Craig: Good Luck with your obsidian studies! and thanks for your friendship and help. Pete Armitage

AN ARCHAEOLOGICAL ANALYSIS OF CENTRAL OREGON UPLAND PREHISTORY

by

CHARLES LAWRENCE ARMITAGE

A DISSERTATION

Presented to the Department of Anthropology
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 1995

"An Archaeological Analysis of Central Oregon Upland Prehistory," a dissertation prepared by Charles Lawrence Armitage in partial fulfillment of the requirements for the Doctor of Philosophy degree in the Department of Anthropology. This dissertation has been approved and accepted by:

____

Chair of the Examining Committee

____

Date

Committee in charge:

Dr. C. Melvin Aikens, Chair
Dr. William Ayres
Dr. Ann Simonds
Dr. Gordon Goles

Accepted by:

____

Vice Provost and Dean of the Graduate School

An Abstract of the Dissertation of

Charles Lawrence Armitage for the degree of Doctor of Philosophy

in the Department of Anthropology to be taken June 1995

Title: AN ARCHAEOLOGICAL ANALYSIS OF CENTRAL OREGON UPLAND PREHISTORY

Approved: ______________________________________

Dr. C. Melvin Aikens

Through an analysis of archaeological evidence including, site survey data from 1050 recorded sites located on the Ochoco National Forest, and a collection of some 300 projectile points recovered from these surveys, human adaptation in the central Oregon uplands is examined. Additional evidence is presented from excavations at four multi-component, Middle to Late Archaic sites located on Wind Creek, a tributary of the South Fork of the John Day River.

An analysis of the projectile points provides a typology and a typologically-based cultural chronology for the central Oregon upland region. The chronology identifies 7 cultural periods, beginning with the Early Archaic and extending into historic times. Eight formal groupings of projectile points are identified, which are subdivided into 22 historical types. A geochemical analysis of obsidian artifacts identifies 21 sources of obsidian, that were used by prehistoric occupants of the central Oregon uplands.

The four excavated Wind Creek sites provide insight into the structure and composition of central Oregon upland sites. Eight radiocarbon dates place the site chronologically between 4000

BP and 800 BP, and the tools indicate that both plant processing and tool manufacture were important activities at these sites.

Analysis of site survey data relates the survey sample of 1050 sites to environmental and physiographic variables. Analysis of the site tool assemblages identifies three general groups of sites that appear related to Limited, Moderate, and High degrees of activity. Upland settlement patterns are further examined using computer-generated plots of the spatial distribution of sites, indicating that clusters of sites are related to water sources and geographical locations currently containing high densities of plant and animal resources. Examination of the spatial distribution of sites indicates that people returned to the same localities over thousands of years. This suggests that the general distribution of certain plant resources may not have not changed significantly over a long time. The archaeological evidence thus demonstrates that the central Oregon uplands have provided a stable area for exploitation of plant and animal resources, and that the area has been utilized throughout the Holocene, particularly over the last 6000 years.

CURRICULUM VITA

NAME OF AUTHOR: Charles Lawrence Armitage

PLACE OF BIRTH: Chester, Pennsylvania

DATE OF BIRTH: January 13, 1952

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon
Idaho State University
University of Arizona
Lycoming College

DEGREES AWARDED:

Doctor of Philosophy in Anthropology, 1995, University of Oregon
Master of Arts in Anthropology, 1983, Idaho State University
Bachelor of Arts in Anthropology, 1975, University of Arizona

AREAS OF SPECIAL INTEREST:

North American Archaeology
Archaeological Method and Theory
Computer Applications
History of Anthropology

PROFESSIONAL EXPERIENCE:

Partner and Archaeological Consultant, Continuum Cultural Resource Consultants, Denver, Colorado, 1992 through present

Supervisory Archaeologist, Western Cultural Resource Management, Reno, Nevada, 1992

Staff Archaeologist, San Juan County Museum Association: Division of Conservation Archaeology, Bloomfield, New Mexico, 1992

Staff Archaeologist, Archaeological Investigations Northwest, Portland, Oregon, 1991

Armitage, C. L., J. C. Newberry-Creasman, J. C. Mackey, C. M. Love, D. Heffington, K. Harvey, J. E. Sall, K. Dueholm, and S. D. Creasman
1982 The Deadman Wash Site. Western Wyoming College Cultural Resource Management Report No. 6.

Armitage, C. Lawrence
1983 An Archaeological Model and Subsistence for the Central Oregon Northern Paiute. Unpublished M.A. thesis Idaho State University.

Mackey, J. C., D. Cullen, S. Creasman, J. E. Sall, K. Harvey, and C. L. Armitage
1983 Paleoenvironmental Reconstruction and Subsistence Change at the Deadman Wash Site in Southwestern Wyoming. Journal of Intermountain Archaeology. Vol 1(1).

Mackey, J. C., J. E. Sall and C. L. Armitage
1983 Blairtown Dune Site: A Multi-Component, Prehistoric Dune Site On Bitter Creek, Southwestern Wyoming. In J.C. Mackey (ed). Recent Excavations in the Northwestern Plains and Great Basin.. Western Prehistoric Research Archaeological Monograph 3.

Armitage, C. Lawrence
1987 An Archaeological Model of Subsistence and Population Density For the Central Oregon Northern Paiute. Journal of Intermountain Archaeology. vol. 5(1) pp.3-44.

Fagan, John, Charles Armitage, Claudia Hemphill, Jo Reese, and John Witherow
1991 Northwest Pipeline System Expansion Project. Cultural Resources Assessment Report Oregon Segments. Phase 1: Survey, Inventory, and Preliminary Assessment. Prepared for Northwest Pipeline Corporation by Archaeological Investigations Northwest, Portland, Oregon.

Hemphill, Claudia B., Charles L. Armitage, Neal H. Heupel, and Mark W. Hemphill
1993 Cultural Resource Surveys of the Upper Deep and Sam Planning Area, Paulina Ranger District, Ochoco National Forest. Report prepared by Continuum Cultural Resource Consultants Inc., on file, Ochoco National Forest, Prineville, Oregon.

ACKNOWLEDGMENTS

The completion of this dissertation has been aided by the help of various people involved with excavation and analysis of the Wind Creek sites, specialized analyses of central Oregon obsidian, archaeological site survey of the Ochoco National Forest, in addition to editing and review of this dissertation. Their help is gratefully acknowledged and contributions listed below.

The excavation of the Wind Creek sites was made possible through combined efforts of Dr. Madonna Moss, and later, Thomas Burge, former Forest Archaeologists for the Ochoco National Forest. Crew members involved with the excavation of the Wind Creek sites included Sheri Campbell, Grady Caulk, Mandy Cole, Nancy Eide, Felicia Rounds, and Marci Todd. Analysis of the Wind Creek artifacts was aided by Nancy Eide, Thomas Burge, and Gary Popek. Additional analyses of bifacial material and a sample of flakes from the Wind Creek sites were performed by Sarah Scott. Radiocarbon dating was performed by Beta Analytic, site maps were drafted by Clark Pope, and Wind Creek projectile points were illustrated by Nancy Eide. Soil and faunal analyses of the Wind Creek sites were done by Grady Caulk at Washington State University, and a flotation analysis by Mandy Cole at Oregon State University.

Specialized analyses of central Oregon obsidian were performed by Dr. Richard Hughes (geochemical sourcing), Scott Byram (obsidian hydration of central Oregon projectile points), and Tom Origer (obsidian hydration of Wind Creek artifacts). Craig Skinner added detailed information and synthesis of previous obsidian sourcing and hydration of the Beaverdam Creek site. Funding for these specialized analyses of obsidian were provided through a grant from the University of Oregon Department of Anthropology Archaeological trust fund, and the Ochoco

National Forest. These funds have greatly improved our knowledge of central Oregon obsidian utilization.

Archaeological site survey of the Ochoco National Forest began in 1978, and has been conducted by numerous District Archaeologists, Forest Archaeologists, and private contract firms. The site survey data is the end result and forms the data base for much of this dissertation.

Finally, the review and editing of this dissertation was undertaken largely by Dr. C. Melvin Aikens, in addition to my other committee members, Dr. William Ayres, Dr. Ann Simonds, (both members of the Department of Anthropology), and Dr. Gordon Goles (Department of Geology). The critical comments, hours spent in review, and editorial suggestions provided by my committee members are greatly appreciated.

Special acknowledgments should be given to my parents, for always being there when I needed any help or encouragement, the Ochoco National Forest for granting permission to use the site survey and Wind Creek excavation data, and to a very good friend, Claudia Hemphill, with whom I was able to formulate ideas, discuss anthropological theories, and drink many cups of coffee.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

LIST OF FIGURES

Figure Page

Figure Page

CHAPTER I

INTRODUCTION

Previous analyses of anthropological data from central Oregon (Armitage 1983; Couture 1978; Mahor 1954; Zilverberg 1983) have led to cultural ecological models of subsistence, applicable to restricted locales. However, the structure of the prehistoric cultures, their patterns of settlement, and how these may have changed through time, are all problems not well understood.

This study is a preliminary attempt to address the needs of central Oregon prehistory by analyzing the structure of archaeological remains recorded from the uplands of the Ochoco National Forest. The dissertation reports results of archaeological recording of some 1150 prehistoric sites, the excavation of four archaeological sites occurring along Wind Creek (a tributary of the John Day River), a typological analysis of a collection containing more than 300 projectile points recovered from surface surveys of the Ochoco National Forest, and obsidian source analyses of a sample 69 of these projectile points. Ethnographic and climatic data are briefly introduced to provide a background for the research, and the newly recorded archaeological data are synthesized to offer a framework describing upland patterns of archaeological site structure as it existed throughout the Holocene in the uplands of central Oregon. The study is of particular relevance to the problem of human use of "boundary zones" lying between distinctively different cultural areas. In this case the study area is an upland zone that separates the Great Basin from the Columbia Plateau.

Background and Approach to the Research Problems

The central Oregon upland study area is located between the Columbia River and the inland lakes and playas of the Great Basin. Despite its strategic location in the boundary zone between two major culture areas, comparatively little synthetic research has been conducted here. Archaeological research within the last decade or so has yielded a large number of lithic dominated sites, widely scattered across a varied landscape. The sites contain large amounts of flake debitage and groundstone, indicating that the central Oregon uplands were utilized for hunting and plant procurement by Native American groups. No systematic synthesis and evaluation of the data has been attempted, however, for this important upland boundary zone between the Plateau and Great Basin, and that is the objective of the present research.

It is also true that ethnographic references concerning the Native Americans of the study area are few. Although there are two Indian reservations located in the area (in Burns and Warm Springs) the only ethnographic research describing these cultures consists of a culture element trait distributional study (Stewart 1941), three articles concerning contemporary Northern Paiute seasonal rounds and plant utilization (Couture 1978; Couture et al. 1986; Mahor 1954), and some unpublished field notes describing the ethnography of the Warm Springs tribe (French and French n.d.). Ethnohistorical data offer a few more observations, but in general information is sparse. In this dissertation the ethnographic/ethnohistoric period is only touched on by presenting the historically known geographic distribution of Northern Paiute peoples within the bounds of the upland central Oregon study area to provide a spatial frame of reference for the archaeological data.

Cultural Chronology

Development of a cultural chronology is critical to discovering how a culture persists and changes through time, and understanding how it is related to cultures in surrounding areas. Chronological research has been conducted to the south and north of central Oregon, but substantial research has yet to be conducted in central Oregon itself. Research in the Fort Rock area to the south indicates a continuous occupation for at least 11,000 years and possibly 13,000 years. Within this time span are periods of hiatus, generally attributed to abandonment of certain areas; population movements, and changes in projectile point styles have long been correlated here with human adaptations to a shifting environment (Bedwell 1973; Jenkins 1994). The archaeological record of central Oregon is highly relevant to such questions.

Previous attempts to develop cultural chronologies for central Oregon (Armitage 1983; Minor et al. 1987) have relied upon cross dating of known projectile point types of the Great Basin. Two major problems weakened these attempts. Small sample sizes militated against statistical rigor, and because no uniform measurement system was applied to the projectile points, the types derived were difficult to compare. Still these studies provide a basic framework that is the beginning point for the new analysis presented in this dissertation.

One analysis of projectile points from central Oregon (Armitage 1983) yielded information suggesting that six cultural periods were represented in the study area. The first period, prior to approximately 6500 BP, was hypothetical because no projectile points could be related to it. Projectile points from the second period included willowleaf, large side-notched, and lanceolate styles. Relative dating suggested that this period extended from about 6500 BP to 4500 BP. During period three (4500 BP to 3000 BP) large side-notched projectile points disappeared, and in period four (1000-1500 BP) corner-notched and eared projectile points were predominant. During period five, relatively dated from 1500 BP to 600 BP, expanding stem and split stem points were predominant. This was followed by a sixth period dating from approximately 600 BP to the present. Small side-notched and stemmed points were found in this period.

Another attempt to develop a cultural chronology (Minor et al. 1987) resulted in the identification of Early, Middle, and Late periods. The early period contained Cascade and lanceolate projectile points and was correlated with the Paleo Indian/ Early Archaic period. The Middle Period contained large side-notched points and corner-notched points and could be correlated with the Middle Archaic period. The Late Period contained small corner-notched, side-notched, and stemmed projectile points and was correlated with the Late Archaic and historic period. A cultural resource overview for Bureau of Land Management lands in central Oregon (Lebow et al. 1990) similarly identified four periods, consisting of Paleo Indian, Early Archaic, Middle Archaic, and Late Archaic.

The present study attempts to resolve these variant interpretations into a single, defensible system that takes advantage of all available data and incorporates a new analysis of projectile point data from the heart of the region. The new analysis utilizes a large number of projectile points, and a system of measurements describing the projectile point forms is used to objectively define the projectile point typology. This typology, in conjunction with a series of radiocarbon dates from four newly excavated sites in central Oregon forms the basis of a new cultural chronology for the central Oregon upland region, where the present research is centered.

Settlement Patterns

The identification of settlement patterns has been a primary focus of hunter/gatherer archaeological research. Various theories have been presented to explain the distribution of archaeological sites in relation to combinations of environmental and cultural variables.

Binford (1980) has examined inter-site variability of contemporary Eskimo sites and has described the adaptive pattern practiced by their occupants as one of "logistic collecting". Collectors are logistically organized when they supply the group as a whole with specific resources by sending out organized task groups. Their occupation patterns are characterized by various kinds of activity loci, occupied ephemerally by logistically organized food procurement parties. The seasonal round of collectors is highly organized, with task groups targeting specific locally and seasonally productive resource patches (Binford 1980:344). Binford contrasts collectors to a second type of adaptive system that he names "foragers". Foragers are groups that make a series of seasonal residential moves associated with productive resource patches. The group stays together, rather than sending out offshoots, and harvests whatever is available in their landscape on an "encounter" basis. This is a form of adaptation typically found in relatively uniform environments with relatively little seasonal variation. Binford describes the G/wi San bushmen, studied by Yellen (1977), as characteristic of this adaptive pattern (Binford 1980: 339). Binford recognizes two main types of sites as characteristic of both foragers and collectors: the residential base and the location. While collectors form, additionally, field camps, stations, and caches.

Thomas (1973) described the structure of prehistoric Great Basin archaeological sites in the Reese River area, located in central Nevada. He recognized base camps and procurement sites, based upon tool assemblages, and through a distributional study of site locations tested Julian

Steward's (1938) ethnographic description of Great Basin groups. He concluded that a settlement pattern such as Steward had described had been characteristic of the Great Basin for at least the past 2500 years.

Research by Jochim (1991:311) demonstrates that explanation of behavioral variability is important when discussing prehistoric settlement patterns. As environments fluctuate through time resource density and distribution changes. Settlement patterns thus reflect the spatial and temporal variability of the resources.

From settlement pattern research such as the above it has been demonstrated that organizationally significant site types and tool assemblages may be identified. In the present analysis the spatial patterns of a large sample of archaeological sites within a large study area are quantitatively analyzed with the intent of defining a complete range of site types and describing how they occur across the natural landscape.

In order to describe site patterns, archaeological surface survey data from the Ochoco National Forest are utilized. Approximately 1150 prehistoric archaeological sites have been identified and recorded. In defining settlement pattern structures, environmental variables are analyzed as well as site type and the placement of sites in relation to each other. A preliminary analysis of these data (Armitage 1983) indicated that a complete range of archaeological periods is represented in the central Oregon uplands, and the analysis to follow traces human settlement patterns throughout this time span.

The Wind Creek Archaeological Sites

New data are also presented through reportage of four archaeological sites excavated in 1986 along Wind Creek, a tributary of the John Day River. Because few archaeological sites have been excavated in the central Oregon uplands area, these four provide valuable new information. Radiocarbon dates indicate that the Wind Creek sites were first occupied during the Middle Archaic period (4000 BP), and a diverse range of artifact types was recovered from three sequent cultural components. The Wind Creek data provide an idea of how certain archaeological sites were used through time, and information on the internal structure of certain central Oregon archaeological sites.

Towards A New Perspective on Central Oregon Archaeology

The location of central Oregon between the Columbia Plateau and the Great Basin has led people to speculate that it was a marginal or hinterland use zone between these two culture areas. Culture area classifications have drawn distinctions between Great Basin and Columbia Plateau Cultures on the basis of language (Mason 1896), subsistence (Wissler 1922), and culture element traits (Driver and Massey 1957; Jorgensen 1980). Central Oregon has been classified as Plateau (Wissler 1922), as a Salmon Resource Area (along with the Northwest Coast) (Wissler 1922), as an area combined with California and the Plateau (Driver and Massey 1957), and as a zone occupied by both Columbia Plateau Sahaptin speakers and Great Basin Northern Paiute (Jorgensen 1980).

Such disparate perspectives as these are not easily resolved through archaeological study, and if they can be resolved it will only be after significant groundwork has been laid. The present study is a contribution towards that groundwork. It begins with the recognition that the cultures of the Columbia Plateau and Great Basin must be seen as a historic phenomenon growing out of prehistory. Cultural adaptations through time in central Oregon were no doubt affected by the cultures of both regions, but at the same time conditioned by the environmental structure of the uplands that lie between the Plateau to the north, and the Great Basin to the south. As a distinctive environmental zone, central Oregon upland prehistory expectably has its own character, reflected in the human settlement patterns that developed in-situ there. Understanding how Native Americans settled into the borderland environment of the central Oregon uplands may help us also to ultimately understand better the Columbia Plateau and Great Basin cultures generally.

CHAPTER II

CENTRAL OREGON ENVIRONMENT

The study of prehistoric settlement patterns requires understanding the structure of both the archaeological sites and their environmental settings. The environment and how it may have changed through time is critical to understanding why archaeological sites occur in certain topographic locations, and to understanding the spatial patterns of these sites. Certain environmental variables such as topography change very slowly, while other variables such as life zones and faunal distributions may fluctuate with climatic shifts.

Central Oregon contains prehistoric archaeological remains that provide clues to upland human adaptations within an area geographically situated between the Great Basin and the Columbia Plateau. The Ochoco National Forest (Figure 1) encompasses a large portion of this upland area and provides an archaeological data base from which settlement patterns and their change through time may be examined. Setting out the environmental background requires discussions of topography, geology, and life zones, and provides a framework within which central Oregon settlement patterns may be studied.

Geology

Geologically central Oregon may be divided into two categories; the hills, mountains, and plateaus that have been produced by tectonism, and those land forms produced by volcanic eruptions. Central Oregon has a far greater amount of the second type of land formation than is

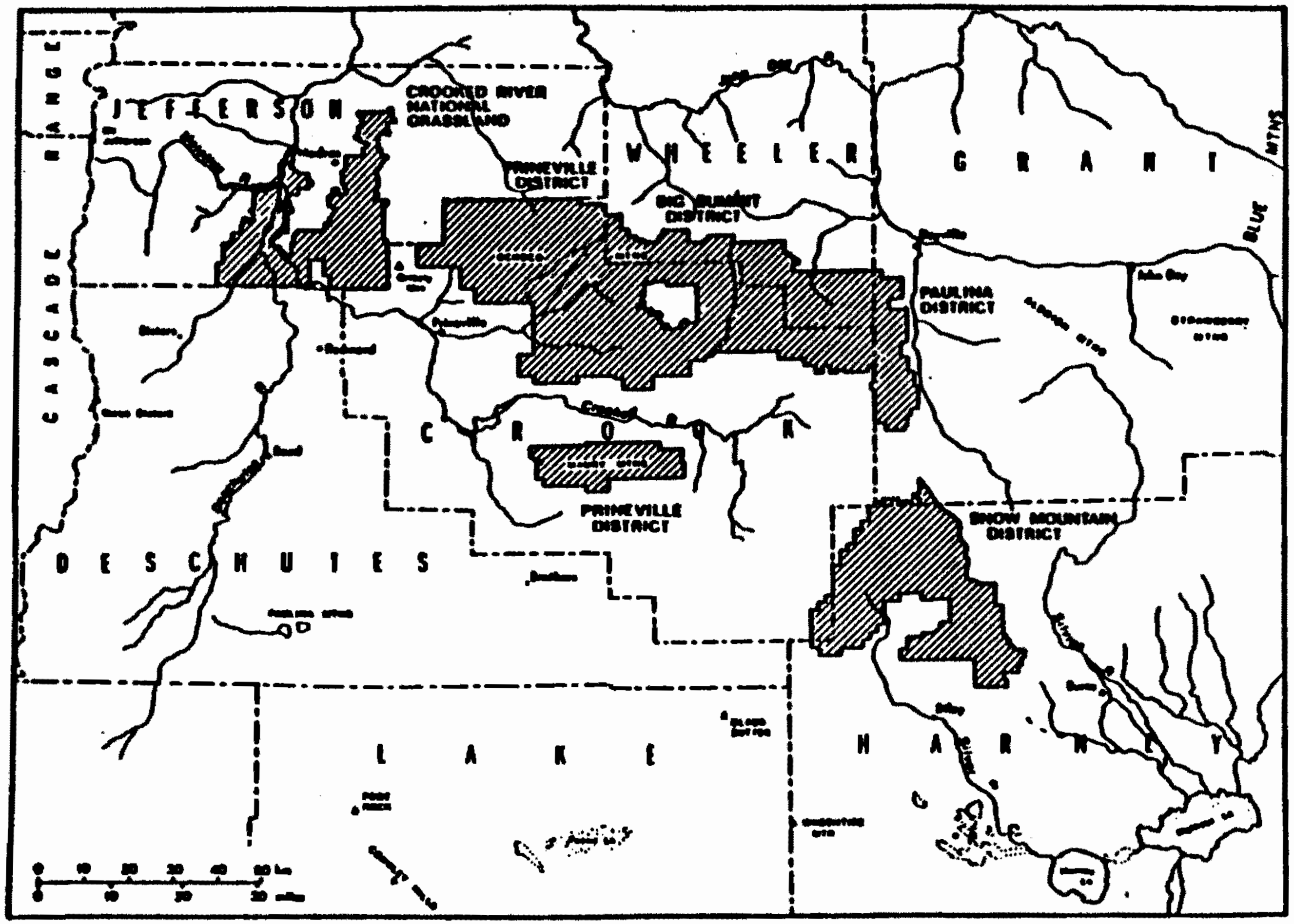


Figure 1. Location of the Ochoco National Forest in central Oregon (from Minor et al. 1987:2).

typical of the Great Basin generally (Russell 1905:14). The land forms reflect widely extended erosion, but are principally the result of volcanic activity. The valleys between the mountains are level floored, the result of deposition brought down from the uplands by streams, mainly carrying sediment eroded from extensive lava flows and material blown from volcanoes. Much of the soil in central Oregon is thin, and composed largely of sand and gravel.

