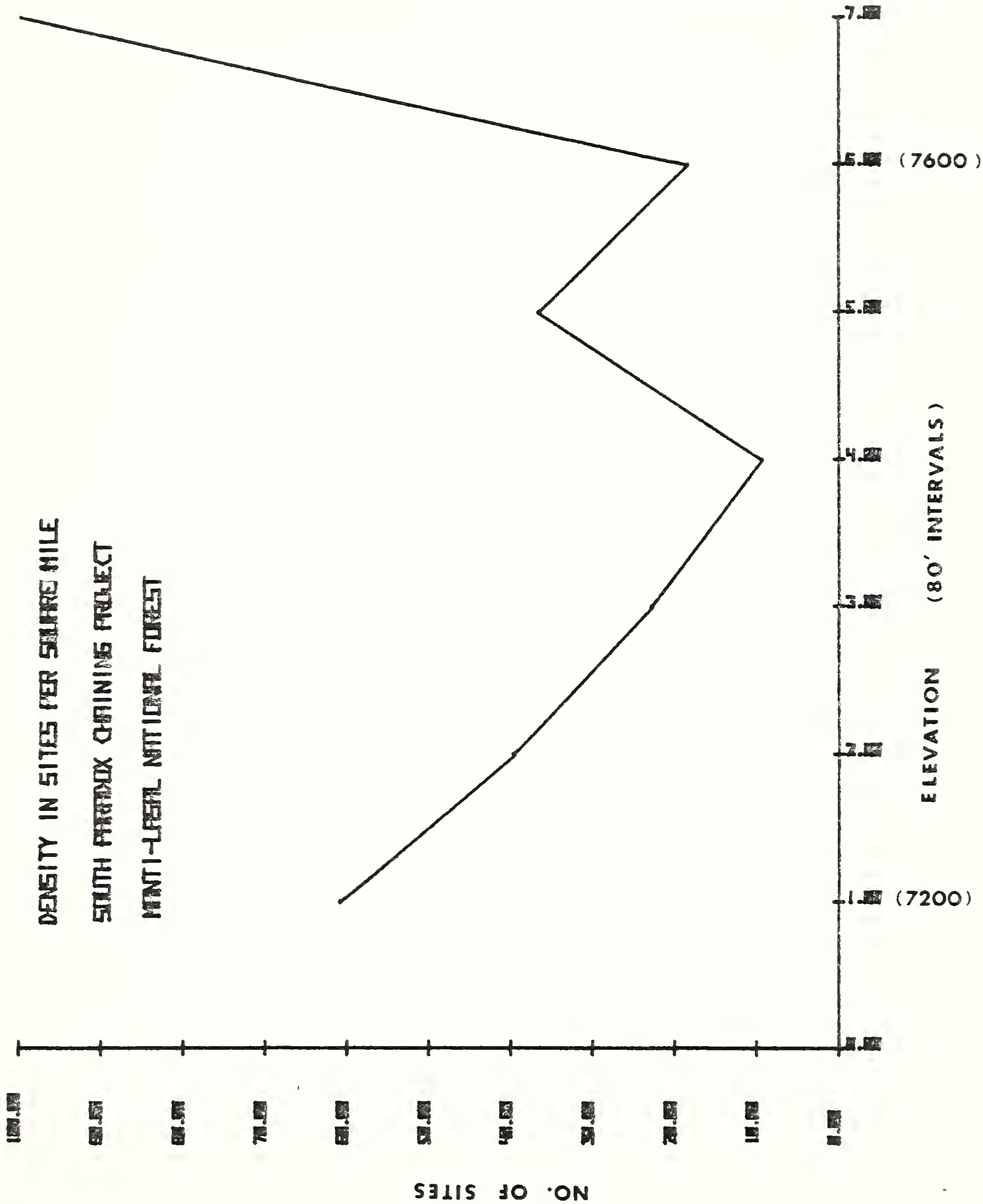
It is clear that some estimates were better than others in this case. The total number of sites, 62 expected and 50 observed shows an over-estimate of 19 percent. This is within the range of error we expected from a 5 percent sample and, interestingly enough, is in the opposite direction of the error recorded in the preliminary report. The greatest occured in those estimates of site attributes other than location. From test data we expected more variability and less reliability in estimates of these attributes. The prediction of 20 sites having architecture was grossly over-estimated. The total survey shows such sites to occur only in the southern end of the survey area. Two of the four sites found were present in the 5 percent sample survey. The highly non-random distribution of these sites account for this error. A more properly stratified sampling design based on slope or elevation could have increased the accuracy of the prediction of the numbers of sites with architecture.