The extreme southern portion of central Oregon consists of a sandy desert covered by thick sheets of pumiceous sand and dust. Such desert extends from the south central part of Crook County, southeast across the northern part of Lake County, into Harney County, and it is bounded by mountains of volcanic origin. At least one thick layer of volcanic ash, probably from mount Mazama, is interbedded over a wide area, three to six feet below the surface (Baldwin 1992:131). Obsidian flows occurring in the volcanic rock formations to the south and south-east provided native populations with needed raw material for lithic tools, and prehistoric settlement patterns in the central Oregon uplands were tied in part to these obsidian flows. The extreme southern portion of the study area is characterized by porous soils, with underlying lava sheets, thus is practically without surface streams. An old river channel, probably cut as the main water channel for large Pleistocene lakes, leads northward from the vicinity of Glass Butte, eventually joining the Deschutes River (Russell 1905:19).

North of the just described desert is a rugged plateau, formed by structural deformations and drained by the Crooked River. The uplifted plateau is broad and irregular, extending north from Burns, and west into Prineville. Located on this plateau are Powell Butte, Paulina Mountain, and Pine Mountain; all igneous domes cut by erosion. Northwest of the plateau is the Deschutes River and the Haystack region, containing rolling hills and rich soils. To the east are the Ochoco and the Blue Mountains. Within this uplifted plateau, and the Ochoco and Blue Mountains, lies the Ochoco National Forest and the archaeological sites analyzed in this discussion of central Oregon prehistory.

Topography

Central Oregon includes three physiographic areas (Figure 2), situated between the Basin and Range province to the south and the Plateau province to the north. The Ochoco National Forest covers approximately 93 square miles of this region, that primarily consists of the western extension of the Blue Mountains, with very small portions of the Deschutes-Umatilla Plateau, and the High Lava Plains.

The major drainages in the study area are the Deschutes River forming the western boundary; the John Day River, forming the eastern boundary; the Crooked River, flowing through the central part of the area; and the Malheur River, to the southeast. All flow north into the Columbia River. The Deschutes River has its sources primarily in the large lakes of the Cascade Mountains. Along this swiftly flowing river there are canyons with walls reaching as high as 800 feet. There are two important tributaries of the Deschutes River; the Crooked River, which flows through the central part of the study area, and the Metolius River, flowing east into the Deschutes. Principal feeder tributaries of the Crooked River are Ochoco Creek, Bear Creek, and Beaver Creek (Van Winkle 1914:78). The John Day River rises in the Blue Mountains, flowing westward and then north to join the Columbia near the Dalles. The John Day River is divided into the Upper John Day, the North fork of the John Day, and the Middle and South forks of the John Day. The river cuts through lava sheets, forming steep-walled canyons (Van Winkle 1914: 71).

To the south in Harney Basin the principal stream is the Silvies River, flowing south into Malheur Lake. Its summer discharge is small, but there is a high flow in the spring. To the

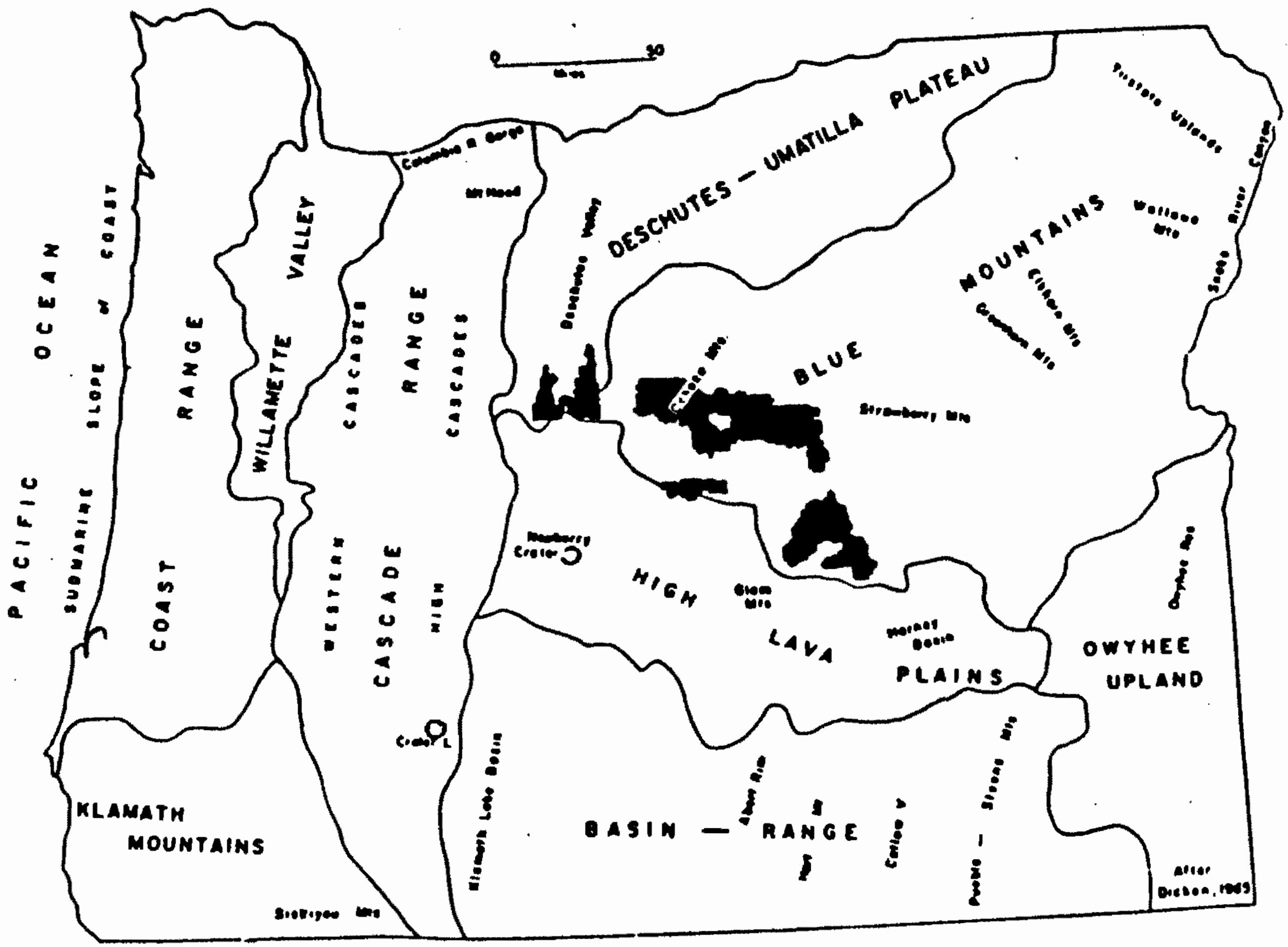


Figure 2. Location of the Ochoco National Forest in Relation to the physiographic divisions of Oregon (adapted from Baldwin 1981:5, after Dicken 1965, by Minor et al. 1987:5).

east of the Silvies river is the Malheur River, which flows north into the Snake and eventually into the Columbia. Central Oregon contains drainage systems connected with those of both the Columbia Plateau and the Great Basin. Some of its rivers and streams flow into the Columbia, while some empty into inland Great Basin lakes and playas, such as Harney and Malheur Lake in southern Oregon (Bailey 1936:8). The central Oregon uplands can thus best be classified as a transition region between the Columbia Plateau and the Great Basin.

Central Oregon Life Zones

The state of Oregon shows a wide diversity of life forms, containing 5 of the 7 primary life zones found on the North American continent (Bailey 1936:11). Within the study area of central Oregon three of these life zones are found. The plant communities within the Upper Sonoran life zone are dominated by sagebrush, juniper, saltbush, and rabbitbrush. This zone covers the low warm valleys along the Deschutes River, the Crooked River, parts of the John Day River, and the basin area surrounding Harney and Malheur Lakes. The Upper Sonoran zone is classified as desert with some juniper (Bailey 1936:16). The elevation of this zone is generally low, ranging from 2000 to 3500 feet above sea level. Important plant food resources including Grossulariaceae, currant; Berberidaceae, barberry; Typhaceae, cattail; Scirpus validus, tule; and Saueda intermedia, seepweed; occur along major drainages and playas. In the dry sagebrush areas many seed crops occur in addition to wild onion (Allium spp.) (Lebow et al. 1990).

The Transition zone vegetation is characterized by sagebrush, mountain mahogany, and forests of pine. It covers much of central Oregon, within a medium elevation range, and is found on rolling to steeply dissected hills, or "dipping" plateau regions consisting of numerous open rolling hills, with numerous open flats (Paulson 1977:9). It is in this type of terrain that the Wind

Creek sites occur. The Transition zone contains numerous edible plant resources, including large amounts of roots, tubers, seeds, and some berry species. Some of the more important plant resources include: Wyethia amplexicaulis, mule-ear wyethia; Balsamorhiza spp., balsamroot; Brodeia hyacintha, wild hyacinth; Lomatium spp., desert parsleys; Perideridia gairdneri, yampa; and Allium spp, wild onion. The Transition zone of central Oregon was an important place of human use, because many plant resources occurred there (Hemphill et al. 1993).

The third major life zone found within central Oregon is the Canadian zone. It is limited in occurrence to small high-elevation portions of the Ochoco Mountains, and is characterized by forests of pine, lodgepole, and fir. It ranges in elevation from 5000 to 7000 feet above sea level. Edible plant resources were found here but not in the same quantity as in the Transition zone. In the Canadian zone there is an increase in the number of meadows and ridges. In the meadows various lily species (Lilaceae) occurred, including camas (Camassia spp.), and yellow bells (Fritillaria pudica), in addition to various species of berries occurred within the stands of lodgepole and aspen. The dry ridges produced large amounts of root crops (Hemphill et al. 1993).

Post Glacial Climates

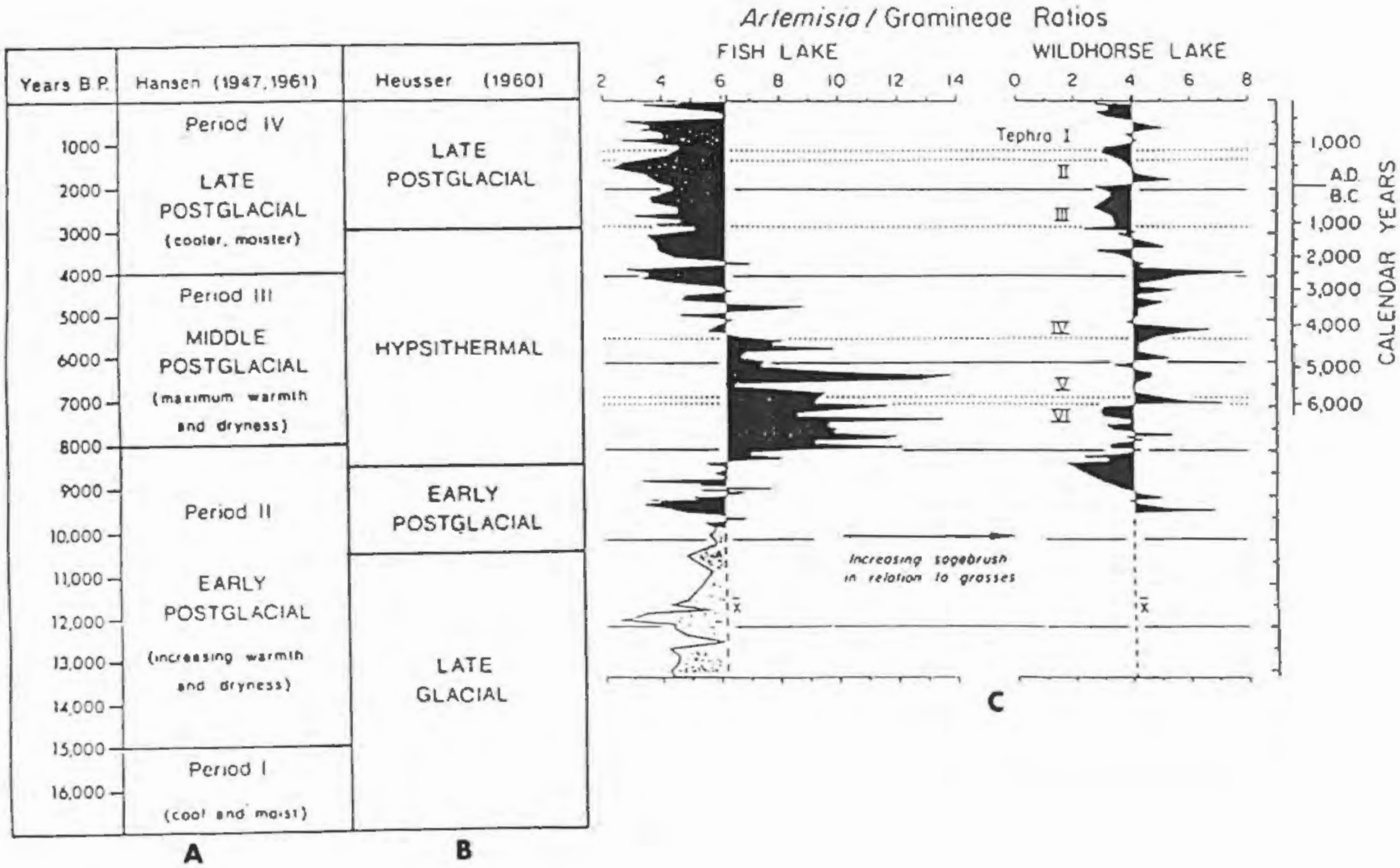
Several early paleoclimatic schemes presented for the western United States include those of Antevs (1955) for the Great Basin, and Hansen (1947) and Heusser (1960) for the Pacific Northwest. These studies indicated that there have been several major climatic fluctuations since the continental glaciers retreated from the Pacific Northwest at the end of the Pleistocene about 11,000 to 12,000 years ago (Toepel, Willingham and Minor 1980:10).

The period extending from the end of the Pleistocene to the present is referred to as the Holocene epoch. The first period within the Holocene is termed the Anathermal, characterized by a transitional cool and wet climate (9000-7000 BP). This was followed by the Altithermal period, defined as a time of increasing warm and dry conditions (7000-4000 BP). The third period within the Holocene, lasting from 4000 BP to the present is the Medithermal. During this period the climate became cooler and wetter (Antevs 1955). Hansen (1947) proposed three similar but not identically defined periods for the Pacific Northwest, which he termed Early Postglacial, Middle Postglacial, and Late Postglacial. Deevey and Flint (1957) refer to the Middle Holocene warm /dry period as the Hypsithermal.

More recently, research on Holocene glacier fluctuations (Davis 1988, Easterbrook 1986), and other paleoclimatic research (Mehringer 1985, and Wigand 1987) has modified the earlier chronologies (Figure 3). The glacial studies indicate that in the mountains of the Pacific Northwest, by 10,000 BP glacial ice had receded to its current level. Subsequently, Neoglacial ice advances occurred during the last 5000 years. Current research in the Cascade Range and the Blue Mountains indicate that there have been three glacial advances during the Holocene: an Early Holocene phase older then a Mount Mazama volcanic ash (6800 BP), an early Neoglacial advance (2000-3000 BP), and multiple late Neoglacial advances during the last 700 years (Easterbrook 1986: 154-155).

No research has been conducted on the paleoclimate of the study area proper, but immediately to the north and south well dated pollen sequences permit an extrapolation for central Oregon climate (Reid et al. 1989, Mehringer and Reid 1988, Wigand 1987). To the northwest is a sequence from Carp Lake; and to the south are pollen sequences from Diamond Pond, Wildhorse Lake and Fish Lake, all located near Malheur Lake, in the Harney Basin. Recent paleoclimatic research has also been conducted to the east, in the Silvies Plateau. (Reid et al. 1989).

Figure 3. Post-Glacial Sequences in Northwestern North America. A.: from Hansen 1961; B.: from Heusser 1960; C.: from Mehringer 1986.



Years B.P.
Hansen (1947, 1961)
Heusser (1960)
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
Period IV
LATE POSTGLACIAL
(cooler, moister)
Period III
MIDDLE POSTGLACIAL
(maximum warmth and dryness)
Period II
EARLY POSTGLACIAL
(increasing warmth and dryness)
Period I
(cool and moist)
LATE POSTGLACIAL
HYPSITHERMAL
EARLY POSTGLACIAL
LATE GLACIAL
A
B
Artemisia / Gramineae Ratios
FISH LAKE
WILDHORSE LAKE
2 4 6 8 10 12 14
0 2 4 6 8
Tephra I
II
III
IV
V
VI
Increasing sagebrush in relation to grasses
1,000
A.D.
B.C.
1,000
2,000
3,000
4,000
5,000
6,000
CALENDAR YEARS
C

The Carp Lake sequence comes from the southwestern part of the Columbia Basin, near Goldendale, Washington. The pollen record spans 33,000 years and may be divided into four broad periods. The first period (33,000-23,500 BP) is dominated by nonaboreal pollen and indicates an environment similar to the modern steppe communities of the Columbia Basin (Reid et al. 1989). The period from 23,500 to 10,000 BP shows a continuation of nonaboreal pollen, indicating an arid periglacial steppe or tundra vegetation. From 10,000 to 8500 BP there is a spread of temperate taxa indicating a shift to warmer but dry conditions. By 8500 BP a predominance of pine pollen correlates with the development of pine woodlands, indicating more humid conditions, and the appearance of Douglas-fir forests by 4000 BP suggests cooler conditions (Reid et al. 1989).

The sequences from Fish Lake, Diamond Pond, and Wildhorse Lake (Mehringer 1985, Wigand 1987) overlap to span a period from 13,000 BP to the present. There is a predominance of grass over sagebrush from 13,000-8700 BP, followed by a decline in grass and a dominance of sagebrush. The abundance of grass indicates a period of effective moisture, which is reflected along the shorelines terraces and beach ridges of Malheur Lake. At Wildhorse Lake a subsequent period of decreased effective moisture is dated between 7000 and 4000 BP, at Fish Lake between 8000 and 5500 BP, and at Diamond Pond between 6000 and 5400 BP (Wigand 1987). Rising water tables are indicated by the prevalence of pollen and seeds at Diamond Pond between 5400 and 3600 BP. At Diamond Pond the period between 5400 and 4000 BP is generally represented by increasing effective moisture, as also indicated by increasing sagebrush pollen and expansion of sagebrush into pre-existing shadescale desert. (Wigand 1987). There is also an increase of grass over sagebrush beginning about 4700 BP and continuing generally to the present, though interrupted by dryer sagebrush peaks about 3700 and 400 BP. Evidence from Wildhorse Lake

(Mehringer 1985) indicates that grass increases about 3400 BP, with reversals to sagebrush about 1700 BP and 600 BP, and expanding juniper grasslands until 2000 BP. This period of effective moisture intensified between 4000 and 2000 BP, and between 2000 and 1400 BP there was reduced effective moisture, followed by an increase between 1490 and 900 BP, a drought between 500 and 300 BP, and greater effective moisture between 300 and 150 BP (Wigand 1987).

The pollen and geologic research reported by Reid et al. (1989) on the Silvies Plateau is closest to the central Oregon uplands. The Silvies Plateau is located east of the south fork of the John Day River. This uplifted area borders Harney Basin to the south, while extending north into the Strawberry Mountains. The Silvies Plateau falls within the Transition and Canadian zones, and is thus environmentally similar to the Central Oregon study area. It should be possible to draw direct correlations to environmental changes between both of these areas. Reid et al.'s (1989) research indicates that by 9500 BP a mixed grass, sage, and sedge tundra with occasional spruce had given way to a sagebrush steppe. Pre-Mazama soil formation began about 8000 BP, with Mount Mazama erupting about 6800 BP. Between 5000 and 4000 BP pine expanded, with a climax pine forest established about 4000 to 3000 BP. A post Mazama soil formation occurred between 4000 and 3200 BP, with a second formation between 2400 and 1100 BP. By 1900 BP it was drier with evidence of forest fires. Pine forests expanded again about 500 BP with evidence of droughts at 500 and 700 BP.

Mehringer (1985) and Wigand (1987) describe the Holocene in general as a post glacial period of relatively cool, moist conditions yielding to warmer and dryer conditions, followed by cooler, moist conditions after 4500 BP. Differences between upland (current Transition and Canadian zones) and lowland (current Upper Sonoran zone) climates should have followed a pattern where cooler temperatures existed in the upland with more grasses and pine, and during the early post glacial periods more spruce, than in the lowland where warmer conditions should have existed with greater amounts of sagebrush, greasewood and saltbush, and juniper. Mehringer's and Wigand's climatic research emphasize a history of short, sharp, changes in amounts of effective moisture. Some of these environmental changes are of considerable magnitude (see Figure 3).

Summary of Potential Implications of Environmental Zonation/Climatic Fluctuations for the Present Study

The central Oregon upland environment exhibits characteristics of both the Columbia Plateau and the Great Basin. As a marginal area situated between two broader physiographic regions it is characterized by some drainages flowing into the Columbia River, and some into the Great Basin playas and lakes. The volcanic rock in the southern and south-eastern portions of the study area provided obsidian for lithic reduction, while the uplands found in the central and northern portions of the study area provided an environmentally stable Transition and Canadian zone resource base.

Although no paleoclimate research has been conducted immediately within the study area, research to the north (Carp Lake), east (Silvies Plateau), and the south (Steens-Malheur region) suggests a pattern of fluctuating climate throughout the Holocene. At a general level these climatic shifts may be described as follows: between 13,000 and 8700 BP there was a period of high effective moisture, followed by decreased effective moisture from 7000 to 4000 BP with moisture again increasing through to the present, with abrupt and short lived decreases in effective moisture about 3700 and 400 BP.

Within this long term climatic perspective, short term punctuated variation occurred. This variation at times was of considerable magnitude and affected the distribution of fauna, plant communities, and lakeshore margins. One response to fluctuating environment by Native Americans utilizing the study area might have been the development of a fluid band structure. This fluidity would have allowed a maximum utilization of a wide range of resources, associated with expansion and contraction of group territories across a wide range of elevations and life zones.

As lakeshore margins in the lowlands became less productive in the Early Archaic, uplands may have been first utilized, increasing rapidly with the development of the pine climax forests in the Middle Archaic Period. The eruption of Mount Mazama (6800 BP) may also have contributed to the development of plant resources in the upland areas. The shifting environmental conditions in the Late Archaic may have led to a substantial population increase during this time, and subsequent neoglacial times. Within this frame of reference the central Oregon upland settlement patterns documented in this dissertation may be placed, and the patterns of obsidian procurement, and the excavations from the Wind Creek sites analyzed.

CHAPTER III

CULTURAL BACKGROUND

Little is known ethnohistorically or ethnographically about the Native Americans who occupied the central Oregon study area, and an initial effort to develop an ethnographic model for the region was abandoned due to a lack of adequate information. It is recognized that within the current study area, the archaeological record offers better possibilities for describing prehistoric native settlement patterns than does the limited ethnographic information. In this chapter the geographic distribution of Northern Paiute bands is briefly sketched to provide a spatial frame of reference, and a discussion of previous archaeological research reviews earlier studies of prehistoric settlement patterns in adjacent regions.

Northern Paiute Groups

Little has been published on the Northern Paiute people who occupied the study area in historic times. Descriptions of their culture have been limited to incidental comments by fur trappers and early European explorers who encountered native people in the course of their travels. Ethnographic research by Omer Stewart (1939, 1941) resulted in a short monograph in which he mapped the geographic location of 21 groups of Northern Paiute living throughout the northern Intermontane region (Figure 4), and provided a culture element trait distributional study.

Based upon the research of Stewart, along with work by Berreman (1938), and Blyth (1938), three groups or bands of Northern Paiute were identified in the central Oregon area;

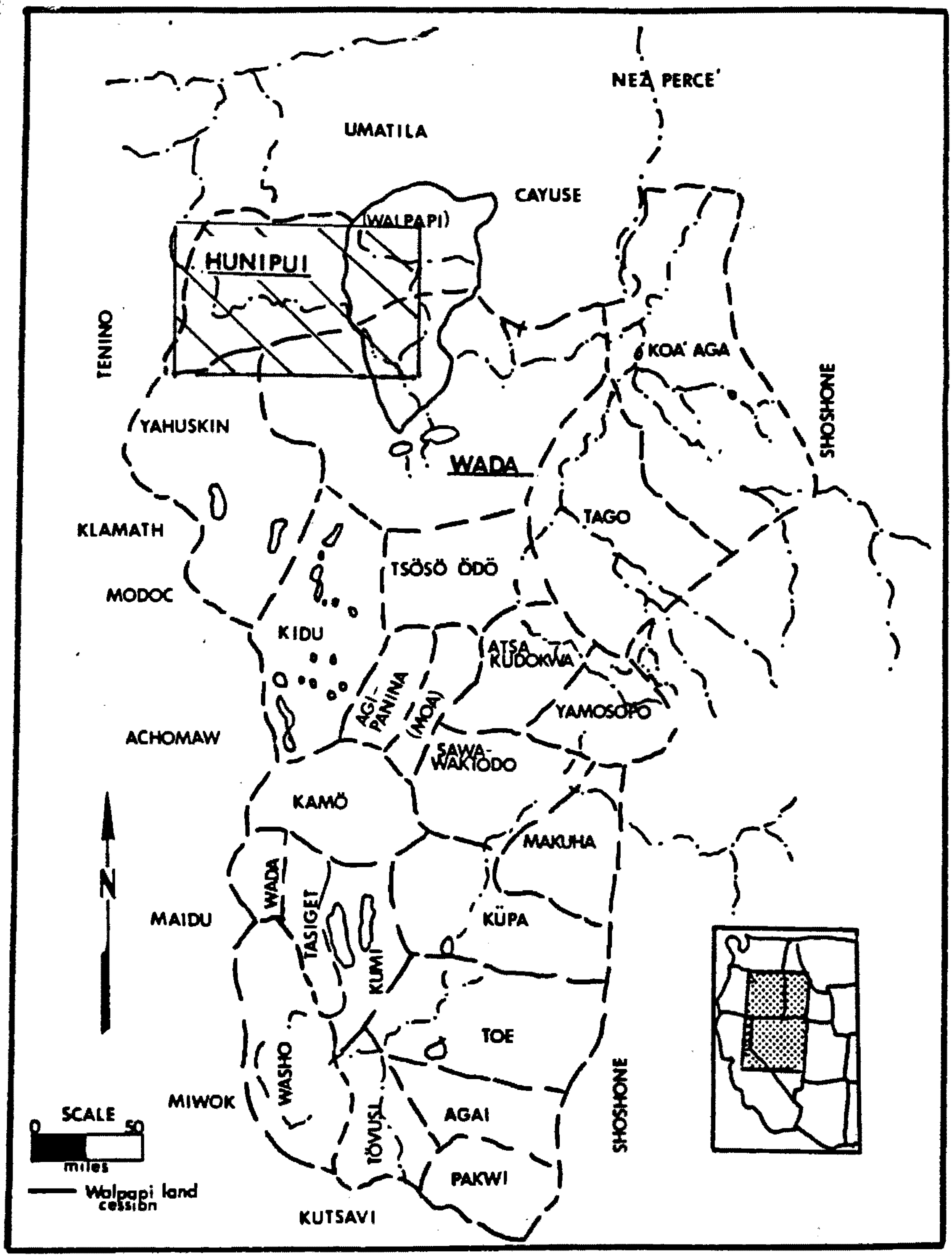


Figure 4. Northern Paiute distribution (adapted from Stewart 1939: map 1). Rectuangular box with hashed lines represents the approximate location of the central Oregon study area.

however the exact geographic distribution of these groups is thought to have been more vague and indefinite than the original cartographic work indicated (Fowler and Liljeblad 1986: 438). The three groups were the Wadatoka (Wada Seed Eaters), residing in the Harney Basin immediately south of the study area, and the Hunipuitoka (Root Eaters) and Waapitoka (Juniper-Deer Eaters), who occupied various portions of the study area. Couture (1978; et al. 1986) has postulated a seasonal cycle for the historic Harney Vallley Paiute (Figure 5). The winter months would be spent in the low elevation areas near permanent water sources such as Harney Lake, and Late Spring, Summer, and Fall months would be spent fishing, and hunting and gathering roots, seeds and berries in higher elevations. Her model applies to one of the three groups historically occupying the central Oregon area. A similar model has been postulated by Zilverberg (1983) for the Blue Mountain region of Northeastern Oregon, and for the central Oregon uplands (Armitage 1983). The central Oregon uplands thus, represent only the Spring, Summer, and Fall portion of the archaeological record. Occupation of the study area should be seasonal, and short-termed in duration.

Research by Fowler and Leland (1967) into Northern Paiute classification systems, James Mahor 's (1954) study of the ethnobotany of the Warm Springs Indians, Marilyn Couture' s (1978; et al. 1986) studies concerning ethnobotany of the Burns Reservation Paiute, and Oregon State University's (1972) study of the nutritive value of plants used by the Warm Springs Indians, all have contributed to anthropological theories concerning the contemporary central Oregon Northern Paiute and the resources they utilize. Much more research, however, must be focused upon these issues before any correlations may be drawn between the contemporary situation and that found in the prehistoric record.

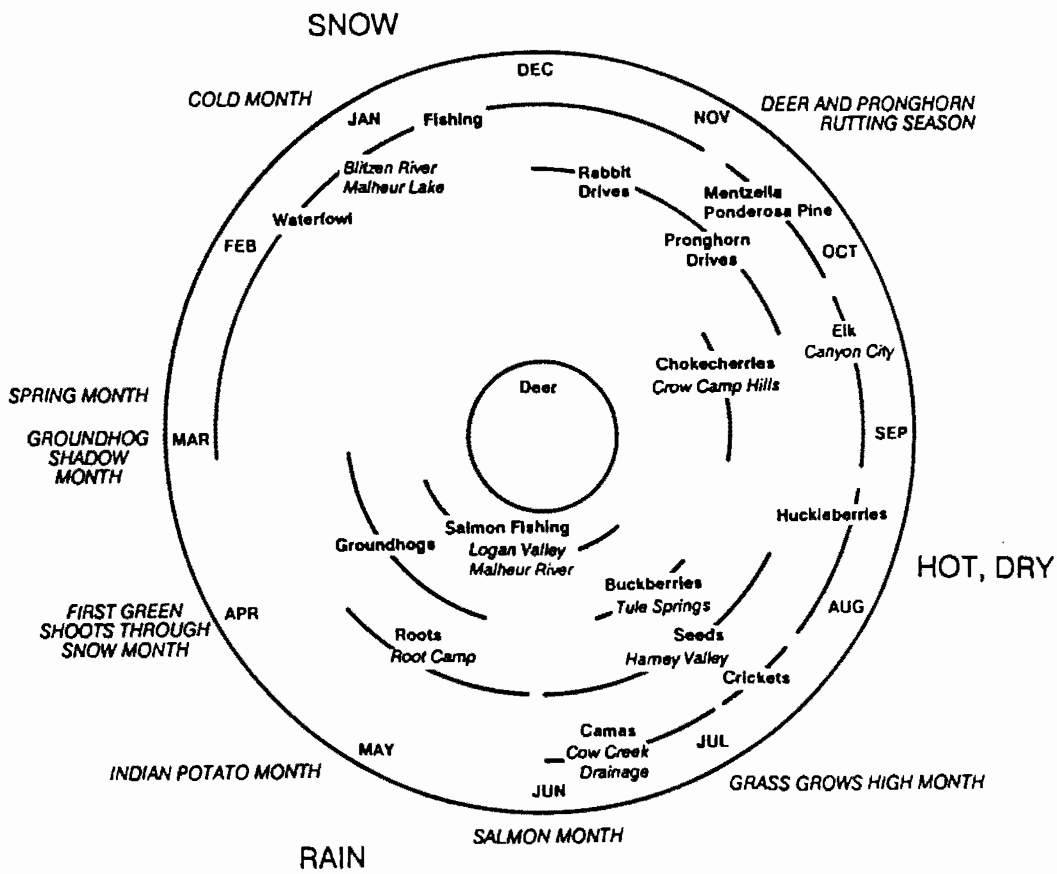


Figure 5. Harney Valley Northern Paiute seasonal round (from Couture et al. 1986:153).

Archaeological Research

Previous archaeological work in central Oregon has been severely limited. More spectacular remains from the Columbia River and the caves and rock shelters of south-central Oregon have drawn archaeologist's attention, leaving a large gap in our general understanding of central Oregon prehistory. Upon reviewing the previous archaeological research conducted here it is apparent that the data available for this region have been primarily those collected from surface surveys on government-owned land. Detailed cultural chronologies have been developed for areas surrounding central Oregon, and some less detailed ones for central Oregon, but the available data on the study area have not been systematically synthesized.

As more research is conducted a picture of central Oregon prehistory is emerging that indicates a long time span of occupation beginning at least 10,000 years ago and continuing to the historic period. Reviewing the archaeological literature places central Oregon in regional perspective, and is critical to understanding the nature of central Oregon archaeological remains, the cultural chronology, and the occurrence of upland environmental adaptations.

Cultural Chronology

The results of cultural chronological research in central Oregon and the surrounding areas indicate a long timespan of human occupation (Figure 6). Attempts to develop cultural chronologies initially relied upon relative dating methods. As dating methods became more sophisticated, so did the chronologies.

Early archaeological research in south-central and northern Oregon was conducted by Luther Cressman between 1932 and 1956. This established that the region had been occupied by

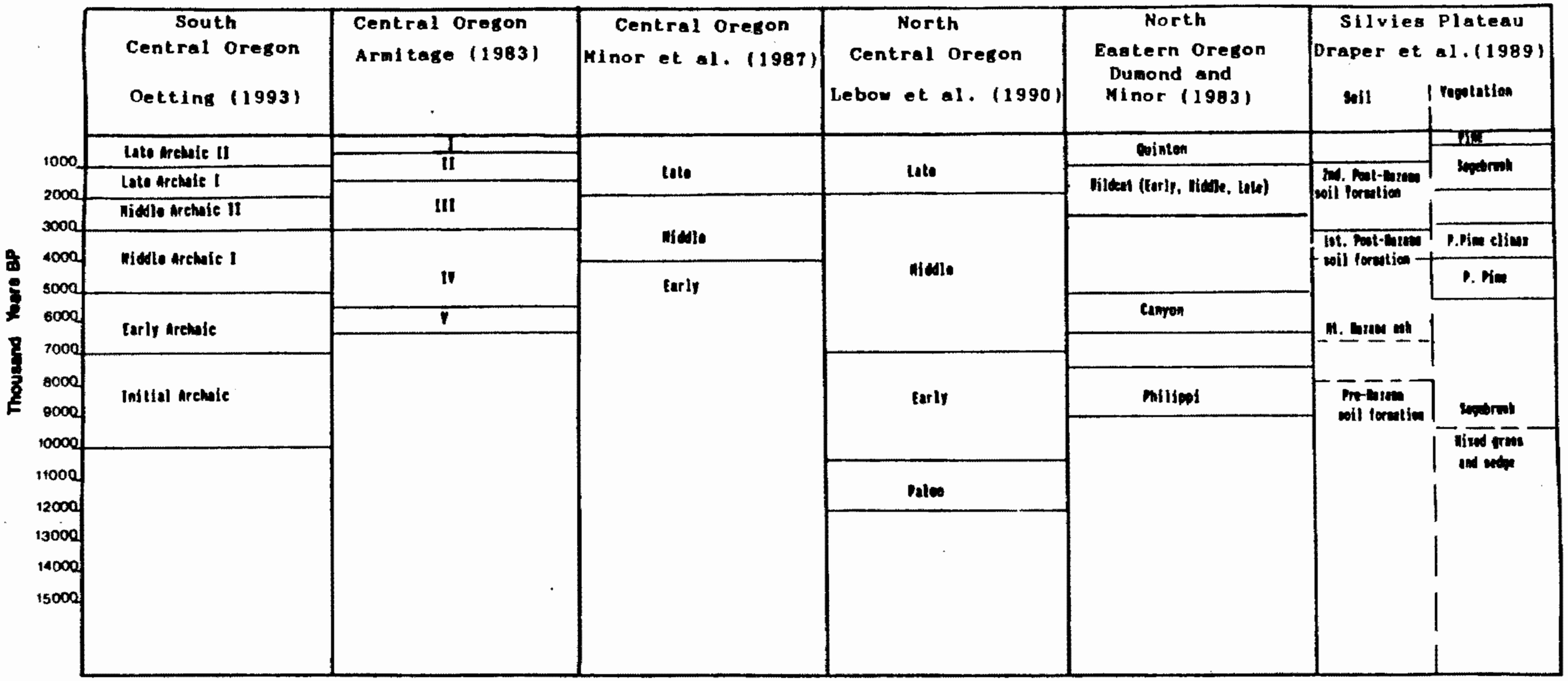


Figure 6. Previous cultural chronologies for the areas surrounding central Oregon and related soil and vegetation changes.

humans throughout the Holocene (Cressman et al. 1942). More recently, research by Bedwell (1973) at Fort Rock Cave and the Connley Caves in south-central Oregon yielded four cultural periods, which he placed between 13,000 BP and 3000 BP, with a hiatus indicated from 7000 to 5000 BP. Weide (1968) conducted research in the Warner Valley area, discussing types of archaeological sites. She developed a three phase chronology on the basis of projectile point styles, with her dates ranging from 7000 BP to 500 BP. At Dirty Shame Rockshelter (Aikens et al. 1977), perishable and non-perishable cultural remains were found. A long range of human occupation was documented that broadly parallels those known from the Connley and Catlow Caves (Aikens 1993). Projectile points included Windust, Lake Mohave, Humboldt, Northern Side-notched, Elko Eared, Corner-notched, Pinto, and Willowleaf. Six cultural zones were identified. Zone Six dated to 9500-8850 BP. Between Zone Six and Five there was a 1000 year hiatus. Zone Five dated to 7900 BP-6500 BP; it contained Scottsbluff and Western Stemmed projectile points. Zones Four and Three extended from 7100-5800 BP, followed by a 3000 year hiatus. Zone Four contained mainly Pinto projectile points, with one Northern Side-notched point. Zone Three contained Elko, Rosegate, and Northern Side-notched projectile points. Zone Two fell between 2750 and 1150 BP, and contained Rosegate and small side-notched projectile points. Zone One dated from 1400-350 BP, and contained Desert Side-notched, Cottonwood, and Eastgate points.

The Steens Mountain archaeological project (Aikens et al. 1982, Beck 1984, Jones 1984, Wilde 1985) yielded valuable settlement data for southern Oregon. This extensive survey project attempted to identify settlement patterns in an upland region south of the present study area, addressing the need to understand short term activity sites as well as the longer term permanent camp sites (Aikens 1993). From a 5% survey of a very large project area 133 sites were identified, of which 106 were mapped and collected, yielding over 146,000 artifacts. A large number of projectile points were used to seriate the occupations, and six periods were identified from 10,000 BP to historic times (Wilde 1985).

At the Wildcat Canyon site near the Columbia River to the north of the current project area, a cultural chronology was developed for the Upper John Day River (Dumond and Minor 1983). This included the Philipi Phase (7980 BP), the Canyon Phase (6500-5000 BP), the Wildcat Phase (4340-1010 BP), and the Quinton Phase (500 BP). The Wildcat Canyon chronology is the best defined sequence in the study region, and is an important guide to the chronological sequences recognized in the central Oregon uplands. The Wildcat Canyon site contains evidence of Early Archaic occupation (Philippi Phase) in the form of some milling stones, manos, lithics, and bone tools. In this period there was no evidence of fishing, or of houses, suggesting a mobile subsistence pattern based upon hunting and collecting (Dumond and Minor 1983). The Middle Archaic has been divided into two subphases. The Canyon Phase is similar to the Early Archaic, with an increase in the amount of groundstone artifacts. There is a brief hiatus, followed by the Wildcat Phase, which is interpreted as an intensively occupied summer camp with evidence of fishing. By 2000 BP pithouses occur, and the Wildcat Canyon site of this period is interpreted as a winter village occupation. It is during this time that the Wildcat Canyon site was most intensively occupied. Following 1000 BP the site again became a summertime camp (Dumond and Minor 1983).

In the north-central Oregon area a revised cultural resource overview of Bureau of Land Management lands (Lebow et al. 1990) analyzed 903 archaeological sites, described settlement patterns, and identified Paleo- Indian, Early Archaic, Middle Archaic, and Late Archaic cultural periods. Excavations conducted at Round Butte Dam (Roscoe 1967; Ross 1963) focused upon several rockshelters along the Deschutes River. Radiocarbon dates of 7990 BP, 2675 BP, and 2650 BP were obtained from this project and the excavated material from the rockshelters included mussel shells, fish hooks, and fish remains.

The chronologies just discussed are summarized in Figure 6. As the chart suggests, the archaeological chronology for the central Oregon study area has not been adequately analyzed to bring it into reasonable congruence with the chronologies developed for the surrounding areas, and that is one of the main tasks of this dissertation.

Regional Settlement Pattern Research

Early excavations in south-central Oregon (Cressman 1936, 1939, 1942) identified a pattern that may be characterized as a Desert Culture adaptation (Jennings 1957). In northern Oregon along the Columbia River, an adaptation to fish resources was identified (Cressman 1960, Daugherty 1960).

Later research in south-central Oregon (Weide 1968) explored settlement patterns and mobility more specifically, describing winter villages, spring and summer camps, hunting camps, and quarries. From recent research in the Warner Valley (Fowler 1993) and the Fort Rock Basin (Aikens and Jenkins 1994), a picture is emerging of lowland lacustrine adaptations that included fishing, and upland adaptations focused upon root processing.

Theories about upland adaptations in south-central Oregon began with the research of Fagan (1974). He postulated an Altithermal occupation of upland spring oriented sites, with a return to lowland occupation after the Altithermal period. The Steens Mountain project (Aikens et al. 1982) further addressed the issue of upland occupations in south central Oregon. The study combined the results of the survey with excavated sites, and concluded that habitation in the area has remained relatively stable in the past. Fluctuations in utilization of the upland area were associated with climatic shifts and reduced waterside resources in the lowlands (Wilde 1985).

The Fort Rock Basin prehistory project began in 1989 and within a five year period resulted in further evaluation of upland occupation in the Fort Rock area (Aikens and Jenkins 1994). A model of shifting settlement patterns from a Middle Archaic lowland village occupation to an upland Late Archaic village occupation pattern is suggested, associated with an intensification of root exploitation. This ongoing research should yield valuable information about changing environmental conditions, root exploitation, and Late Archaic settlement adaptations.

Research concerning lacustrine adaptations has been conducted in the Malheur Lake area (Minor 1980; Musil 1992; Newman et al. 1974), and around ancient lakes of south-central Oregon (Oetting 1989; Oetting and Pettigrew 1985; Willig 1988). These studies have presented a picture of adaptations to the lakeshores of south-central Oregon over a long period of time beginning perhaps 11,000 years ago. Research in Harney Basin (Musil 1992) has identified pithouses dating between 3200 and 900 BP, with a change to wickiups after 900 BP. Musil interprets the housepits as indicating developing sedentism, and the wickiup architecture as indicating a more mobile adaptation, possibly associated with drought conditions .

Additional cultural resource surveys conducted for the Deschutes River (Cole 1969; Krieger 1938; Hibbs and Willard 1976) and the John Day River (Polk 1976) identified a large number of pithouses, indicating sedentism and intensive utilization of a riverene environment. Hibbs and Willard (1976) recorded 135 Native American sites, of which 37 contained pithouses. On an average the sites with pithouses contained one to six structures, but larger sites contained 29 and 31 pithouses. At Mack Canyon (Cole 1969), numerous pithouses were recorded in several seasons of excavation. The radiocarbon dates from these excavations were all later than 2000 BP, indicating a late Middle Archaic times (Lebow et al. 1990: 93). A survey by Polk (1976) along the John Day River resulted in the identification of 76 prehistoric sites, including 47 at which housepit depressions were noted.

To the north and east of the central Oregon uplands, three recent archaeoogical projects have been conducted that have provided information about Middle and Late Archaic adapations to this area. A recent archaeological survey by Endzweig (1992) along Pine Creek, which flows into the John Day River north and east of the study area, and her recent dissertation (Endzweig 1994) from the same area identified two types of housepits. The earlier variety dated to the Late Middle Archaic Period were large and deep, while the later variety were shallow and small. From her research Endzweig postulated a shift from broad spectrum subsistence in the Late Middle Archaic to a more specialized adaptation in the Late Archaic. Her research indicates that the area north of the central Oregon uplands was most heavily occupied during the Late Archaic Period. Research conducted at Mitchell Cave, near Mitchell, Oregon (Connolly et al. 1993) corresponds to that found by Endzweig. At this rockshelter excavation evidence of Late Middle and Late Archaic adaptations were found, again with the highest concentrations of habitation during the Late Archaic Period. Schalk (1987) proposes that housepits first occurred on the steppe-forest margin of the Columbia Basin by 5000 BP, with settlement attracted to the optimal zone of plant and fish resources. This intensification was probably associated with scheduling of resource procurement and increased sedentism.

Archaeological research along the Deschutes River has included excavations at Lava Island Rockshelter (Minor and Toepel 1984), identifying Middle to Late Archaic stone tool manufacture and storage; the testing of 11 lithic scatters near Lava Island Rockshelter; a cultural resource survey south of Redmond (Lyman et al. 1983); a Deschutes River survey

(Scott 1986a); excavation of six archaeological sites on the Deschutes National Forest (Scott 1986b), excavations at Sand Springs (Scott 1985) and the Peninsula Site (Stuemke 1989), identifying fishing technology and a long occupation time span (4080 BP and 2980 BP); the Cascade Lakes Highway Project (Pettigrew and Spear 1984), excavations at the Dusty Mink and Grayling Springs Sites (McFarland 1989); and surveys of Fall River (McFarland 1989), the Deschutes and Little Deschutes Rivers (Gibson 1989); and an excavation near Sunriver (Cole 1977).