A level III survey at 5 percent intensity allowed the land manager to make an accurate prediction of the number of cultural resources present in the proposed project. It also gave excellent predictions of the amount of time and cost involved in completing the level IV inventory required for project clearance. The number of sites, their importance and size controls the degree of mitigation necessary, hence, a mitigation plan can be roughed out based upon sample estimates. Results of the intensive survey have, in this case, verified the accuracy and reliability of the sample predictions.

One question has not been answered; however, did the results of the level III inventory justify the effort expended? The cost of the sample was not quantified, but at $100 per man-day, the cost was approximately $600 for the 100 acre sample. This must be weighed against the $300 estimate to examine the same area during a level IV inventory. The total cost of the project will reach nearly $6700. A contract for $6000 could have been let for a level IV inventory at the outset and saved the Forest Service $600-700. What the land manager bought for this 12 percent increase in cost was the assurance that an adequate mitigation plan could be worked out prior to commiting the entire amount to an intensive inventory. Had the sample shown the project to be unfeasibly due to high site densities, the project could have been modified or canceled with a savings of $5400.

Paradise Valley Land Exchange

A proposed land exchange includes 6000 acres of coal-bearing land now in National Forest. A level III inventory was initiated to estimate the number, size, and significance of the cultural resources present.


DENSITY IN SITES PER SQUARE MILE
SOUTH PARADOX CHAINING PROJECT
MANTI-LASAL NATIONAL FOREST
(7600)
(7200)
ELEVATION (80' INTERVALS)
NO. OF SITES

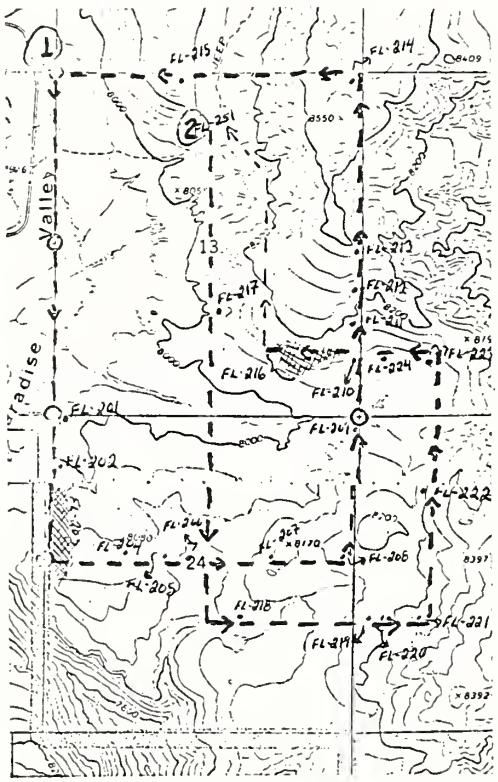


Figure 1. Archeological sites in Paradise Valley. Lines with arrows show the two survey routes. Scale 1:24000.

In turn, an estimate of the amount and cost of possible mitigation measures was desired.

The sampling was carried out by selecting a four section block east of Paradise Lake as the sampling universe. Transects paralleling section lines were surveyed by two and three man crews for three days, totaling 8 man-days of work. No stratification of the area into different sample units was done.

A total of 25 sites were located during the survey of 2 percent of the 2560 acre target area. With a single exception, all sites lay above the 8000' contour. Only one site was found above 8400'. Six sites obviously met National Register criteria and others appear to qualify for nomination. Only 5 of the sites were small enough to permit near total collection during the survey. Two of the sites were very large. extending from one-eighth to one fourth of a mile along the transect route.