The above are all lithic-dominated Middle to Late Archaic sites which document riverine settlement patterns in central Oregon surrounding the upland zone addressed in the present research. Some of the sites contain grinding implements but others (Gibson 1989; McFarland 1989) contain only lithic material. These sites are similar, in terms of artifact composition and age, to the Wind Creek sites, located in the current study area near the south fork of the John Day River. They also show similarities to the archaeological sites identified by Reid et al. (1989) in their survey of the Silvies Plateau in south-eastern Oregon, to the east of the present study area.

Excavations by Reid et al. (1989) on the Silvies Plateau identified 15 open air archaeological sites. Radiocarbon data indicated occupation between about 3000 BP and 500 BP. There was little evidence for occupation prior to 3000 BP or after 500 BP. Reid et al. (1989) explain the lack of sites earlier than 3000 BP as a result of upland erosion throughout much of the Middle and Late Holocene. This erosion may have erased evidence of early high elevation sites and buried lower elevation sites of this period. Their survey identified no Late period Numic occupation sites, and they offer no explanation for this lack.

The Silvies Project provided detailed information about climate and geological processes, but little information about settlement patterns or site structure. Reid et al. concluded that formed tools were scarce in the Silvies assemblages, and when found generally consisted of fragmentary bifacial tools and debitage. Small amounts of groundstone were also found. Archaeological site features were scarce, and generally disturbed past the point of recognition (Reid et al. 1989:246). When discussing geological processes they conclude that Holocene erosion has built alluvial fans at the mouths of canyons, margins of floodplains, and valley walls, and they speculate that these areas may contain large housepit villages (Reid et al 1989:246).

The evidence of previous research in the area surrounding the central Oregon uplands thus indicates that the area was occupied over a long period of time. Cultural adaptations were made to both river and lakeshore environments. Limited research has been devoted to the upland environment, but a picture is emerging of Middle and Late Archaic adaptations in the surrounding region, that must have been related to occupations in the uplands as well. It is the intent of this dissertation to present in detail substantial evidence of upland utilization, and to analyze the structure of the numerous sites located here.

Problems of Central Oregon Chronology and Settlement In Relation to the Wind Creek Sites and The Ochoco National Forest Archaeological Site Survey

Previous anthropological research surrounding and within the central Oregon region has yielded a general picture of the antiquity of human occupation, and varying cultural adaptations to diverse environments. The occupants of the region appear to have practiced broad-spectrum hunting/gathering economics from most ancient times, through to the historic period.

Evidence of Paleo-Indian occupation of north-central and central Oregon is scant, and probably limited by site formation processes, including the mantle of volcanic deposits (summa rized by Scott 1985) (Lebow 1990: 54). Evidence of Early Archaic occupation is better demonstrated. Previous research indicates that the John Day and Deschutes Rivers, as well as the eastern slopes of the Cascades, were first utilized during this period. A riverine adaptation to salmon is suggested by at least 10,000 BP at the Dalles (Cressman et al. 1960), while research at Wildcat Canyon (Dumond and Minor 1983) suggests a more generalized hunting and gathering adaptation there. It is during this period that the first evidence of occupation in the central Oregon uplands occurs in the form of stemmed, shouldered projectile points. Paleoenviromental research for this time period suggests a period of decreased effective moisture between 7000 and 4000 BP.

The Middle Archaic witnessed a period of increased effective moisture between 4000 and 2000 BP. Human occupation in the upland region becomes more noticeable, and it is during this period that the earliest radiocarbon dates occur in the Wind Creek sites, as well as in the sites excavated by Reid et al. (1989) on the Silvies Plateau. Ames and Marshall (1981) state that it is during this period that the "winter village pattern" appears on the Columbia Plateau to the north. Pithouses occurring along the Deschutes and John Day River date to this period. Use of upland resources was perhaps intensified, as well as fishing and riverine adaptations.

Many of the archaeological remains found in the central Oregon uplands are related to the Middle and Late Archaic periods, and provide clues to upland Middle and Late Archaic settlement patterns. The research of the present dissertation is focused on this area and these time periods.

In summary, archaeological research in the general central Oregon region so far has focused upon lakeshore and riverine adaptations at low elevations. Upland settlement patterns in the Northern Great Basin region are now starting to be examined (Aikens and Jenkins 1994), however, and beginning to suggest a picture of increasing upland utilization and intensification through time. The Wind Creek sites provide additional information on these adaptations for the central Oregon uplands, and a foundation for settlement pattern research in the same area. The archaeological data on assemblage composition and site distribution derived from a sample of 1050 surface sites, recorded in the upland region surrounding the Wind Creek sites, provides additional detail on upland occupation in central Oregon , which is brought together in this dissertation for the first time.

CHAPTER IV

ANALYSIS, CLASSIFICATION AND CHRONOLOGY OF CENTRAL OREGON PROJECTILE POINT TYPES

Methodology

The collection of central Oregon projectile points upon which this analysis is based consists of artifacts recovered during archaeological testing and excavation of the Wind Creek sites (see Chapter V), and surface surveys conducted on the Ochoco National Forest between 1978 and 1994.

The collection contains 365 points (measurements in Appendix A). Fifty-eight of these projectile points were reworked or broken to the extent where they were not classifiable and were eliminated from the analyzed set, leaving 307 samples in the classification phase of the analysis.

The methodology used for measuring the form of the projectile points was that developed by Holmer (1978). The outlines of the projectile points were traced and from these drawings seven measurements were recorded (Figure 7). These consisted of: P1- the center of the base; P2- maximum horizontal extent of the basal concavity or convexity; P3- lower (proximal) corner of the notch opening (may be equal to P2 for certain point types); P4- maximum inward extent of the notch; P5- upper (distal) corner of the notch opening; P6- edge of the blade about half the distance between the notch and the tip; and P7- the tip (Holmer 1978:8). The measurements were recorded by measuring distances from an X and Y axis on half of the projectile point (see Figure 7) resulting in thirteen X and Y paired distance measurements. These paired measurements were then

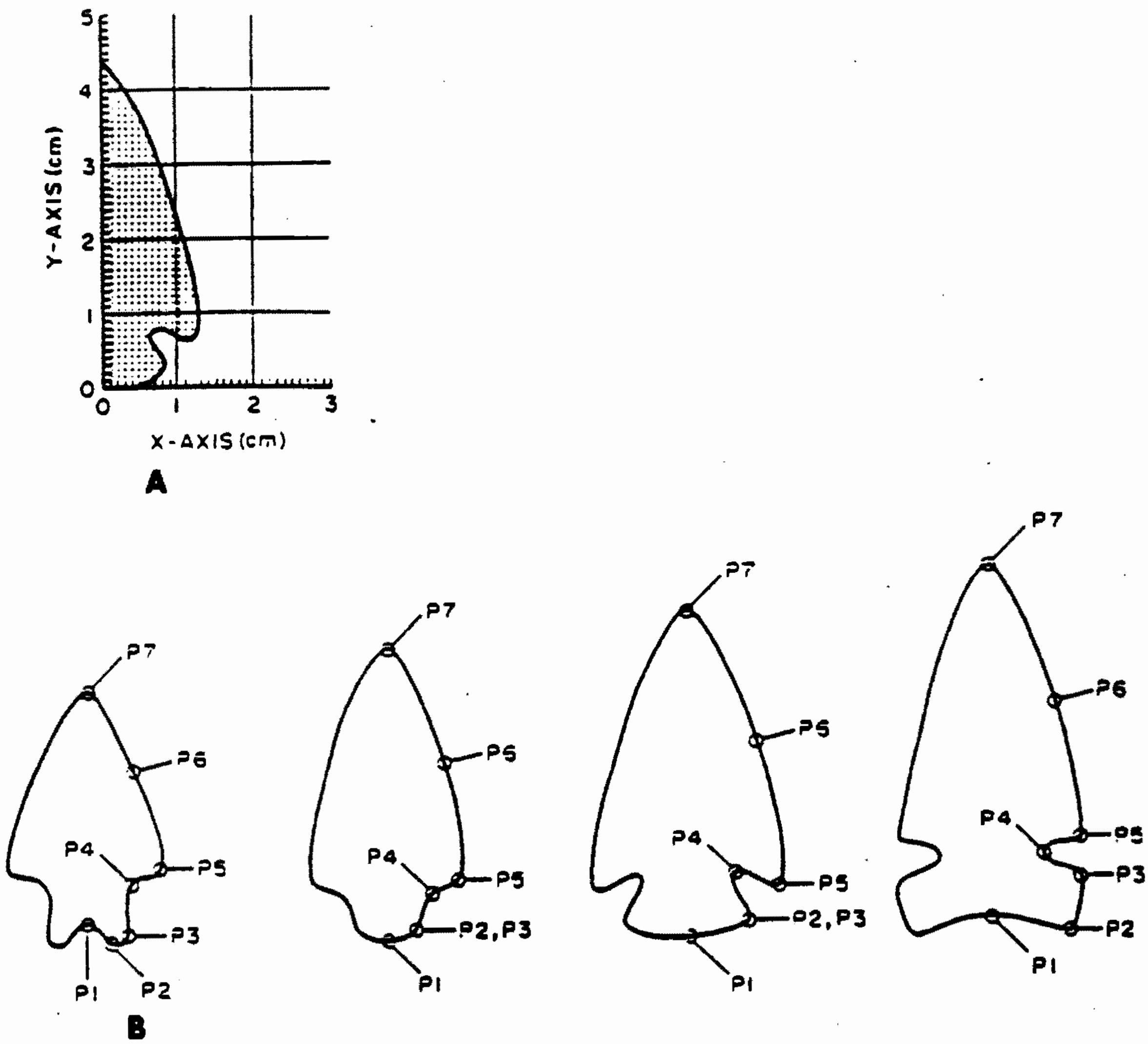


Figure 7. Location of projectile point measurements (from Holmer 1978:7).
A. Plan view of a typical projectile point measurement.
B. Measurement locations for various types of projectile points.

converted to seven distance measurements and six angle measurements through a series of computations (Table 1). The sixth angle measurement used by Holmer, a compilation of other angle measurements, was not deemed necessary for this analysis and thus, a total of 12 measurements were used in this classification.

The distance and angle measurements were then clustered into morphological groups using a squared Euclidean clustering measure and complete linkage method. This procedure compares variable measurements and forms a dissimilarity matrix representing distances between variables. The matrix is then clustered, forming groups of cases with similar variable measurements. Various procedures, or algorithms, exist for constructing the dissimilarity matrix (referred to as clustering measures), and for forming the clustering criteria (referred to as clustering linkage methods) (Orton 1982). The selection of the correct measure and method to use then depends upon the type of data being analyzed and their ranges of variation. The squared Euclidean measure forms a variable matrix of squared Euclidean distance coefficients for all possible pairs of cases. This measure is the sum of the squared differences over all variables. The complete linkage method, or "furthest neighbor technique" is calculated as the furthest distance (difference) between two cases (Norusis 1988). The cluster results may be graphically displayed in a dendrogram format allowing visual inspection of the clusters.

The clusters were then classified using a discriminant function analysis. This statistical technique measures the reliability and association of groups. Several methods of analysis are available to designate the criteria that separate the groups. This analysis follows that of Holmer (1978), and Wilde (1985) in the choice of the WILKS' method. This method uses a stepwise inclusion in which all variables are independently analyzed according to the amount of intergroup variability they control.

Table 1. Equations for Converting Coordinate Data to Distance and Angle Measurements[a]

Variable	Distance Equations
1 M1 (P1 to P2)	COMPUTE M1=SQRT(((X1-X2)**2)+((Y1-Y2)**2))
2 M2 (P2 to P3)	COMPUTE M2=SQRT(((X3-X2)**2)+((Y#-Y2)**2))
3 M3 (P3 to P4)	COMPUTE M3=SQRT(((X4-X3)**2)+((Y4-Y3)**2))
4 M4 (P4 to P5)	COMPUTE M4=SQRT(((X5-X4)**2)+((Y5-Y4)**2))
5 M5 (P3 to P5)	COMPUTE M5=SQRT(((X5-X3)**2)+((Y5-Y3)**2))
6 M6 (Length of point)	COMPUTE M6=Y7
7 M7 (Width of point)	COMPUTE M7=2*X5

Variable	Angle Equations (Measured from horizontal)
8 A1 (P1 to P2)	COMPUTE A1=ATAN((Y2-Y1)/(X2-X1))
9 A2 (P2 to P3)	IF(X2 EQ X3 AND Y2 EQ Y3) A2=(((1.57+A1)-((ABS(A1- 3))/2)))
	IF(X2 EQ X3 AND Y2 NE Y3) A2=1.57
	IF(X2 LT X3) A2=ATAN((Y3-Y2)/(X3-X2))
	IF(X2 GT X3) A2=3.14+ATAN((Y3-Y2)/(X3-X2))
10 A3 (P4 to P3)	IF(X3 EQ X4) A3=1.57
	IF(X3 GT X4) A3=ATAN((Y3-Y4)/(X3-X4))
	IF(X3 GT X4) A3=ATAN((Y3-Y4)/(X3-X4))-3.14
11 A4 (P4 to P5)	IF(X4 EQ X5) A4=1.57
	IF(X4 LT X5) A4=ATAN((Y5-Y4)/(X5-X4))
	IF(X4 GT X%) A4=3.14+ATAN((Y5-Y4)/(X5-X4))
12 A5 (P3 to P5)	IF(X3 EQ X5) A5=1.57
	IF(X3 LT X5) A5=ATAN((Y5-Y3)/(X5-X3))
	IF(X3 GT X5) A5=3.14+ATAN((Y5-Y3)/(X5-X3))
13 A6 (Compilation of notch angles)	COMPUTE A6=A3+A4+A5

[a]. adapted from Holmer(1978:11).
/=division, *=multiplication, +=addition, -=subtraction, **=exponenation, COMPUTE=variable transformation by means of arithmetic expression, IF=variable transformation with conditional assignment, ABS=absolute value, ATAN=arctangent, SQRT=square root, EQ=equal to, NE=not equal to, LT=less than, GT=greater than.

Projectile Point Classification

The initial cluster analysis identified eight morphological groups of projectile points ranging from small side-notched to large stemmed and shouldered points. Upon visual inspection of these groups 22 historical types of points were identified (Table 2). These 22 projectile point types were then analyzed using a discriminant analysis, with the projectile points being retyped according to the results of the discriminant analysis. This procedure continued until a 92 % correct classification level of projectile point types was achieved (Table 3). A cluster analysis graphically displaying the results of the discriminant analysis is presented in Figure 8. This dendrogram shows the relationship between the eight morphological groups of projectile points.

Projectile Point Group 1

Group 1 contained small projectile points with notching from the side or slightly from the corner. The base of the points ranged from rectangular to expanding. The projectile point types within this group consisted of two types representing variants of small side-notched points and a third type representing a small expanding stem variant.

Type 1 (Desert Side-notched variant 1), (n=7) was a small side-notched variety similar to the Desert Side-notched form from the Great Basin (Figure 9). The equivalent form from the Columbia Plateau would be the Plateau Side-notched. The Desert Side-notched projectile point type (Heizer and Baumhoff 1961; Heizer and Hester 1978; Thomas 1981) ranges in dates from 1500 BP to historic times in the Great Basin, while the Plateau Side-notched variety also ranges in dates from approximately 1500 BP to historic times (Nelson 1969; Lohse 1984). This point type has a wide distribution across western North America.

Table 2. Projectile Point Groups and Type Descriptions

Group	Type	Projectile Point Description
1	1	Small side-notched with a rectangular base. Desert Side-notched.
1	2	Small side-notched with an indented rectangular base. Desert tri-notched.
1	3	Small side-notched to slightly corner-notched with an expanding stem and contracting base. Rosegate variant or Columbia Valley Lateral Barbed.
2	5	Small basal-notched to corner-notched with a straight to expanding stem. Columbia Pin Stem.
3	4	Medium side-notched to slightly corner-notched with a rectangular base. Northern Side-notched variant.
3	9	Medium side-notched with only one notch and expanding base. Northern Side-notched variant.
3	10	Medium side-notched with an expanding convex base. Northern Side-notched variant.
3	11	Medium side-notched to corner-notched with a straight to expanding stem and an indented base. Gatecliff Split Stem.
3	12	Medium side-notched to corner-notched with a straight to expanding stem. Rosegate variant.
4	6	Medium corner-notched with a straight to expanding stem. Rosegate variant.
4	7	Medium corner-notched with an expanding stem and straight base. Elko Corner-notched variant.
4	8	Medium side-notched with a rectangular base. Northern Side-notched variant.
4	13	Medium corner-notched with an expanding stem and slightly indented base. Elko Eared (Elko Corner-notched variant).
4	14	Medium corner-notched with an expanding stem and straight to slightly concave base. Elko Corner-notched variant.
4	15	Medium side-notched to corner-notched with a contracting stem forming a pointed base. Gatecliff Contracting Stem.

Table 2. (Continued)

Group	Type	Projectile Point Description
5	16	Large basal to slightly corner-notched with an expanding stem and a straight base. Elko Corner-notched variant.
6	18	Large corner-notch with an expanding stem and straight to slightly concave base. Elko Corner-notched variant.
7	19	Large side-notch with a rectangular base. Northern Side-notched variant.
8	17	Large shouldered with a straight stem and a straight to slightly indented base. Windust variant.
8	20	Large stemmed to shouldered with straight to expanding stem and a straight to slightly concave base. Mahkin Shouldered.
8	21	Large shouldered with an expanding stem and straight base. Windust variant.
8	22	Large lance to slightly shouldered with an indented base. Black Rock Concave Base.

Table 3. Classification Results of Projectile Point Discriminant Function Analysis [a]

Group	N[b].	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Predicted Projectile Point Type Group Membership[c]																					
1	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		100%																					
2	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			100%																				
3	21	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				100%																			
4	18	0	0	0	15	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
					83.3%					11.1%										5.6%			
5	15	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						100%																	
6	30	1	0	0	0	2	26	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		3.3%				6.7%	86.7%			3.3%													
7	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								100%															
8	18	0	0	0	0	0	0	0	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0
									94.4%	5.6%													
9	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
										100%													
10	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
											100%												
11	14	0	0	1	0	0	0	0	0	0	0	12	1	0	0	0	0	0	0	0	0	0	0
				7.1%								85.7%	7.1%										
12	16	0	0	0	0	0	0	0	0	1	0	0	12	0	0	2	0	0	0	0	1	0	0
										6.3%			75.0%			12.5%					6.3%		
13	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
														100%									
14	45	0	0	0	0	0	0	0	3	0	1	0	1	0	40	0	0	0	0	0	0	0	0
									6.7%		2.2%		2.2%		88.9%								

Table 3 (Continued)

Group	N[b].	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Predicted Projectile Point Type Group Membership[c]																					
15	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
																100%							
16	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	0
																	87.5%			12.5%			
17	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
																		100%					
18	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	0
																			100%				
19	31	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	30	0	0	0
										3.2%										96.8%			
20	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
																					100%		
21	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
																						100%	
22	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
																							100%

[a] Graphic representation of the results of the Discriminant Function analysis. This table shows the total correct group classifications for all the projectile points measured. This indicates that 93.16% of the cases were correctly classified within 22 projectile point type categories.

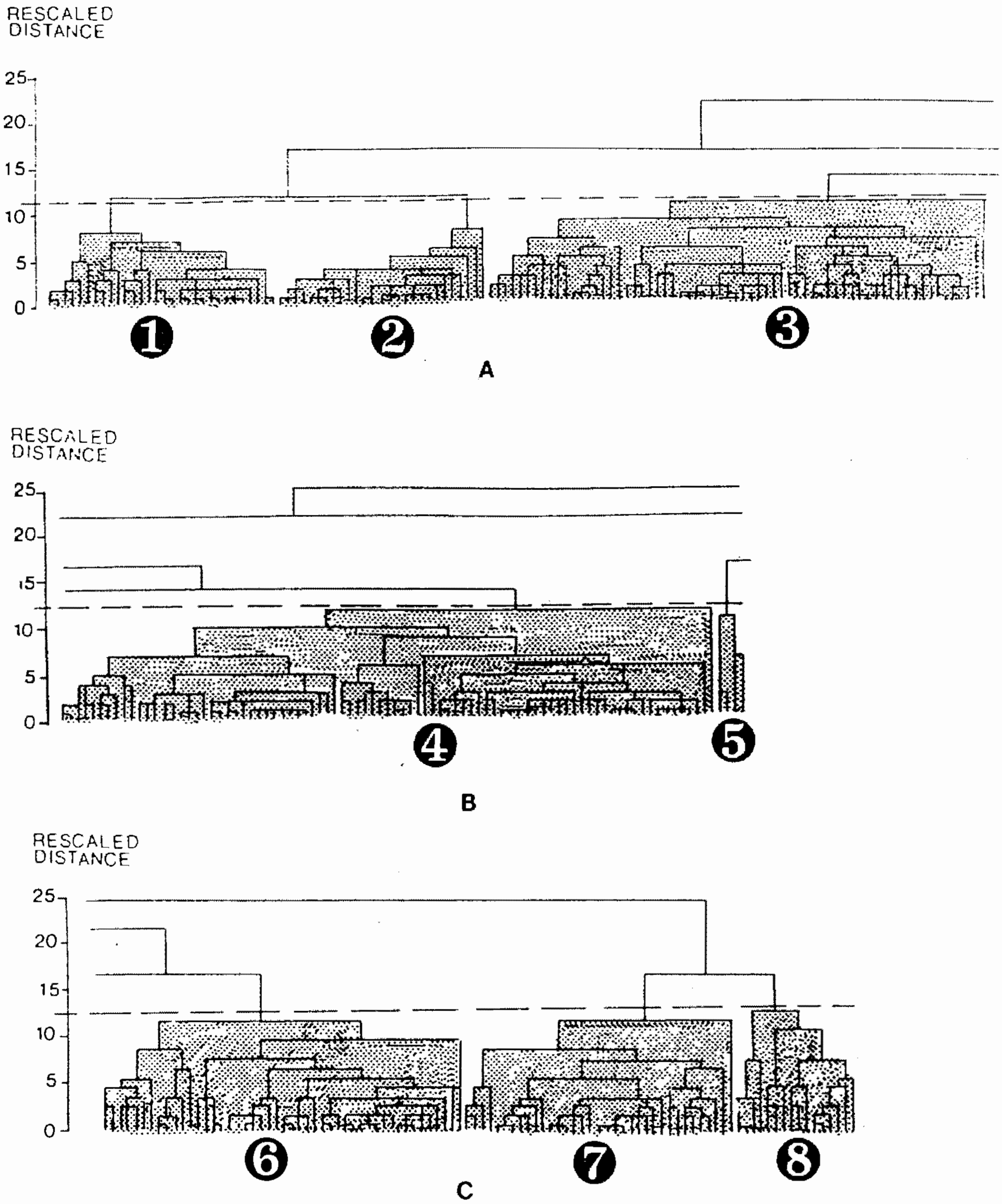
[b] N=the number of cases measured within each group.

[c] Total number of cases within each group and the percentage of individual projectile point types that were classified with each group.

Figure 8. Cluster Analysis of Central Oregon Projectile Points'.

A. Morphological groups 1, 2, and 3.
B. Morphological groups 4, and 5
C. Morphological groups 6, 7, and 8.

This cluster analysis is based upon an analysis of 307 projectile points, using a squared Euclidean, clustering measure, and a complete clustering linkage. It is meant only as a graphic representation of the similarities between the projectile points. The shaded areas of the dendrogram represent morphological groups or clusters and the numbers below the dendrogram identify the groups. The dendrogram is read left to right with vertical lines denoting joined clusters. Parts A, B, and C belong to the same analysis, with B attached on the right hand edge of A, and C on the right hand edge of B. The horizontal dotted line represents the distance at which the clusters are joined. It has been rescaled to fall within a range of 1 to 25.


RESCALED DISTANCE
25
20
15
10
5
0
1
2
3
A
RESCALED DISTANCE
25
20
15
10
5
0
4
5
B
RESCALED DISTANCE
25
20
15
10
5
0
6
7
8
C

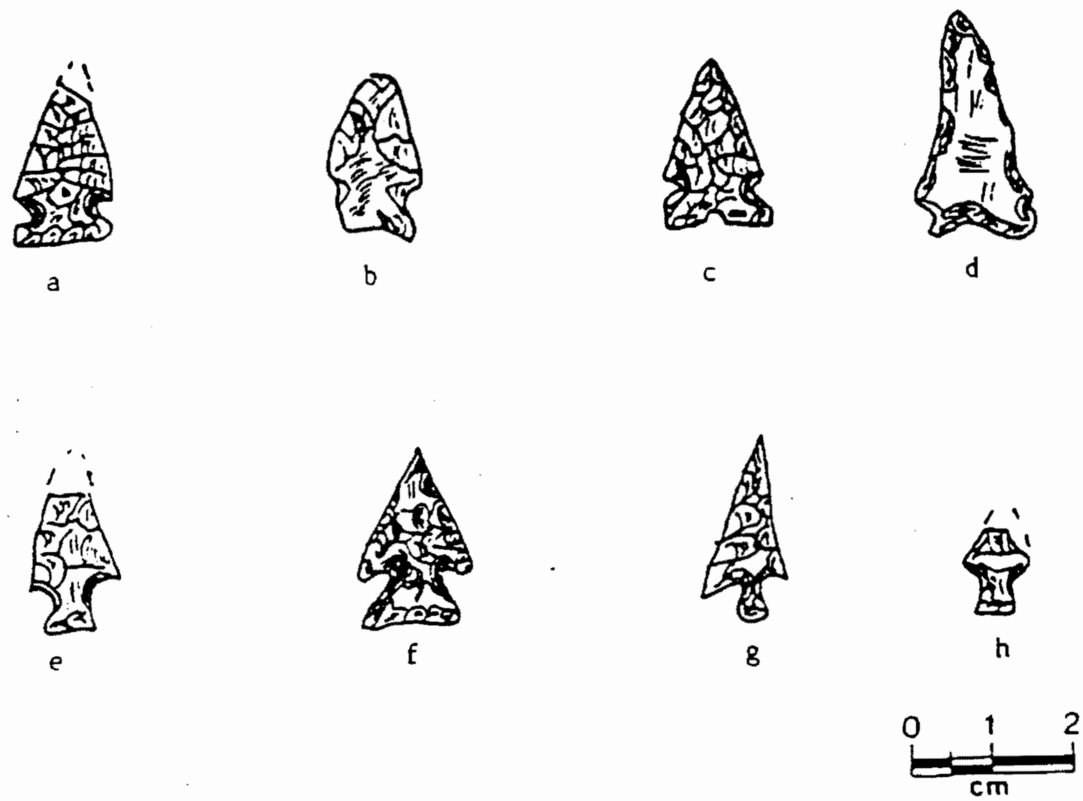


Figure 9. Central Oregon projectile points: types 1, 2, and 3. Type 1: a, b; Type 2: c, d; Type 3: e, f, h.

Projectile point Type 2 (Desert Side-notched variant 2), (n=5) was a small side-notched variety with a notch in the base (see Figure 9). This type is similar in form to the Great Basin Desert Side-notched point, with the addition of the notch in the base. This point type has been referred to as a Desert tri-notched point in the Great Basin with a time range of 500 BP to historic times (Holmer 1986). There is no precisely named equivalent point type in the Columbia Plateau but Type 2 is closely related to the Columbia Plateau side-notched points.

Type 3 (Rosegate variant 1), (n=21) consisted of a small side-notched to slightly corner-notched variety with straight to slightly expanding stems and flat to contracting bases (see Figure 9). This point type is similar to the Rose Spring Side-notched points of the Great Basin, and the Columbia Corner-notched points of the Columbia Plateau. The time period of the Rose Spring point type extends from approximately 1500 BP to historic times. The equivalent point type from the Columbia Plateau is the Columbia Corner-notched type B, (Lohse 1984) with a temporal distribution of 2000 to 150 BP.

Projectile Point Group 2

Group 2 included small corner to basal-notched points of a stemmed and expanding stemmed variety. The second group contained exclusively projectile point Type 5.

Type 5 (Columbia Pin Stem), (n=15) was a small basal notched variety commonly referred to as a Columbia Stemmed type A (Figure 10). The temporal distribution of this point on the Columbia Plateau is from approximately 2000 to 150 BP (Lohse 1984). There is no equivalent type in the Great Basin. Type 5 is similar to the Gunther Barbed type of the Oregon-California coastal zone with a temporal distribution of 1500 BP to historic times.

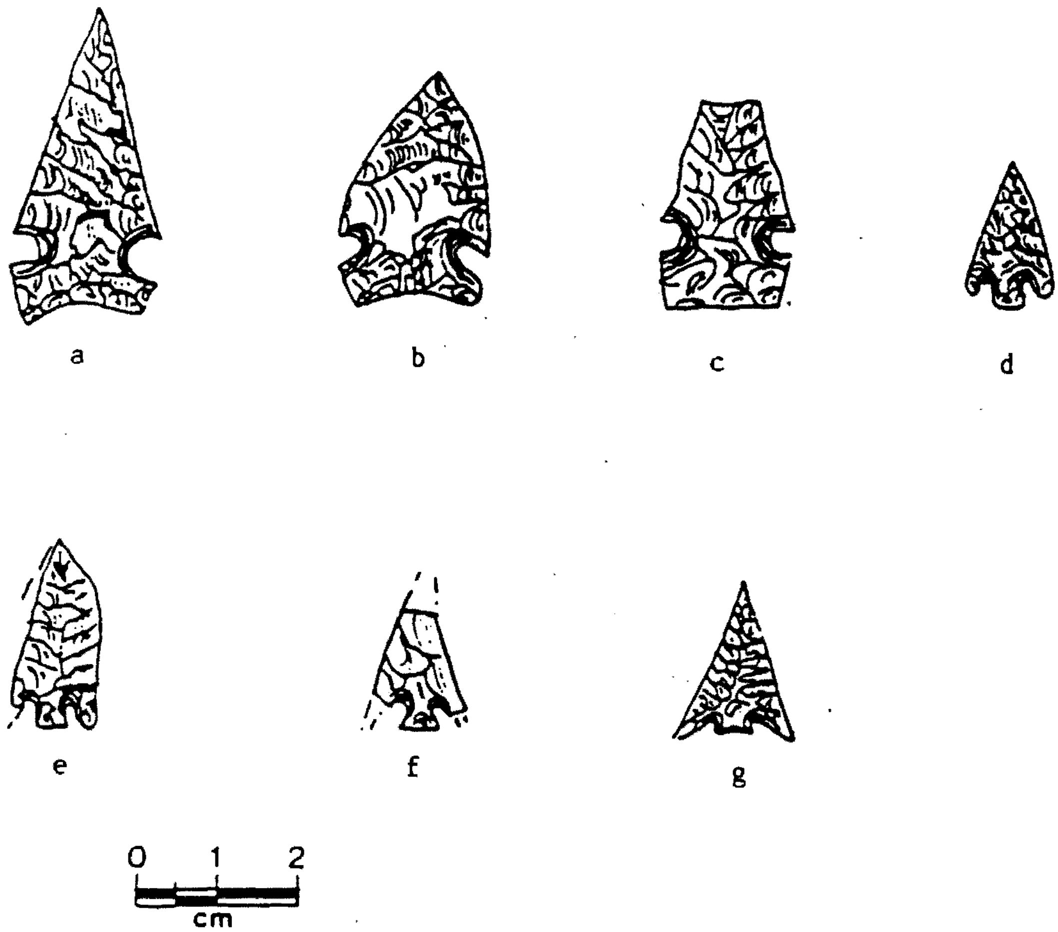


Figure 10. Central Oregon projectile points: types 4, and 5. Type 4: a, b, c; Type 5: d, e, f, g.

Projectile Point Group 3

Group 3 included predominantly medium side-notched to slightly corner-notched points with straight to expanding stems and rectangular to expanding bases. Included within this group were medium sized lanceolate indented base points. The projectile point types within the third group consisted of three variants of medium side-notched points, two variants of expanding stem points (one type with an indented base, and one with a flat base), and a variant of a lanceolate indented base point. The third group contained projectile point types 4, 9, 10, 11, 12, and 13.

Type 4 (Northern Side-notched variant 1), (n=17) was a medium side-notched variety commonly referred to as Northern Side-notched (see Figure 10). In the Great Basin this point type has a temporal distribution from 5000 BP to 7000 BP (Wilde 1985). On the Columbia Plateau the equivalent type is Cold Springs Side-notched, with a temporal range from approximately 3500 to 7000 BP (Lohse 1984).

Type 9 (Northern Side-notched variant 2), (n=5) was a medium side-notched variety containing only one notch. It is probably a Northern Side-notched variant (Figure 11).

Type 10 (Northern Side-notched variant 3), (n=2) was a medium side-notched variety with a convex base. This type, again, is probably related to Northern Side-notched (see Figure 11).

Type 11 (Gatecliff Split Stem), (n=14) was a medium sized projectile point with notching from the side (shouldered) with an indented base. This form has been referred to as a Gatecliff Split Stem projectile point in the Great Basin (see Figure 11). It has a time frame from 2600 BP to 5300 BP (Thomas 1981). There is no equivalent type on the Columbia Plateau.

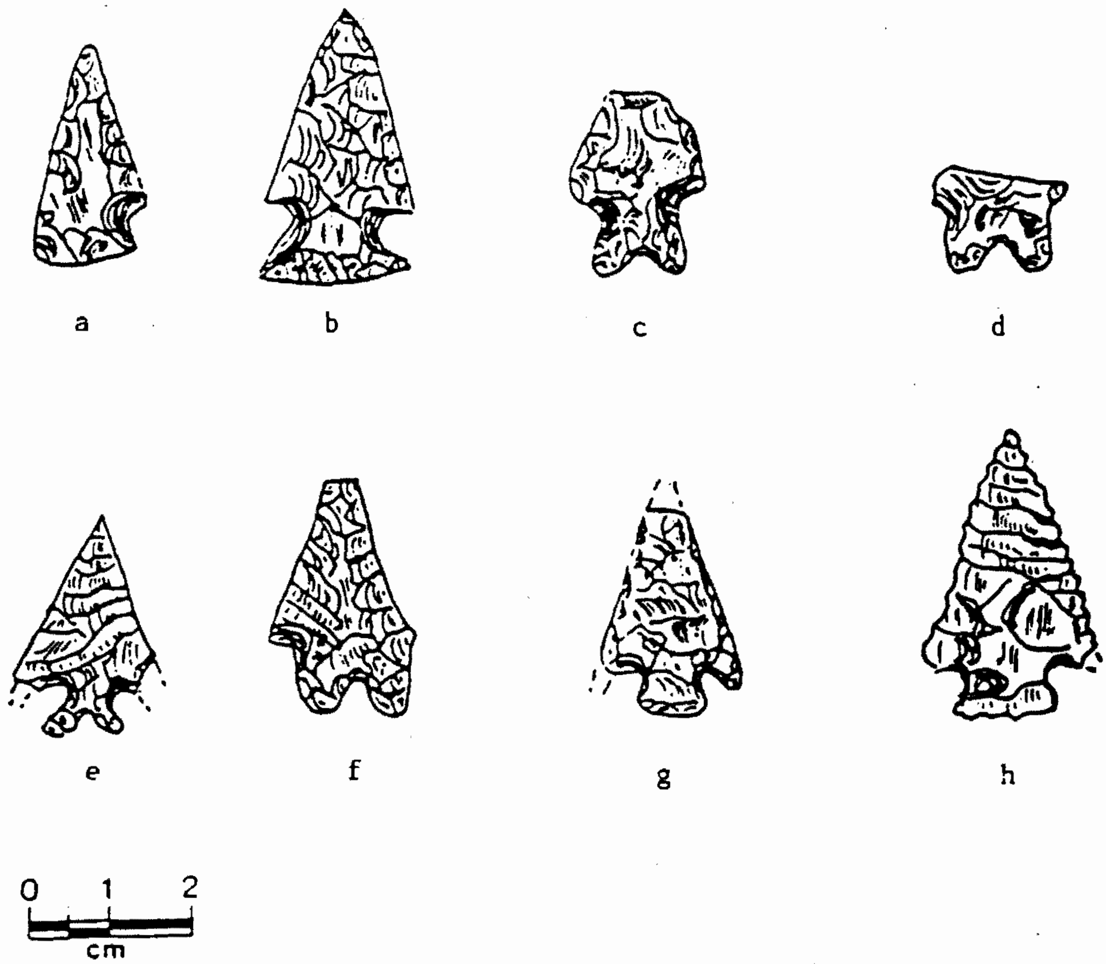


Figure 11. Central Oregon projectile points: types 9, 10, 11, and 12. Type 9: a; Type 10: b: Type 11: c; d, e, f; Type 12: g, h.

Type 12 (Rosegate variant 2), (n=16) was a medium sized stemmed projectile point, with notching from the side. The stem of the projectile point ranged from straight to slightly expanding (see Figure 11). The form is similar to the Rabbit Island Stemmed variety of the Columbia Plateau. The temporal range of this form is from 2000 to 4000 BP (Lohse 1984). There is no equivalent form in the Great Basin but it appears most similar to the Rose Spring type point.

Type 13 (Humboldt), (n=2) was a medium sized lanceolate point with a concave base (see Figure 13). In the Great Basin this type has been referred to as a Humboldt Concave base type. Its temporal range is from 2000 to 7000 BP (Holmer 1986). There is no equivalent form on the Columbia Plateau.

Projectile Point Group 4

Group 4 included medium corner-notched to slightly side-notched points with straight, expanding and contracting stems, and expanding to slightly rectangular bases. Included within this group were contracting stem points. The projectile points within this group consisted of one corner-notched type with a straight to slightly expanding stem, four corner-notched types with expanding stems, and one corner-notched to shouldered type with a contracting stem. The third group contained projectile point types 6, 7, 8, 14, and 15.

Type 6 (Rosegate variant 3), (n=30) was a medium sized corner-notched variety with a straight to slightly expanding stem (Figure 12). In the Great Basin this point type is commonly referred to as a Rose Springs Corner-notched variety, which has a temporal distribution of 220 to 2800 BP (Heizer and Hester 1978). On the Columbia Plateau the equivalent projectile point type is a Columbia Corner-notched, with a temporal distribution from 0 to 2000 BP (Lohse 1984).

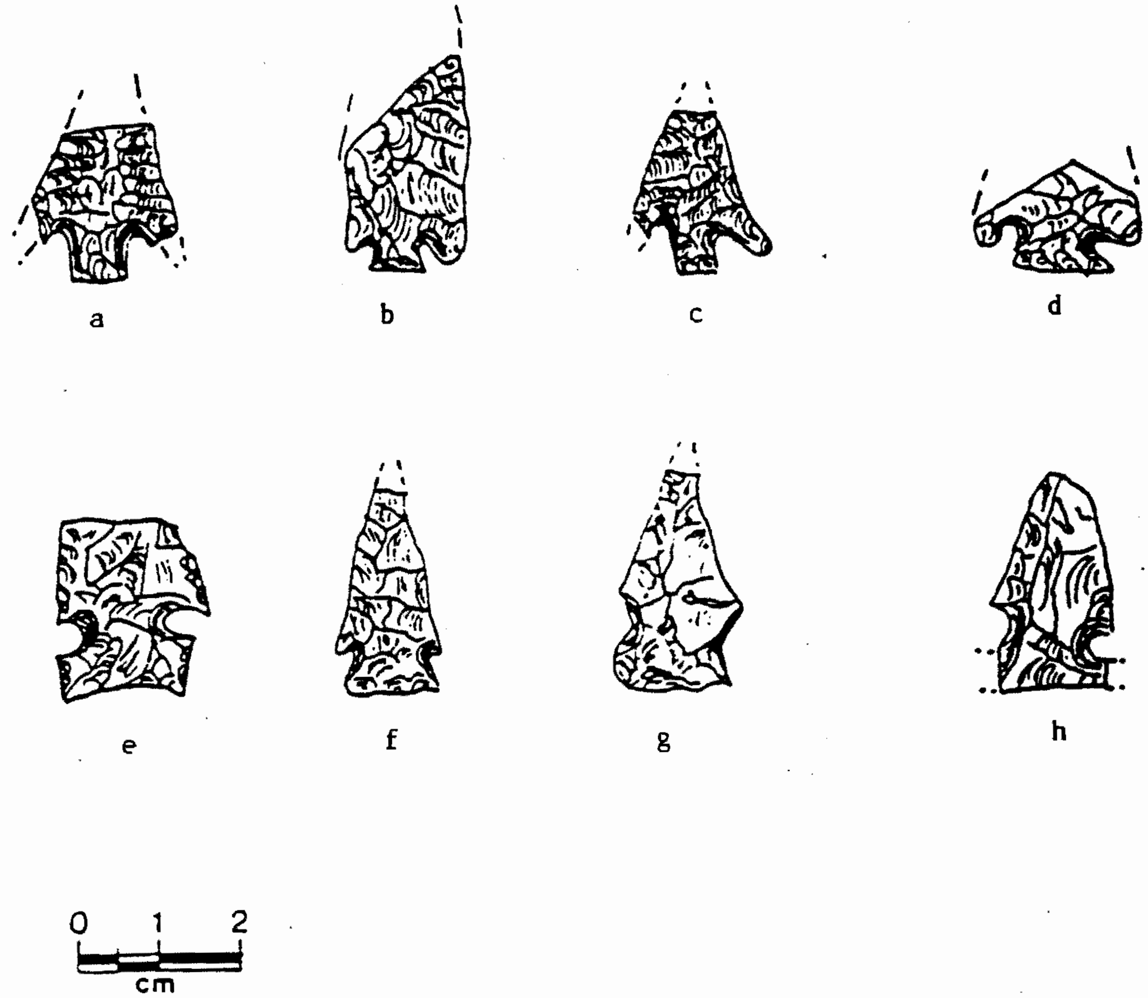


Figure 12. Central Oregon projectile points: types 6, 7, and 8. Type 6: a, b, c; Type 7: d; Type 8: e, f, g, h.

Type 7 (Elko Corner-notched variant 1), (n=3) was a medium sized corner-notched variety with an expanding stem (see Figure 12). It is similar to the Elko Corner-notched projectile points found in the Great Basin. In the Great Basin this point has a temporal range from 800 to 7000 BP (Wilde 1985). On the Columbia Plateau its equivalent is the corner-notched Quilomene Bar type. This has a temporal distribution from approximately 2000 to 3000 BP (Lohse 1984).

Type 8 (Elko Corner-notched variant 2), (n=18) was a medium sized corner-notched to slightly side-notched variety with a slightly rectangular to expanding base (see Figure 12). This is similar to the Elko Corner-notched type with a temporal distribution in the Great Basin from approximately 800 to 7000 BP (Holmer 1980). The Columbia Plateau equivalent of this form would be the Columbia Corner-notched type A. This has a temporal range of 2000 to 4000 BP (Lohse 1984).

Type 14 (Elko Corner-notched variant 3), (n=45) was a medium sized corner-notched point form with an expanding stem, and flat to slightly concave base (Figure 13). In the Great Basin this form has been referred to as an Elko Corner-notched type with a temporal distribution from 800 to 7000 BP (Holmer 1986). There is no equivalent form on the Columbia Plateau.

Type 15 (Gatecliff Contracting Stem), (n=8) was a medium sized slightly shouldered to corner-notched point with a contracting stem (see Figure 13). In the Great Basin this kind of point has been referred to as Gatecliff Contracting Stem with a temporal distribution from 2400 to 3700 BP (Thomas 1981). On the Columbia Plateau it resembles a Rabbit Island Stemmed point with a temporal distribution from 2000 to 4000 BP (Lohse 1984).

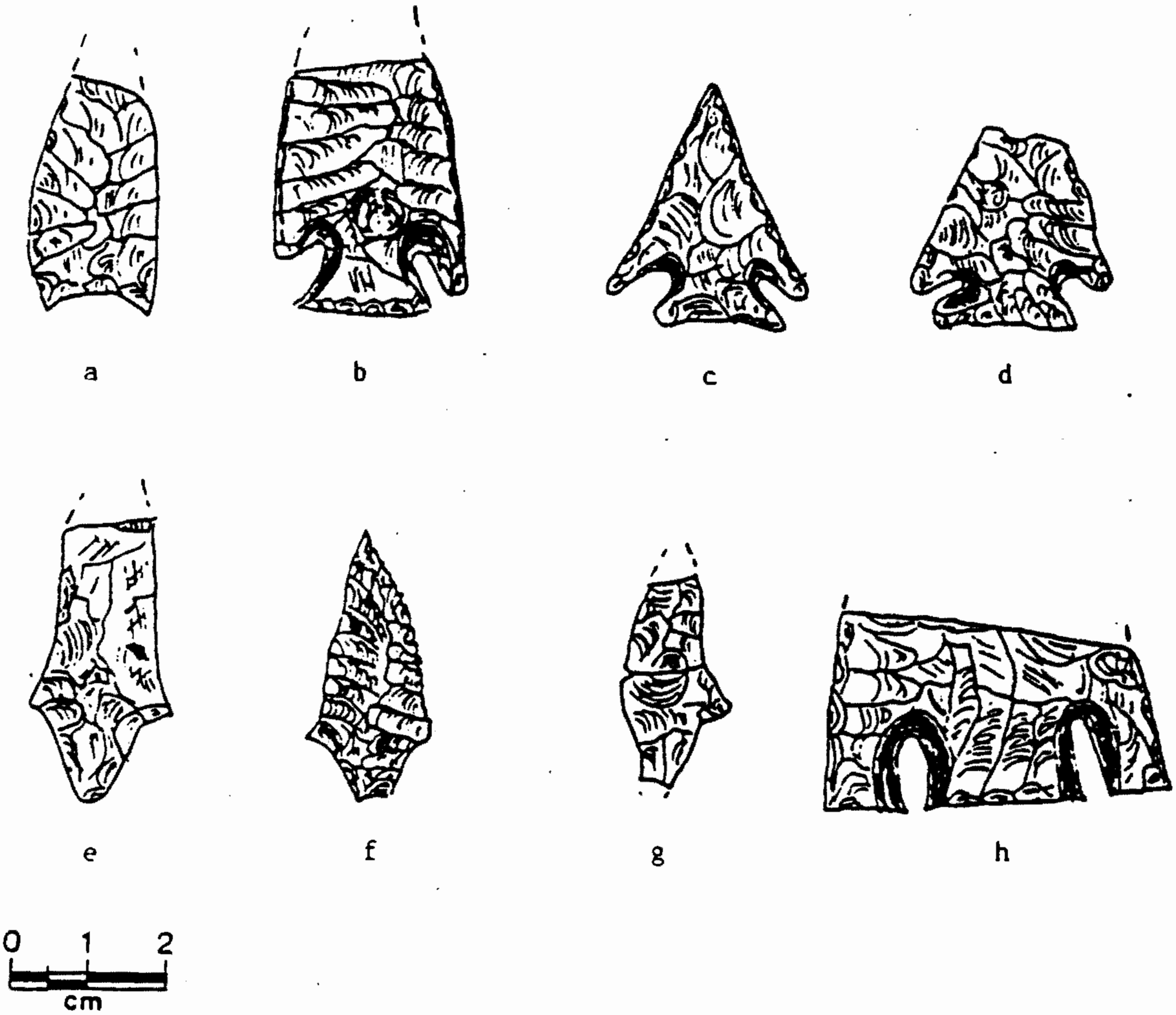


Figure 13. Central Oregon projectile points: types 13, 14, 15, 16. Type 13: a; Type 14: b, c, d; Type 15: e, f, g ; Type 16: h.