Eight transects were surveyed across the 2560 acres of the sample area. Acreage covered in the transects ranged from 1.52 to 9.09 acres per transect or from .06 to .24 percent of the total area. The total area inventoried equals 54.8 acres or 2 percent of the target area. Site densities range from 0 to 950 per section with an overall average of 330 sites per section. The estimated site population for the target area is given as 1321. Predictions of the total number of sites in the 6000 acre exchange lie between 2700 and 3100. With the expected error of a 2 percent sample, this total may vary from 2000 to 4000 sites total. Although this may seem like an unacceptably large variation, either end of the range being verified give the same implications; there are numerous prehistoric sites in the proposed project area and the mitigation that will be necessary will be costly and time consuming. Even eliminating the sites from the exchange, if it were possible, would reduce the acreage from 6000 to 3000 acres.

This data can permit the land manager to make appropriate decisions concerning the project for only a minimal investment in the cultural resource inventory. In this case, the decision not to spend $18,000 to conduct a level IV inventory of the project only to learn that clearance could not be given saved the Forest Service $17,200.

Panguitch Lake Land Exchange

The cultural resource inventory of several parcels of land on the Dixie National Forest resulted in the location of a large, lithic scatter of questionable importance. It covered a good share of the 80 acres being considered for exchange near the shore of Panguitch Lake. The inventory report identified the site as a quarry and lithic workshop, possibly eligible for nomination to the National Register of Historic Places.

Because this particular parcel was critical to the proposed land exchange, further investigation was programmed to resolve the question of significance. A level III sample of the site contents with test excavation, if necessary, was proposed. The objective of this designed research was to obtain sufficient data from the site to permit an assessment of its scientific value.

Field work began with the establishment of a grid of 10 meter squares in two portions of the 80 acre plot where the inventory report identified surface components of the site. A random sample of these grid squares was conducted using a pocket calculator and random number generating program. From each of the selected grid squares, all artifacts were collected. Every flake and sherd was picked up and bagged by sample square. See Figure 1 and 2.

The material collected was taken to the laboratory and examined. Projections were made from the sample contents to estimate the site contents. Computer plots were also drawn to illustrate the distribution of artifact categories.

After the sample collections were made, arroyos and road cuts were closely examined for buried cultural materials. This examination produced no evidence that the site contained any stratified deposits and test excavation was postponed until the laboratory analysis of the surface materials was completed.

The result of this investigation suggested that, although portions of the site near outcroppings of white chert beds were indeed related to quarry activities, other parts of the site showed evidence of more diversified activities. Ceramics, ground stone, foreign lithic materials and a variety of tool types were found that were not directly related to the quarrying and manufacture of white chert tools.

The sample of this site, approximately 20 percent of the area, permitted the archeologist to provide the Forest with an assessment of the archeological significance for a significant reduction in costs. It also permitted a more intensive study of portions of the site than would have occurred for the same cost if the entire site was collected. It also permitted the projection of site contents with a degree of reliability missing in other partial examinations.

Total investment in cultural resource activity at the Panguitch Lake site included 16 man-days for approximately $2000. Adding inventory costs of $240, a total cost to resolve this issue and arrive at an acceptable management decision was $2240, or $28 per acre. Other estimates for evaluating and salvaging the site ran as high as $128 per acre. The advantages of this approach were the intensive examination of a portion of the site, reliable data on the total site by projection, reduced cost, and less involvement in time and man-power.