Projectile Point Group 5

Group 5 contained large basal to slightly corner-notched points, and was exclusively composed of Type 16 (see Figure 13). Type 16 (Elko Corner-notched variant 4), (n=7) was a large basal-notched projectile point form with tangs that extended to the base of the point. The broad stem of the point was straight to slightly expanding. There is no equivalent form in the Great Basin although it may be an Elko Corner-notched variant. The closest style point it may be related to on the Columbia Plateau is the Columbia Basal-notched type with a temporal distribution of 2000 to 3000 BP (Lohse 1984).

Projectile Point Group 6

Group 6 contained points of a large corner-notched variety, with straight to expanding stems, and straight to slightly concave bases. This group was comprised exclusively of projectile point Type 18 (Figure 14). Type 18 (Elko Corner-notched variant 5), (n=39) is similar to the Columbia Corner-notched type (Lohse 1984), while in the Great Basin typology this form is similar to an Elko Corner-notched projectile point. The temporal distribution of this form is from 800 to 7000 BP (Lohse 1984, Thomas 1981).

Projectile Point Group 7

Group 7 included large side-notched projectile points with rectangular bases, and was composed exclusively of projectile point Type 19 (see Figure 14). Type 19 (Northern Side-notched variant 4), (n=32) was a large side-notched form, and is a variant of the Northern Side-notched type. The temporal distribution of this point in the Great Basin is 5000 to 7000 BP

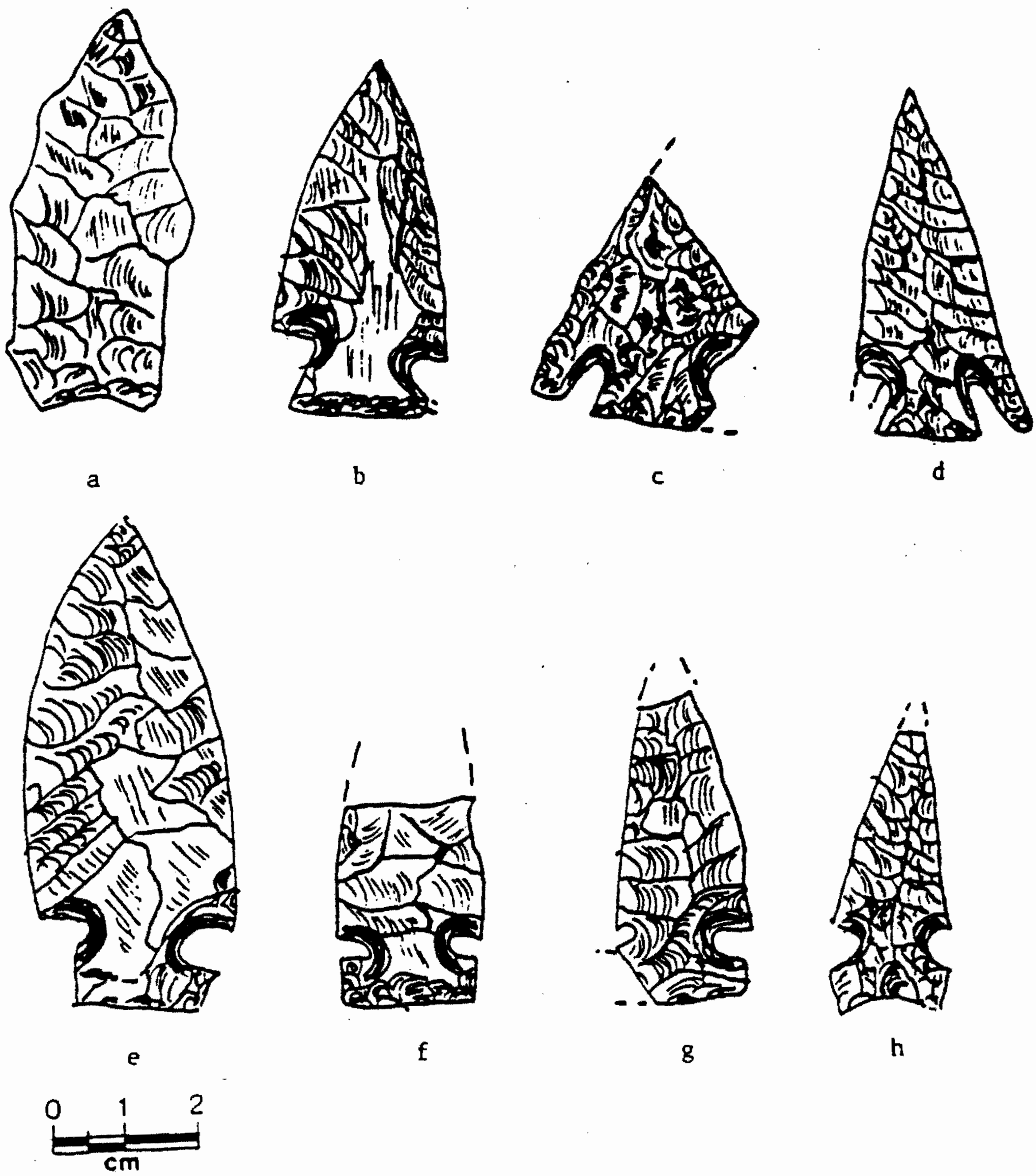


Figure 14. Central Oregon projectile points: types 17, 18, and 19. Type 17: a; Type 18: b, c, d; Type 19: e, f, g, h.

(Wilde 1985). On the Columbia Plateau this type is similar to the Cold Springs points which have a temporal distribution from 3500 to 7000 BP (Lohse 1984).

Projectile Point Group 8

Group 8 contained points that were large shouldered to stemmed with indented to non-indented bases. Two of the types were variants of shouldered points with indented to straight bases. One type was a variant of a stemmed to shouldered base point with a concave base, and one type was a lance to slightly shouldered variety with a concave base. Group eight consisted of projectile point types 17, 20, 21, and 22.

Type 17 (Windust variant 1), (n=2) was a large shouldered variety, one specimen of which had an indented base, and one specimen of which was stemmed (see Figure 14). This style point is similar to the Windust form, with a temporal distribution in the Great Basin and the Columbia Plateau of 7000 to 10,000 BP (Wilde 1985).

Type 20 (Windust variant 2), (n=12) was a large stemmed to shouldered variety with a wide stem, and straight to slightly concave base (Figure 15). No equivalent types are found in the Great Basin, but may be similar to a Windust type with a temporal distribution of 7000 to 10,000 BP (Wilde 1985). The type is most similar to the Mahkin shouldered points of the Columbia Plateau. These have a temporal distribution of approximately 3500 to 7000 BP (Lohse 1984).

Type 21 (Windust variant 3), (n=3) was a large shouldered variety with a straight base (see Figure 15). This is similar to the Windust points of the Columbia Plateau and the Great Basin, which have a temporal distribution from 7000 to 10,000 BP (Wilde 1985).

Type 22 (Black Rock Concave Base), (n=3) was a large lanceolate to slightly shouldered variety with a narrower base than type 21 (see Figure 15). This type is similar to the Black Rock

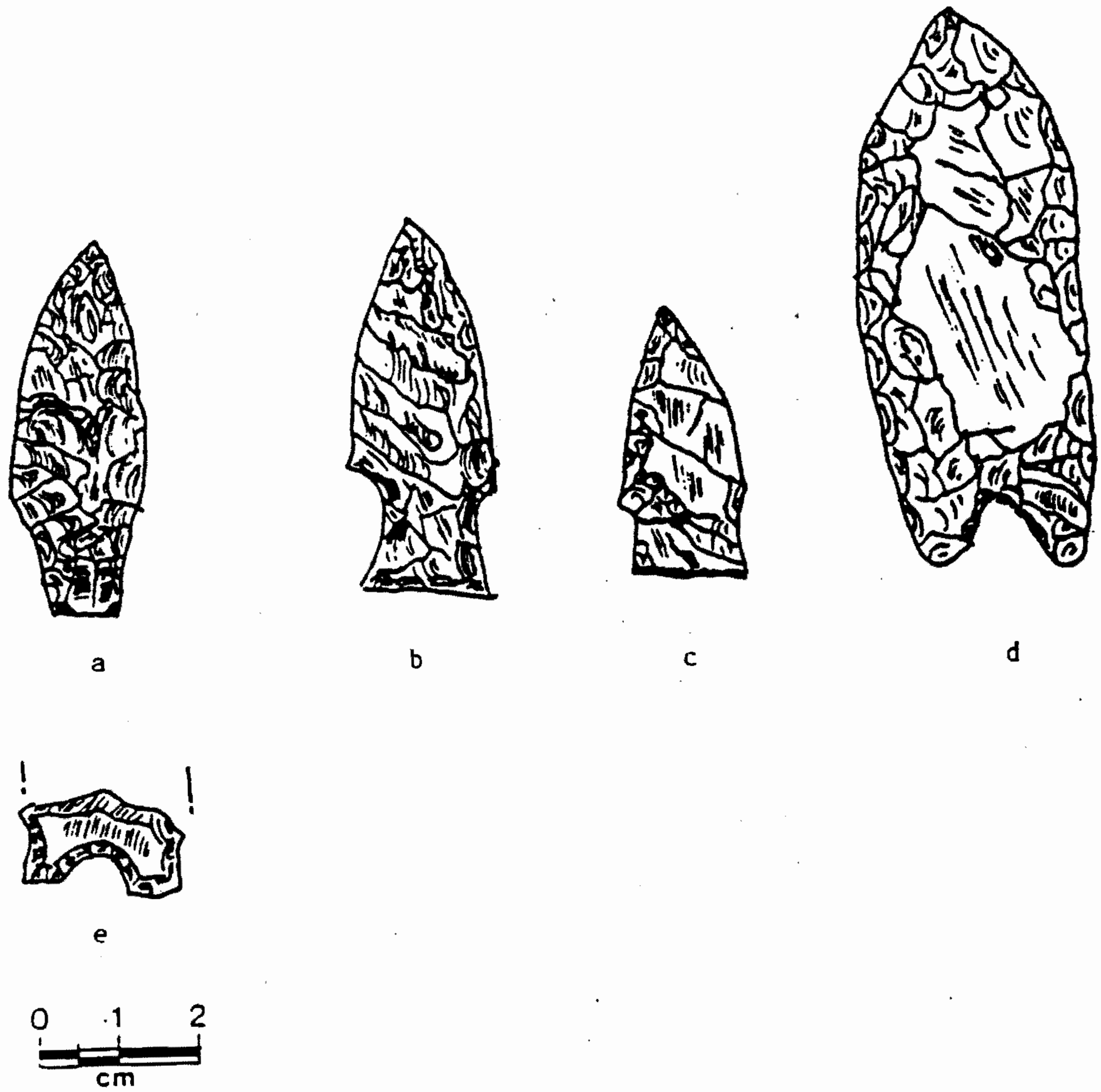


Figure 15. Central Oregon projectile points: types 20, 21, and 22. Type 20: a; Type 21: b, c; Type 22: d, e.

Concave Base type of the Great Basin with a temporal distribution from 2500 to 5000 BP (Wilde 1985). There is no equivalent form on the Columbia Plateau.

Projectile Point Type Inter-Relationships

A discriminant function analysis was used to compare the projectile point groupings. The classification results table (see Table 3) indicate that 92% of the projectile points were placed within the type containing the highest discriminant function score, or that there is a 92 % probability that the 22 types of projectile points are correctly classified. This result indicates that the projectile point measurements contain significant data for classifying the forms of projectile points.

An F statistic was used to compare the autonomy of the proposed types by testing the hypothesis that two types of data (projectile point type measurements) are equal. F statistics were computed between each projectile point type and the results are presented in Table 4. An F statistics of greater than 1.78 (with 12 and 274 degrees of freedom) was deemed necessary to accept the hypothesis that the projectile point type measurements were autonomous (different). All but three types were significantly different at the .05 level.

Types 9, 11, and 13, however, had F values less than 1.78. Type 11 split stem projectile points (Gatecliff Split Stem) contain similar means to Type 13; Concave Base points (Humboldt), and Type 9 single notched points with slightly indented bases. All three of these types, however, were classified within Group 3. The similarity of Humboldt and split stemmed projectile points has been noted previously by Clelow (1967) and verified by Holmer (1978). Except for this ambiguity comparison of all other projectile point types identified F values greater than 1.78,

Table 4. F Statistic Between Pairs of Types After 12 Discriminant Steps and Canonical Functions[a]

Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1																						
2	6.51																					
3	6.24	12.23																				
4	4.82	9.28	13.71																			
5	12.54	21.97	11.81	29.37																		
6	10.96	20.27	8.54	24.57	5.70																	
7	4.38	10.62	6.90	8.34	3.07	4.33																
8	5.51	13.40	8.57	5.74	22.27	13.24	7.11															
9	3.85	9.29	6.08	2.93	13.04	8.59	7.64	3.20														
10	3.58	6.76	3.98	2.12	6.01	4.56	4.20	2.91	2.01													
11	12.05	9.69	13.57	12.06	23.39	19.23	9.09	10.84	6.57	4.70												
12	9.41	17.12	8.16	11.99	17.19	8.61	7.55	4.62	3.95	3.11	10.47											
13	5.01	7.02	4.48	3.50	7.58	4.99	5.64	2.79	1.74	2.09	1.56	1.99										
14	11.40	14.98	12.92	15.08	22.97	12.61	6.72	8.42	7.32	3.52	12.37	10.77	3.96									

Table 4. (Continued)

Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
15	13.91	21.81	12.56	15.57	15.89	8.99	8.65	7.72	7.44	5.06	14.27	4.44	3.58	12.04								
16	28.48	35.59	42.08	31.24	28.48	35.59	42.08	31.24	16.59	9.68	33.12	24.92	10.07	26.88	16.97							
17	21.52	24.58	25.07	19.10	21.52	24.58	25.07	19.10	16.57	10.88	18.61	14.89	8.48	20.85	11.78	14.91						
18	19.33	26.87	36.26	28.23	19.33	26.87	36.26	28.23	10.56	4.78	25.53	17.57	5.27	16.06	10.19	11.79	16.94					
19	10.56	18.99	34.59	8.32	10.56	18.99	34.59	8.32	4.99	3.35	24.40	17.36	4.40	25.90	17.52	19.23	15.94	25.06				
20	18.64	28.11	28.77	20.18	18.64	28.11	28.77	20.18	7.32	4.40	21.37	7.67	2.79	26.44	9.16	17.73	8.97	22.05	14.52			
21	20.44	21.23	23.27	15.99	20.44	21.23	23.27	15.99	9.00	7.52	11.48	15.06	3.69	17.77	14.66	12.74	13.20	15.65	13.92	10.41		
22	11.58	8.32	12.23	8.38	11.58	8.32	12.23	8.38	5.66	5.73	3.40	8.21	2.33	8.97	10.07	12.80	12.86	11.06	9.54	9.47	3.84	

[a] F statistic with 12 and 274 degrees of freedom. F statistics greater than 1.78 are required to reject the null hypothesis that the projectile point groups are similar. Acceptance of the null hypothesis is indicated with an underline.

indicating that their group means are significantly different, and that they represent statistically discrete formal types.

The discriminant function analysis was also used to determine whether the variable measurements are equal. Table 5 ranks the projectile point measurements and their associated F statistics. An F statistic of greater than 1.54 (with 21 and 285 degrees of freedom) was deemed necessary to accept the hypothesis that variable means were significantly different. All the measurements were significant at the 0.5 level, indicating that the mean variable measurements were in fact different. The larger the F statistic the greater the discriminating ability contained in the variable. Thus, measurement 6 (length), and angle 5 (notch angle) are best for determining projectile point group membership, but the results indicate that all the variables are significant.

Chronology

A chronology for the central Oregon Uplands was developed by comparing the historical time distributions for the 22 central Oregon projectile point types with, when possible, their estimated obsidian hydration dates for individual points (see Appendix C) and the known frequency distribution of types over time (Figure 16). The results are similar to previous chronologies developed for the Columbia Plateau (Nelson 1969; Rice 1972; Leonhardy and Rice 1970), and the Northern Great Basin (Aikens et al. 1977; Beck 1984; Bedwell 1973; Jones 1984). More locally, they closely match as well as the chronology developed for the Wildcat Canyon sites (Dumond and Minor 1983) and the greater central Oregon region (Armitage 1983; Minor et al. 1987).

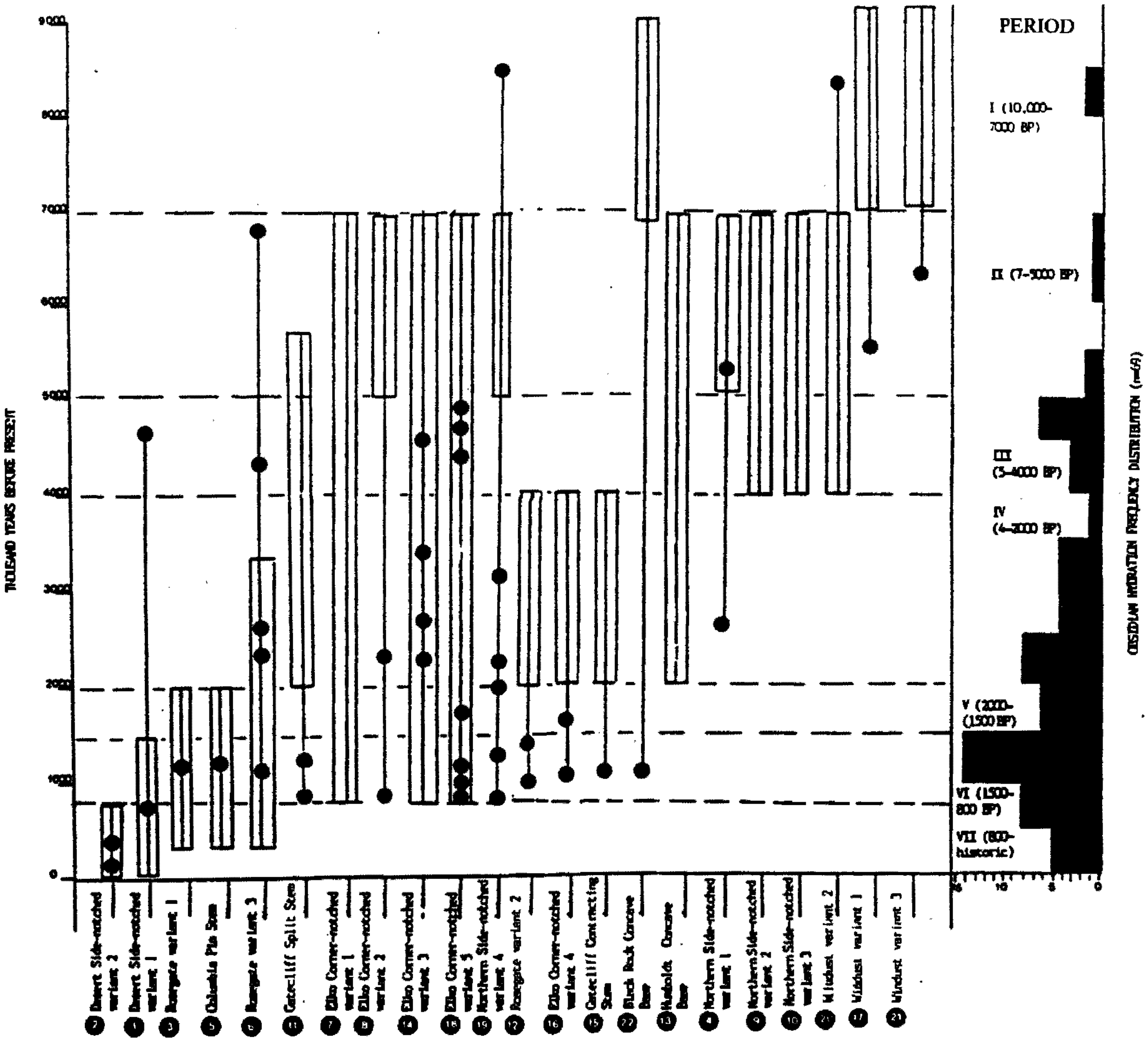
Table 5. Projectile Point Variables and Associated Wilks' Lambda and Univariate F-Ratio [a]

Variable	Wilks' Lambda	F	Significance
M1 (base width)	0.43	17.50	0.00
M2 (base height)	0.49	13.63	0.00
M3 (notch length-lower)	0.54	11.18	0.00
M4 (notch length-upper)	0.43	17.88	0.00
M5 (notch height)	0.42	18.02	0.00
M6 (length)	0.27	36.68	0.00
M7 (width)	0.32	28.75	0.00
A1 (basal indentation angle)	0.38	21.87	0.00
A2 (basal angle)	0.56	10.46	0.00
A3 (lower notch angle)	0.40	20.18	0.00
A4 (upper notch angle)	0.44	16.67	0.00
A5 (entire notch angle)	0.29	32.55	0.00

[a] F statistic with 21 and 285 degrees of freedom.

Figure 16. Graph of Cultural Periods, Time Spans of Projectile Point Types and Obsidian Hydration Rate Frequencies[1].

[1] This graph demonstrates the relation between the historical time span of central Oregon projectile point types, their dates based upon estimated obsidian hydration data, and the obsidian hydration data frequency distribution. The wide vertical bars indicate the historical time distribution for the projectile point types, and the dots represent individual projectile point hydration dates. The obsidian hydration frequency distribition is shown on the far right of the graph and represents a frequency distribution of obsidian hydration analysis of 69 projectile points. The horizontal dotted lines represent cut points for the defined central Oregon cultural periods. At the bottom of the graph are the names and corresponding numbers of the projectile point types.


PERIOD
I (10,000-7000 BP)
II (7-5000 BP)
III (5-4000 BP)
IV (4-2000 BP)
V (2000-1500 BP)
VI (1500-800 BP)
VII (800-historic)
THOUSAND YEARS BEFORE PRESENT
OBSIDIAN HYDRATION FREQUENCY DISTRIBUTION
Desert Side-notched variant 2
Desert Side-notched variant 1
Rosegate variant 1
Columbia Pin Stem
Rosegate variant 3
Gatecliff Split Stem
Elko Corner-notched variant 1
Elko Corner-notched variant 2
Elko Corner-notched variant 3
Elko Corner-notched variant 5
Northern Side-notched variant 4
Rosegate variant 2
Elko Corner-notched variant 4
Gatecliff Contracting Stem
Black Rock Concave Base
Humboldt Concave Base
Northern Side-notched variant 1
Northern Side-notched variant 2
Northern Side-notched variant 3
Windust variant 2
Windust variant 1
Windust variant 3

Obsidian Hydration Dating

Obsidian hydration and characterization analyses were conducted on 48 of the recorded projectile points (see Appendix C). These points represented 16 of the 22 identified types. Based upon obsidian and radiocarbon dates recovered from the Wind Creek sites, an experimentally derived hydration rate of 2.98 microns^2 per thousand years was developed for the obsidian from the Whitewater Ridge source, and an estimated average rate of 3.18 microns^2 per thousand years for the other central Oregon obsidian sources (see Appendix C, Table 25). These rates were then applied to the hydration rim thicknesses of a sample of the projectile points to estimate the temporal range of individual types, to determine whether they fell within the established radiocarbon date range for the same projectile point types.

When the relationship between the obsidian hydration rates and the historical time distributions of the projectile point types as established by the radiocarbon dating was examined (see Figure 16) some of the projectile point types appeared to span longer times than generally thought, while other types fell within their expected ranges. The Desert tri-notched (Type 2), Columbia Pin Stem (Type 5), Rosegate variant 1 (Type 3), Elko Corner-notched variant 3 (Type 14), and Elko Corner-notched variant 5 (Type 18) all fell within their expected ranges. All of the Northern Side-notched types, the remaining Elko Corner-notched and Rosegate variants, and the Windust, Gatecliff Split Stem, and Gatecliff Contracting Stem types all appear to show longer time ranges than are generally accepted for them in the Northern Great Basin.

Cultural Periods

Based on the data presented above, a new chronology of human occupation in the central Oregon uplands has been developed. A series of seven periods is described below, each defined by a characteristic set of projectile point types. Available obsidian hydration data for each period are also summarized.

Period I begins approximately 10,000 BP and extends to about 7000 BP (see Figure 16). During this period three variants of Windust points, a Black Rock Concave base type, and one variant of Northern Side-notched points all occur. The Windust points are shouldered with indented bases, the Black Rock type is a lanceolate with an indented base, and the Northern Side-notched variant is a large side-notched projectile point. This period compares to the Philippi phase at Wildcat Canyon (Dumond and Minor 1983), and to Period 6 as defined by Beck (1984) for the Steens Mountain region. It is also equivalent to Minor , Beckham ,Toepel and Greenspan's (1987) Early period. The obsidian hydration analysis indicated that two samples, representing projectile point types 19 and 20, fell within this first period. These two samples had dates of 8200 and 8500 BP, respectively.

Period 2 begins about 7000 BP and extends to approximately 5000 BP. About 7000 BP there is an increase in the variants of side-notched points, the first appearance of large corner-notched points, and the occurrence of small lanceolate to indented base points. The indented base points are referable as Humboldt type, the corner notched points are similar to Elko types, and the side-notched points are referable to the Northern Side-notched type. One variant of the Rosegate type occurred during this period. This period is comparable to the Canyon Phase at Wildcat Canyon (Dumond and Minor 1983), and to Beck's (1984) Period 5 in the Steens Mountain region.

It falls within Minor, Beckham, Toepel, and Greenspan's (1987) Middle period. Four obsidian hydration dates of 6700, 6400, 5400, and 5300 BP were obtained from projectile points assigned to this period. Point types 6, 4, 17, and 21 were represented by these dates.

Period 3 begins about 5000 BP and extends to about 4000 BP. All the point types found in Period 2 (with the exception of Windust variants 1 and 3) continue through this period. Additions include shouldered indented base points (Gatecliff Split Stemmed), and a small side-notched type of point (Desert Side-notched variant 1). This period is falls within Beck's (1984) Period 5, and is similar to Jones' (1984) Period 3B for the Steens Mountain area. No occupation periods defined from Wildcat Canyon fall within this range. This period also falls within Minor, Beckham, Toepel, and Greenspan's (1987) Middle period for central Oregon. Six obsidian hydration dates of 4800, 4700, 4600, 4600, 4500, and 4400 BP were obtained for this period, representing point types 1, 6, 14, and 18.

Period 4 begins about 4000 BP and extends through 2000 BP. About 4000 BP two variants of Northern Side-notched points and the last variant of Windust points disappear, while all the corner-notched and indented base points continue (Humboldt, Black Rock Concave base, and Gatecliff Split Stemmed). Appearing about 4000 BP are a large basal to corner-notched type (Type 16), a contracting stem (Gatecliff Contracting Stem) type (Type 15), and a medium sized stemmed point (Rosegate variant 2). This period is similar to Beck's (1984) Period 4, and extends into the third phase of the Wildcat Phase at Wildcat Canyon (Dumond and Minor 1983). This falls within Minor, Beckham, Toepel, and Greenspan's (1987) Middle period. Nine obsidian hydration dates were obtained on points assigned to this period, representing types 6, 8, 14, 19, and 4.

Period 5 begins about 2000 BP and extends through 1500 BP. This short period begins with the disappearance of Humboldt type points, and the first appearance of a Rosegate variant type (Type 3), and Columbia Pin Stem points (Type 5). All other point types from the previous period continue through this period. The end of this period is marked by a sharp increase in the number of obsidian hydration dates (see Figure 16). This period is comparable to the second sub-phase of the Wildcat Canyon Phase (Dumond and Minor 1983) and to Jones' (1984) Period 5 Steens Mountain area. This period falls within Minor, Beckham, Toepel, and Greenspan's (1987) Late period. Three obsidian hydration dates of 2000, 1800, and 1800 BP were obtained for this period, representing point types 19, 18, and 16.

Period 6 begins about 1500 BP and extends through 800 BP. About 1000 to 800 BP virtually all the point types of the preceding period disappear, with the exception of Type 1 (Desert Side-notched), Type 3 (Rosegate variant 1), Type 5 (Columbia Pin stem), and Type 6 (Rosegate variant 3). This period is comparable to the first sub-phase of the Wildcat Canyon Phase (Dumond and Minor 1983), and to Jones' (1984) Period 6A for the Steens Mountain area. This period falls within Minor, Beckham, Toepel, and Greenspan's (1987) Late period.. Sixteen obsidian hydration dates were obtained for this period, representing point types 3, 5, 6, 8, 11, 12, 15, 16, 18, 19, and 22. The hydration dates were 1430, 1330, 1330, 1260, 1180, 1150, 1150, 1110, 1080, 1080, 1070, 1040, 1020, and 940 BP.

Period 7 begins about 800 BP and extends into historic times. The beginning of this period is represented by the appearance of Type 2 points (Desert Side-notched variant 2). It is marked by a decrease in the number of obsidian hydration dates, and by 500 BP only Desert Side-notched types of projectile points occur. This period is comparable to the Quinton Phase at Wildcat Canyon and to Jones' (1984) Period 6B for the Steens Mountain region. It falls within Minor, Beckham, Toepel, and Greenspan's (1987) Late Period. Three obsidian hydration dates of 780, 400, and 100 BP were obtained for this period, representing point types 1 and 2.

Projectile Point Occurrences and Co-Occurrences

Of the 307 projectile points classified, 176 (57%) were found in places that contained only a single projectile point. Such discoveries were defined as isolated finds. The remaining 135 projectile points (43%) belonged to sites that contained additional cultural material. Table 6 shows the distribution of projectile points as they occur within archaeological sites, and Table 7 shows the interrelationship between projectile point types found within archaeological sites. As may be seen in these tables the most frequent occurrence is of single projectile point types, indicating that most archaeological sites were related to short term activities. The occurrence of single projectile points at sites is highest among Types 14 (Elko Corner-notched variant 3), 18 (Elko Corner-notched variant 5), and 19 (Northern Side-notched variant 4). All of these projectile point types existed over a long time span. Windust type points (20, 21, and 17), Desert tri-notched (1), and Humboldt Concave Base (13) points have low frequencies and represent periods of low intensity use.

Summary

Analysis of 307 classifiable projectile points collected from the study area indicated that eight morphological groups and 22 historical types are present. Analysis of projectile point type measurements indicates that all of the projectile point types here defined, with the exception of the split stem, concave base, and single notched projectile points, are based on statistically significant

Table 6. Central Oregon Archaeological Sites and Recovered Projectile Points

	Projectile Point Types																					
Site	2	3	5	1	6	19	18	7	8	11	15	12	22	16	14	13	4	9	10	20	21	17
5-120	1	1	1														1					
2-182	1						1								1							
3-30	1																					
2-296				1																		
2-268			1			1																
2-324			1									1										
1-64			1																			
3-130			1																			
2-91			1																			
1-181			1																			
2-117			1																			
3-79		1				1	1															
2-332		1								1					1							
2-232		1						1														
4-428		1																		1		
3-136		1																				
5-70		1																				
1-180		1																				
2-109		1																				
3-44					1		1															
3-36							1		1													
1-164							1															
4-371							1															
1-178							1															
2-113							1															
4-308							1															
3-1							1															
4-63							1															
5-76							1															
1-64							1															
3-4							1															
2-101							1															
3-105							1															
5-87							1															
3-129								1						1						1		
2-111						1			1		1						1					
3-22						1							1									

Table 6. (Continued)

Site	Projectile Point Types																					
	2	3	5	1	6	19	18	7	8	11	15	12	22	16	14	13	4	9	10	20	21	17
3-128						1															1	
4-45						1																
5-15						1																
1-70						1																
4-219						1																
1-177						1																
3-131						1																
2-59						1																
3-23						1																
4-36						1																
4-52						1																
3-99						1																
1-129						1																
2-70						1																
3-118						1																
2-174					1					1												
2-191					1															2		1
5-123					1																	
2-319					1																	
5-84					1																	
2-203					1																	
4-33					2																	
4-307										1												
2-145										1												
1-28										1												
4-66									1													
1-60									1													
4-169									1													
2-187									1													
3-135									1													
3-95													1									
4-45													1									
4-123												1			1							
1-28												1										
2-236												1										
1-184												1										
1-122											1											
1-123														1	1							

Table 6. (Continued)

Site	2	3	5	1	6	19	18	7	8	11	15	12	22	16	14	13	4	9	10	20	21	17
	Projectile Point Types																					
3-134															1		1	1				
2-268															1							
3-5															1							
2-174															1							
2-43															1							
2-173															1							
1-141															1							
2-106															1							
5-71															1							
2-56															1							
3-120															1							
3-103															1							
3-31															1							
4-285															1							
2-16															1							
4-299															1							
1-87															1							
3-3															1							
4-40														1								
2-118														1								
3-128																			1			
2-71																			1			
2-148																	1					
5-5																	1					
2-19																	1					
4-348																	1					

Table 7. Frequency Distribution and Co-Occurrences of Projectile Point Types From Central Oregon Sites

	Projectile Point Types																				
	1	2	3	5	6	19	18	7	11	8	15	12	22	16	14	13	4	9	10	20	17	21
1	1																					
2		1	1	1			1								1	1						
3			5			1	1	1	1						1							
5				5		1						1										
6					5		1			1									1		1	
19			1	1		14	1			1	1			1			1			1		
18		1	1		1	1	13			1			1									
7			1											1						1		
11		1							2						1							
8					1	1	1			5	1	1					1					
15						1	1				1						1					
12				1								2			1							
22						1							2									
16								1							2	1					1	
14		1	1				1					1		1	17			1	1			
13																	1					
4		1	1	1		1				1	1				1		5	1				
9															1		1	1				
10																			2			
20			1		1	1																1
17			1																		1	
21																						1

measurements. This shows that the central Oregon historical types of projectile points are objectively definable, and may be identified by measuring the relevant dimensions of the projectile points. The best measurements for discriminating between these projectile point types are the length and the notch angle of the projectile point types here defined.

These projectile points represent seven time periods that are dated in terms of radiocarbon dates for comparable point types known across the Intermontane West, and are supplemented by locally obtained hydration dates from central Oregon. The early periods are represented by large stemmed and shouldered projectile points. These types are replaced by large side-notched and corner-notched types in the middle periods, and then in turn by small basal notched, corner notched, and side-notched types in the late periods.

Influence on the projectile point types of central Oregon appears to come from both the Columbia Plateau and the Great Basin, beginning with the earliest periods and continuing through historic times. Distinctive Great Basin types are seen in the appearance of Elko, Gatecliff Split stem and Desert Side-notched projectile points, while Columbia Plateau influence is seen in the appearance of small basal notched and corner-notched styles.

Analysis of the date ranges assigned to comparable types on the basis of radiocarbon data from a broad surrounding region as well as locally obtained obsidian hydration data (see Figure 16) indicates that seven time periods may be identified for the central Oregon study area..

The periods are as follows: Period 1, 10,000-7000 BP, Period 2, 7000-5000 BP; Period 3, 5000-4000 BP; Period 4, 4000-2000 BP; Period 5, 200-1500 BP; Period 6, 1500-800 BP; and Period 7, 800 BP -historic time. The chronological framework and time marker projectile point types established in this chapter are used in subsequent analyses of the Wind Creek Sites (Chapter V) and of settlement patterns across the study area as a whole (Chapter VI).

CHAPTER V

THE WIND CREEK SITES

Project Description

The majority of archaeological research in the central Oregon uplands has been limited to surface survey or reconnaissance with only small amounts of subsurface testing. The Wind Creek Archaeological Project represents one of the first large scale excavations in the central Oregon uplands, and the first on the Ochoco National Forest.

The project began in 1984 as a mitigation of impacts to significant archaeological sites in the Wind Creek Timber Sale. The surface reconnaissance was completed by Forest Service archaeologists prior to 1984. Twelve archaeological sites were recorded. It was determined that five of these sites (35GR-147, 35GR-148, 35GR-150, 35GR-159, and 35GR-162) would be adversely impacted by the planned timber sale. A proposal to mitigate the adverse impact was prepared by the Forest Service (Moss 1984). The research design was divided into a testing phase to establish site integrity and research potential, followed by a large scale excavation of selected areas within the five affected sites. The testing phase of the investigation was conducted by Coastal Magnetic Search and Survey Inc. in the Fall of 1984 and early Spring of 1985 (Churchill and Jenkins 1986). The excavation phase was contracted as an in-service project by the Forest Service in the summer and fall of 1985. Time limitations dictated that only four of the five tested sites would be excavated. The fifth site (35GR-150) was withdrawn from the proposed timber sale impact area, thus eliminating the potential adverse effects associated with the timber harvest activities.

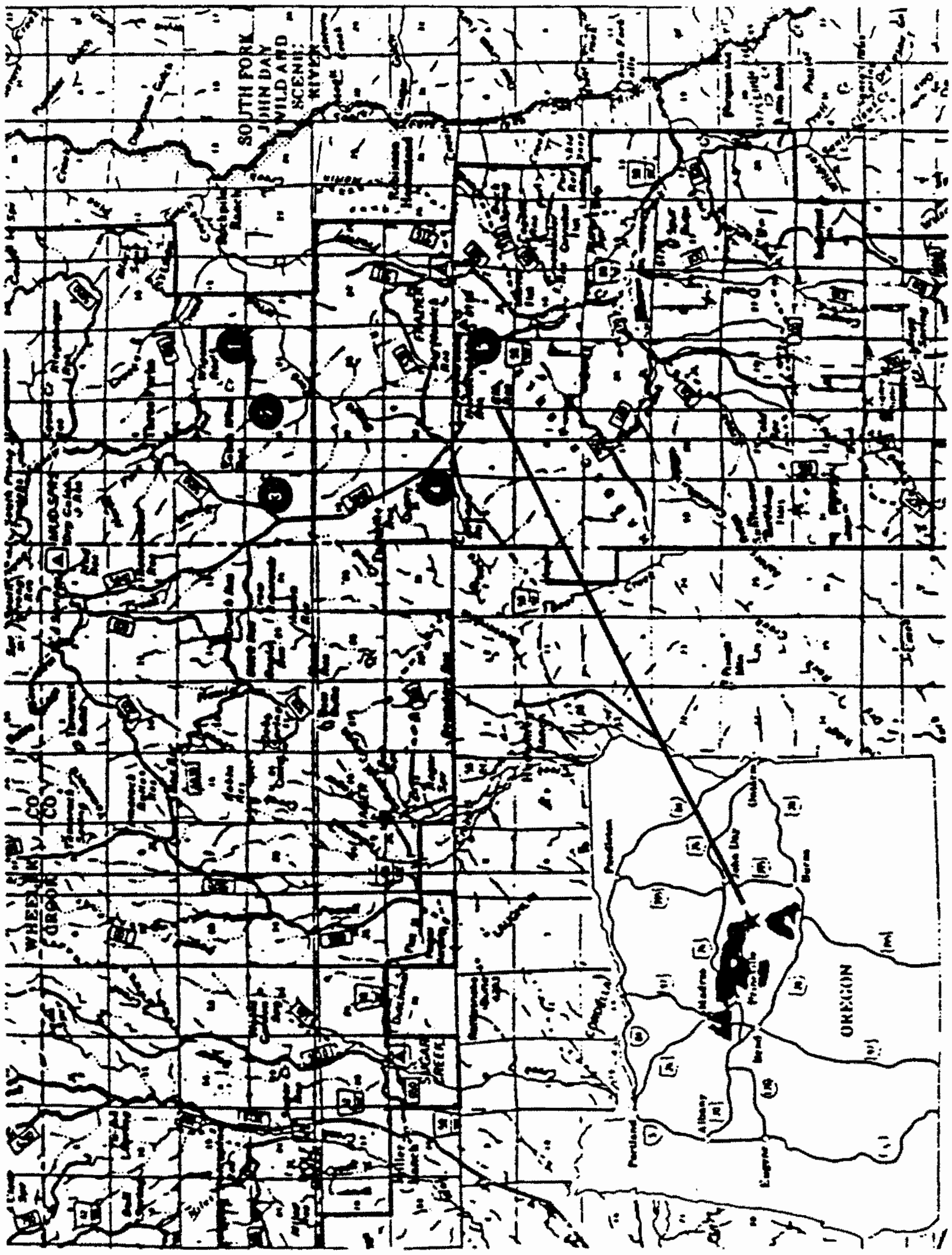
Archaeological excavations at the Wind Creek sites recovered evidence of at least 4000 years of human occupation, indicated by the presence of plant processing tools, evidence of tool manufacturing and repair, and evidence suggesting the hunting of small to medium sized game animals. Recovered faunal remains were, however, extremely fragmentary. With few distal ends of bones represented, identification beyond the genus was virtually impossible (Appendix B). No evidence of dwelling structures was encountered at any of the sites . Possible trade was indicated at one site by the recovery, in the testing phase, of two historic trade beads. One bead was made of rolled copper, and the other bead was made of glass. The geologic and stratigraphic sequences were generally imponderable, with some evidence of ground disturbance. Despite the amorphous nature of the soils, three broad stratigraphic units were identified, with four sequent cultural components proposed among the set of investigated sites.

Project Location

The Wind Creek Archaeological sites (Figure 17) are located on the southern edge of the Blue Mountains, 75 miles east of Prineville, Oregon. The five archaeological sites are located on the North Fork of Wind Creek, or on unnamed ephemeral tributaries of Wind Creek. Wind Creek itself drains into the south fork of the John Day River, which then flows north, eventually emptying into the Columbia River.

The John Day River Basin may be viewed as a major travel corridor with access north to the Columbia Plateau, and south to the interior of the Great Basin. The location of the sites on the headwaters of a major river such as the John Day would reinforce an interpretation of the site

Figure 17. Location of the Wind Creek sites. 1-35GR-162; 2-35GR-150 (tested but not excavated); 3-35GR-159; 4-35GR-148; 5-35GR-147


SOUTH FORK JOHN DAY WILD AND SCENIC RIVER
WHEELER CO
CROOK CO
OREGON

activity spheres as task specific, with major camp sites expected to occur elsewhere along the John Day or Crooked Rivers.

Research Objectives and Goals

The data recovery plan for the Wind Creek Project (Moss 1984) was developed under the aegis of the Programatic Memorandum of Agreement (PMOA) for Lithic Dominated sites. This planning tool, developed with the cooperation of the Forest Service, Advisory Council on Historic Preservation (ACHP) and State Historic Preservation Office, underscores the value of such sites, and structures the nature of the associated research:

> Lithic dominated sites will be assumed to have value for the data they contain about human use of forests through time, and it will be understood that extracting such data requires study of the horizontal and vertical organization of lithic dominated sites, relative and absolute dating of such sites, comparison of such sites with one another and with other classes of sites, studies of the environments in which such sites exist, and the study of any chemical, sedimentological, mineralogical, palynological, or stratigraphic data they may contain, that would bear on their age, function or previous environmental setting (USDA 1984:3).

General concerns about site patterning, environmental reconstruction, and human/land relationships were integral to the goals of the Wind Creek Project. Basic questions concerning site formation, function, chronology and lithic technology were also examined. The excavation phase of the Wind Creek project was an elaboration of the testing goals, as well as the addition of a problem orientation. The testing phase established the nature and extent of the cultural deposits, and it was then possible during the excavation phase to place large block excavation units in areas of the sites containing the most informative cultural deposits.

Field Methods

Traditional methods were employed in both the testing and excavation phases of the Wind Creek project. All work was accomplished by the use of hand tools, specifically square ended shovels, trowels, and occasional picks helped to break through decomposing bedrock and hard pan soils. Metric tapes and line levels were employed for measurement and to maintain horizontal and vertical control. All excavation material was dry screened through 1/4 inch mesh, with the exception of some of the material recovered from the testing phase, which was screened through 1/8 inch mesh. Shaker screens were utilized for the testing phase, because they were light weight and portable. For the excavation standing screens were constructed, enabling efficient excavation of a large amount of dirt by a minimal number of crew personnel. Testing methods involved the excavation of a series of 50 x 50 centimeter test probes, and at least one 1 x 1 meter test probe per site. Initially each site was evaluated with random test probes, regardless of surface concentrations. If large amounts of cultural remains were found in the test probes a 1 x 1 meter test probe was used to expand the sampling results. All pits and probes were excavated in arbitrary 10 centimeter levels. Constant volume samples were taken from each level and screened through 1/8 inch mesh.