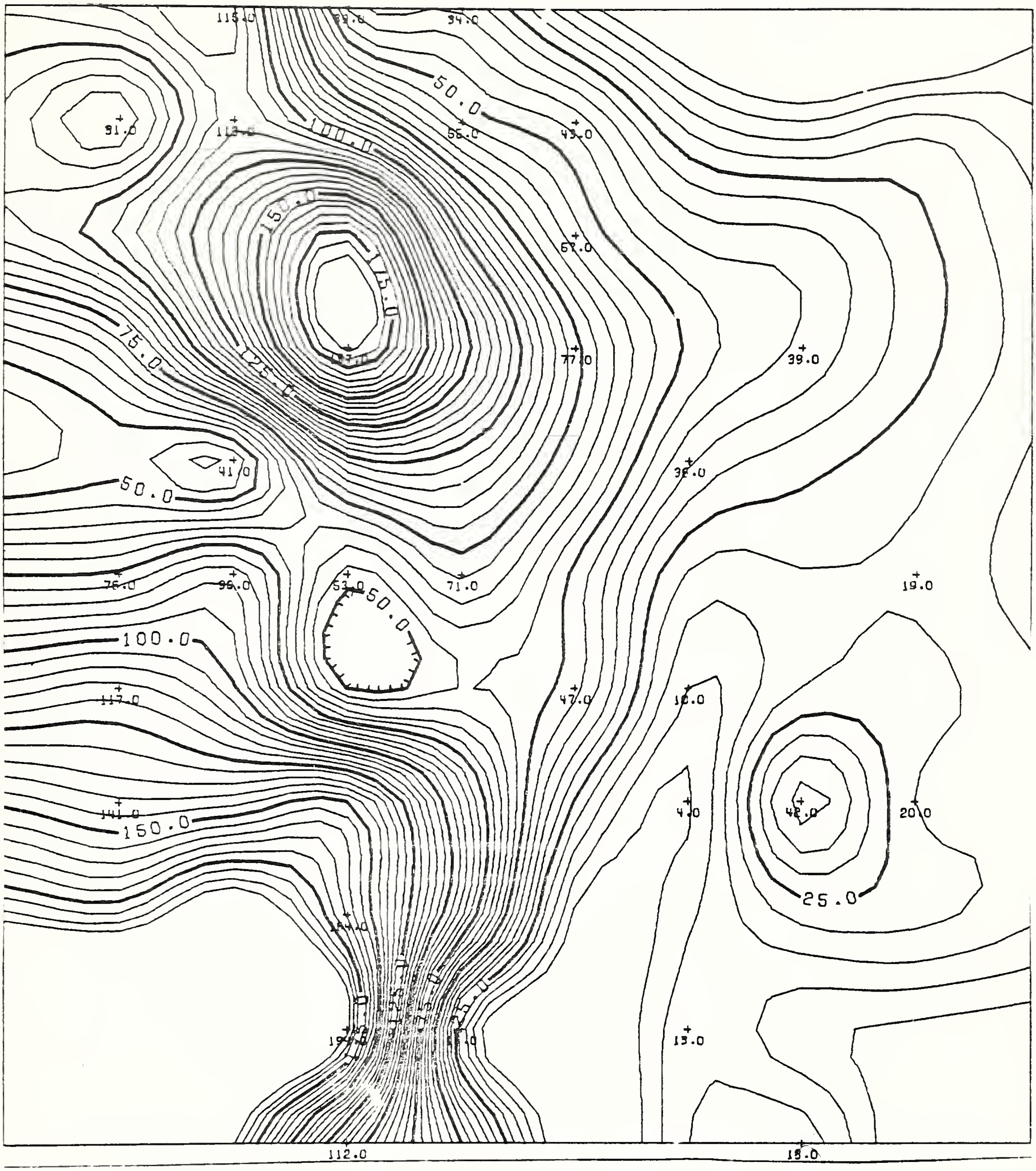


Figure 1: Projected contour lines based on the density of secondary flakes. Intervals are 5 items. Secondary flaking shows two strong foci. One on the west side of the site, the other in the southeast corner.

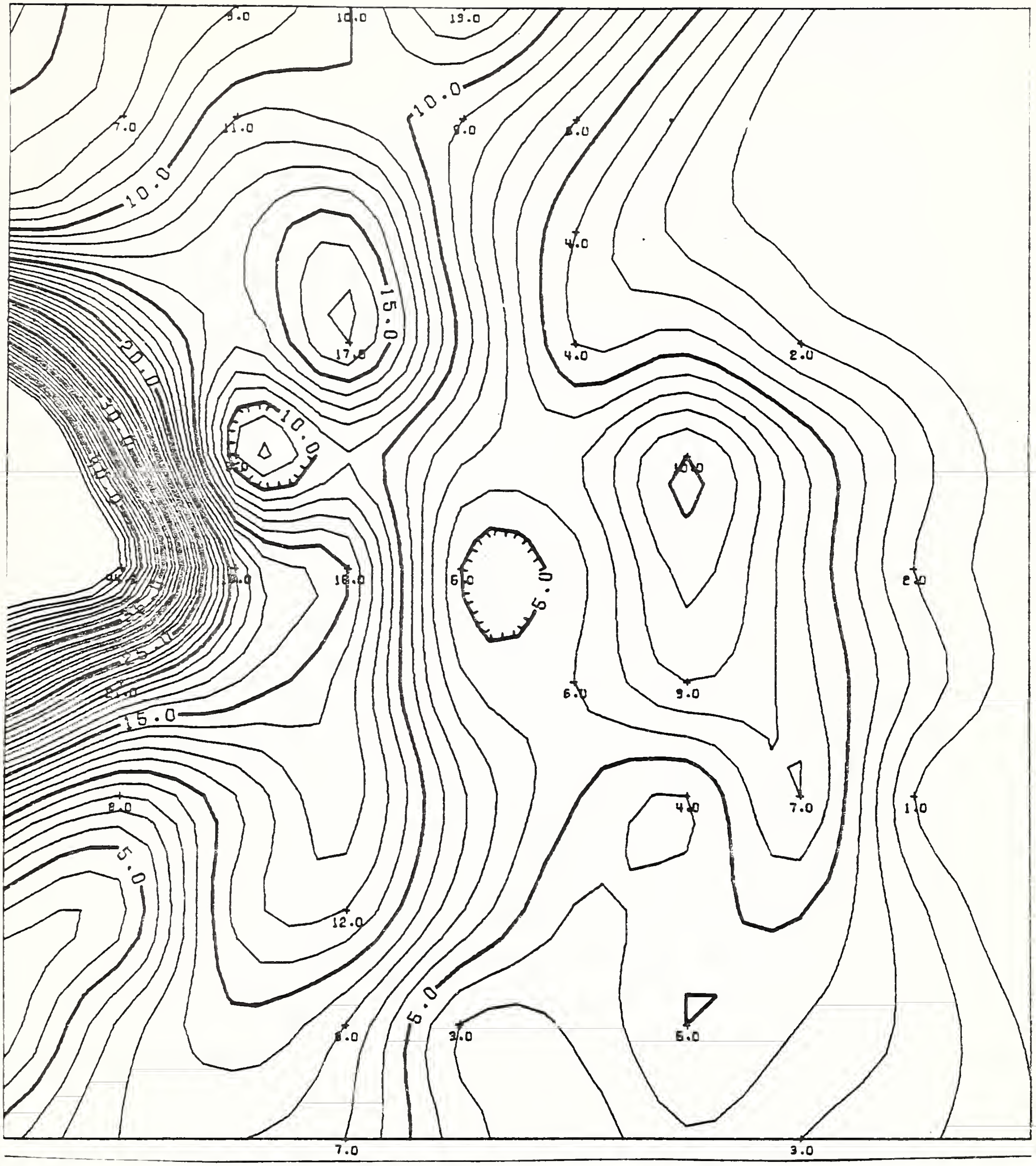


Figure 2: Projected contour lines based on the density of Primary flakes. Intervals equal one item. Primary flaking is focused in the south center of the site.

Summary

Sampling is a useful tool in the cultural resource management program in the Intermountain Region. It has been and will continue to be used with great success in many phases of our program. Plans have been made to further systematize cultural resource procedures and to expand the use of sampling into other areas now using sampling approaches.

Techniques for implementing sampling designs in various programs are also being designed and tested. Training in the uses of sampling schemes is being carried out to familiarize cultural resource management personnel with its requirements and benefits.

It is not a strange procedure with the Forest Service in general, since many other programs such as timber management have used sampling for decades; it is the archeologist that finds sampling a strange new process. It is apparent that sampling has found a widespread usefulness in the Region 4's cultural resource management program as well.