Excavation phase field methods were similar, however, 1/8 inch mesh was not utilized in screening the excavation fill. From every excavation block one 1x1 meter pit was randomly chosen, and a 1000 cubic centimeter constant volume sample removed at 10 centimeter intervals. A floatation analysis of the constant volume samples was then conducted in the laboratory (Appendix D). Excavation pits consisted of 1 x 1 meter units which were expanded outward from the initial pit into a block unit. Stratigraphic maps of every excavation block were constructed, depicting generally the north and east walls, unless a clearer profile could be obtained from other walls. Datum corners for every pit were the north east corners, and all horizontal and vertical measurements were referenced to a permanent site datum. All pit measurements were recorded as depth below ground surface, beginning with level 1. For each site a surface concentration map and contour map was composed. A north/south base line was constructed anchored to a site datum Where possible all testing units were located and placed on the contour map. All cultural material encountered in situ was mapped and collected. After excavation, soil samples were collected and excavation blocks were then refilled by a backhoe.

Laboratory Methods

Testing phase laboratory methods involved cataloging and description of the cultural remains and soil samples recovered from the sites. All artifacts were cleaned, labeled, and then cataloged utilizing a sequential number system. Each catalog entry included information concerning the site, unit, and level. Artifacts were categorized according to function. When function was unable to be ascertained morphological categories were utilized.

All debitage was cleaned, sorted and counted, and size graded. Size grade was determined by sorting the debitage into graduated .05 centimeter circles. The debitage was categorized by material type, including basalt, obsidian, and chert. Soil color was classified according to a munsel color chart.

The excavation phase laboratory methods were similar. All material was cataloged in the field, with a field number. Data recorded included type of site unit, level, date of collection and collector. In the lab the material was then given a permanent number. Artifacts were cataloged according to function and material type. Measurements were recorded concerning the attributes of the artifacts, including length, width, thickness (all in millimeters), and weight (in grams). The debitage was cleaned, typed according to material, and categorized as primary, secondary (interior), tertiary, angular waste, and potlids. Size grading was computed using graduated circles. Projectile points were measured and typed, and soil samples (Appendix E) and faunal material analyzed with standard methods using the facilities at Washington State University. Soil samples were floated, removing the solid material from the soil. The remaining samples were then dried and then separated into organic and inorganic material. Inorganic material included rocks, charcoal and lithics. Organic material consisted of bones, sticks, twigs, and seeds. The seeds were identified by Oregon State University (see Appendix D). Obsidian samples were sourced and their hydration bands measured, and radiocarbon samples were cleaned and sent to Beta Analytic for analysis. All the data from the project was stored on a Forest Service computer located at Fort Collins, Colorado. Analysis was undertaken using SPSS statistical programs. Frequencies and crosstabulations were computed for general data, and cluster analyses were used to classify projectile points.

Site Stratigraphies

Soils

The soils found at the Wind Creek sites ranged from thin to moderately deep, and may be roughly separated into three categories. The first type was found only in association with site 35GR-147. Here the soils were moderately deep, derived from loess and the residuum resulting from erosion of tuffaceous sedimentary rocks. Surface soils consisted of thin loams, silt loams, clay loams, and silty loams. Subsoils were very thin to moderately thick clays. Bedrock consisted of tuffaceous rock, ranging in depth below ground surface from 35 to 101 centimeters (Paulson 1977:106107).

The second soil type was found only at site 35GR-148. It consisted of shallow soils derived from loess, ash, and residuum. Surface soils were gravely to non gravely sandy loams, loams, and silt loams. Subsoils ranged from clay loams to clay. Bedrock consisted of basalt ranging from 12 to 101 centimeters below ground surface (Paulson 1977:11).

The third soil category was found in association with sites 35GR-150, 35GR-159, and 35GR-162. This consisted of shallow to moderately deep derived loess intermixed with colluvium. Surface soils were thin to very thin, non gravely to very gravely textures of clay loams, and clays. Bedrock consisted of basalt ranging in depth below ground surface from 30 centimeters to 101 centimeters (Paulson 1977:11). In general, the soils found at the Wind Creek Sites show little vertical variation as depth below ground surface increases. Surface soils are thin loams, showing some horizontal variation between gravel loam, silt loam, and clay loam. The surface soils at site 35GR-148 are an exception to this, indicating high amounts of sand, and sand ash.

The subsurface soils of the Wind Creek sites increase in gravel and clay content as depth below ground surface increases. Some of the soils at 35GR-148 represent an exception, consisting of sand decreasing in silt and ash content as depth below ground surface increases. Bedrock in all the sites except 35GR-147 consisted of basalt and decomposing basalt. Bedrock at 35GR-147 consisted of tuffaceous rock.

The Wind Creek sites may be divided into three layers, consisting of thin surface soils (duff), a broad middle layer increasing in clay and gravel and clay content as depth below ground surface increases, and a third moderately thick layer which contains high amounts of clay and or gravel. In some excavated pits the distinction between the second and third layer was tenuous, since the clays and gravel would blend together.

Lithic Material

Lithic Sources

Sources of obsidian are found throughout southern Oregon, as well as occurring in some smaller outcrops in the Blue Mountains, to the east of the Wind Creek sites. One or two small sources are found to the north of the study area, near Mitchell, Oregon. Basalt is found through most of the study area, where massive sheet basalt flows are common. More basalt flows are found in the eastern part of the study area. Concentrations of crypto crystalline or sedimentary chert deposits are found in the south central part of the study area as well the western part along the Deschutes River.

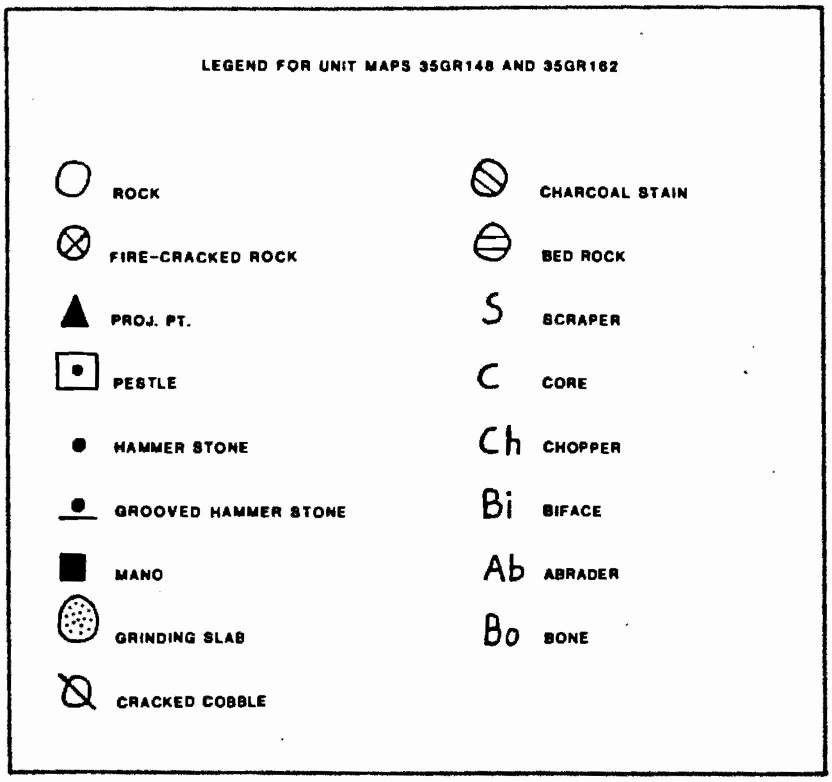
Obsidian Source and Hydration Analysis

A source analysis and hydration study of obsidian recovered from the Wind Creek sites is presented in Appendix C. Thirty eight specimens of obsidian that were excavated from the Wind Creek sites were subjected to obsidian source analysis. The results of this analysis identified 12 chemically discrete sources of obsidian. These results were consistent with the source results obtained from the sample of central Oregon projectile points discussed in the preceding chapter, and indicates that a similar obsidian procurement pattern was occurring throughout the central Oregon area. One group of obsidian sources occurs in an area east of Seneca, Oregon. Three sources were identified in this area: Whitewater Ridge, Wolf Creek, and Little Bear Creek. A second group of obsidian sources occurs to the south, on the Snow Mountain district of the Ochoco National Forest. Included in this group were the Sawmill Creek, Juniper Springs, Buck Spring, and Dog Hill sources. The remaining obsidian samples fell within 7 chemically discrete groups that do not match any known source of obsidian. The majority of the obsidian samples (n=22) were sourced to the Whitewater Ridge source.

A sample of 18 obsidian specimens excavated from the Wind Creek sites were selected for measurement of their hydration rims (see Appendix C). The analysis of these specimens yielded an estimated hydration rate of 2.98 $microns^2$/thousand years for the Whitewater Ridge source and 3.18 $microns^2$/thousand years for the collective obsidian from the Wind Creek sites. The obsidian hydration measurements were consistent with the measurements obtained from the sample of projectile points from the central Oregon area.

Wind Creek Cultural Components

Four cultural components were identified at the Wind Creek sites. Identification of the components was aided by the occurrence of 5 living floors, and 8 radiocarbon dates were obtained. (Figures 18-22, Table 8). The cultural components were identified both analytically and stratigraphically by converting the level-by-level lithic tool counts at each site into a Robinson's matrix. The resulting similarity matrixes of excavation levels and tool percentages were clustered through the use of a chebychev clustering measure, and a complete clustering method. The chebychev distance measure computes the distance between two cases as the maximum absolute difference in values for any variables. The results of the cluster analyses were used to determine cultural components (see below).


LEGEND FOR UNIT MAPS 35GR148 AND 35GR162
ROCK
FIRE-CRACKED ROCK
PROJ. PT.
PESTLE
HAMMER STONE
GROOVED HAMMER STONE
MANO
GRINDING SLAB
CRACKED COBBLE
CHARCOAL STAIN
BED ROCK
S SCRAPER
C CORE
Ch CHOPPER
Bi BIFACE
Ab ABRADER
Bo BONE

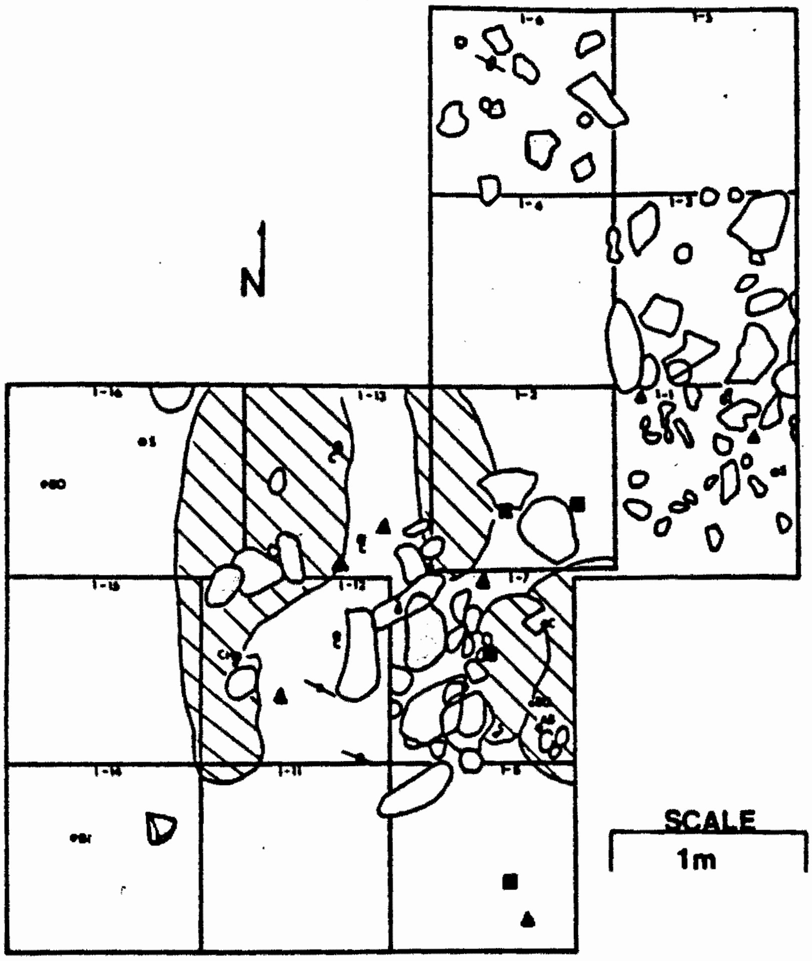


Figure 18. Floor map of component 1 (0-20 cm) at 35GR-162.

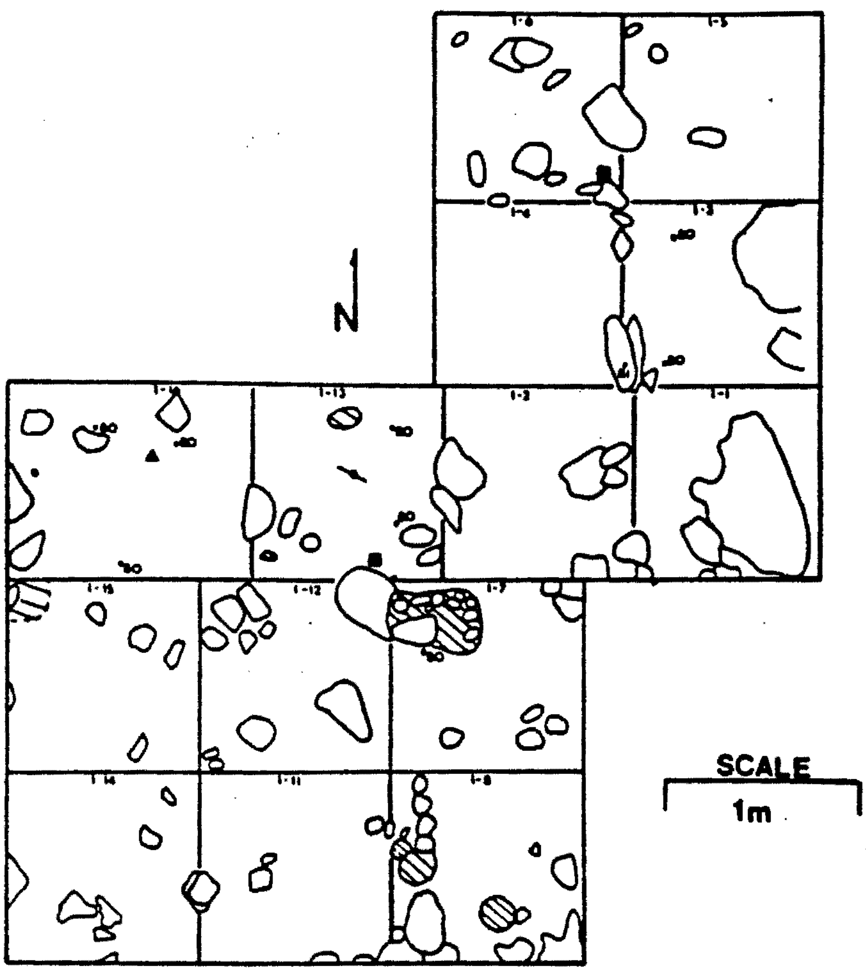


Figure 19. Floor map of component 2 (20-30 cm) at 35GR-162.

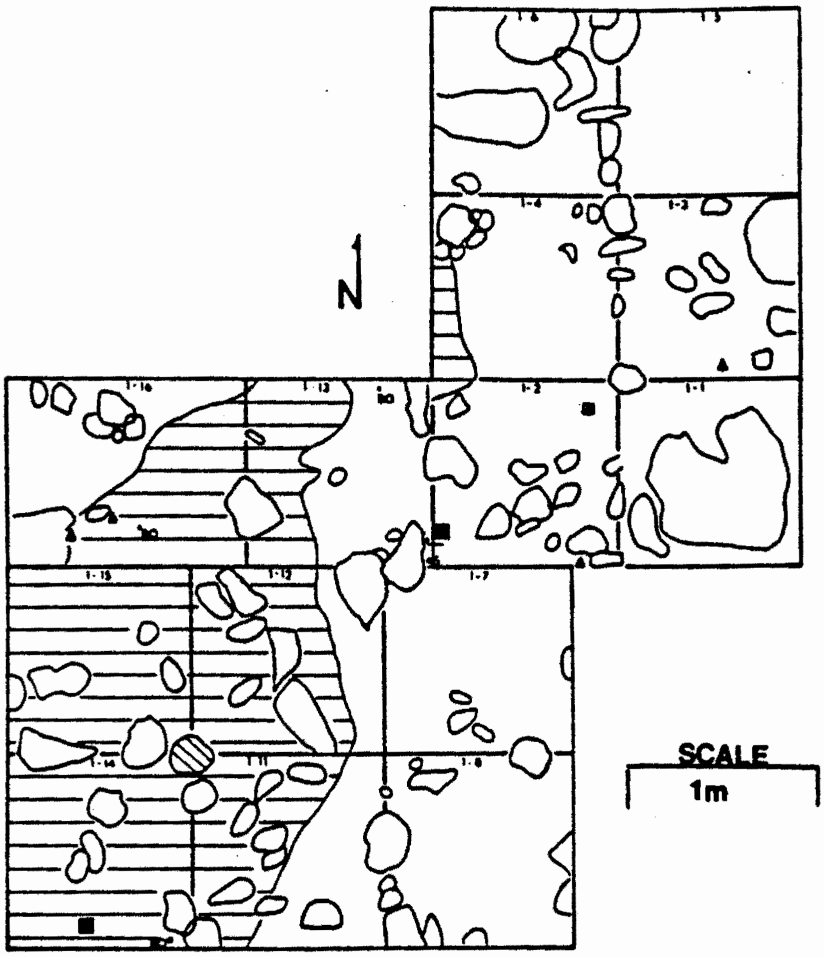


Figure 20. Floor map of component 3 (40-50 cm) at 35GR-162.

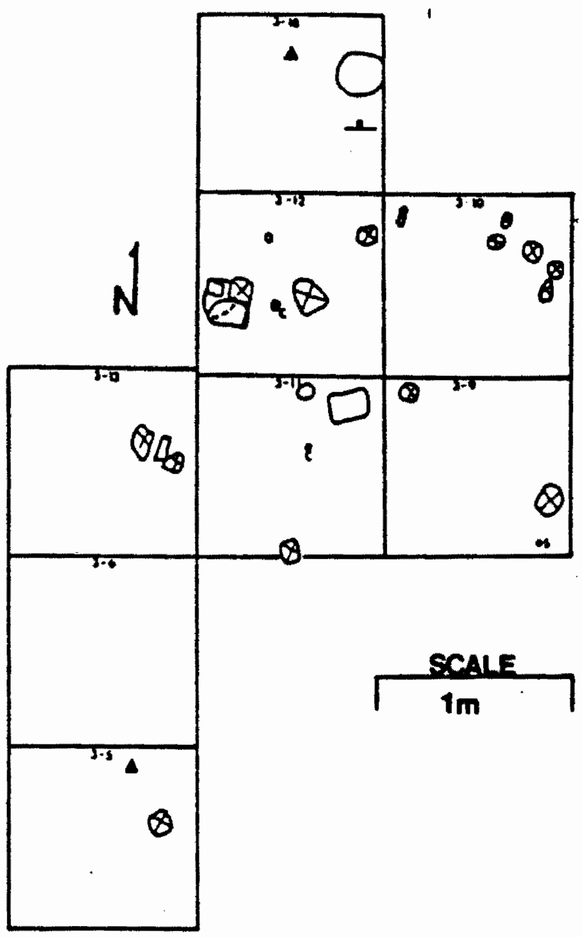


Figure 21. Floor map of component 1 (10-20 cm) at 35GR-148.

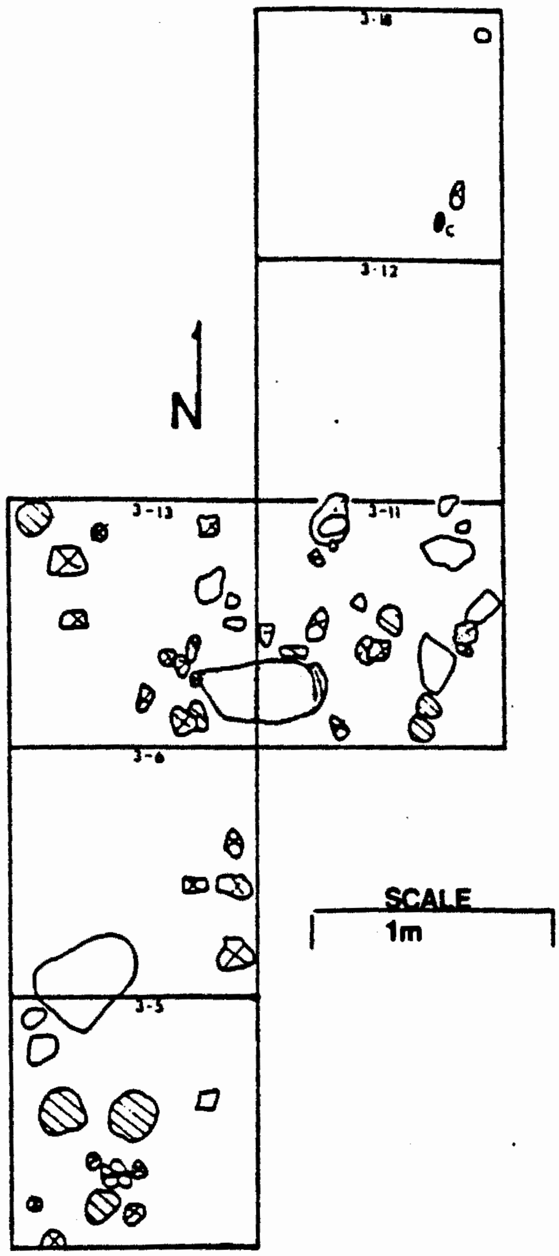


Figure 22. Floor map of component 2 (20-30 cm) at 35GR-148.

Table 8. Summary of Radiocarbon Dates From the Wind Creek Sites

Ident.#	Sample #	Date	Site#	Level	Component	Peroid	Sample Description
Beta-14866	100	880 ± 80 BP	GR159	7	1	6	charcoal
Beta-14218	89	1,690 ± 90 BP	GR162	7	4	5	soil
Beta-14216	40	1,870 ± 70 BP	GR148	4	3	5	charcoal-wood
Beta-14215	38	2,150 ± 80 BP	GR148	3	2	4	charcoal
Beta-14220	44	2,210 ± 60 BP	GR148	2	2	4	charcoal
Beta-14219	98	2,490 ± 70 BP	GR162	4	2	4	soil-black
Beta-14217	54	2,920 ±100 BP	GR159	4	2	4	charcoal
Beta-14865	57	4,030 ±190 BP	GR162	4	2	4	intact hearth

Cultural Periods 6, 5, and 4 (Chapter IV) are represented by the excavations at the Wind Creek sites. Period 6 (800-1500 BP) is represented by Component II at 35GR-159. A radiocarbon date of 880 BP was obtained from this component. Period 5 (1500-2000 BP) is represented by cultural component III at 35GR-148, and Cultural Component IV at 35GR-162. Radiocarbon dates of 1690 and 1870 BP were obtained for these components. Period 4 (2000-4000 BP) was represented by all the other components at the Wind Creek sites. Radiocarbon dates of 2150, 2210, 2490, 2920, and 4030 BP were obtained from these components.

Site Descriptions

35GR-162

Location

Site 35GR-162 (Figure 23) is located on the western edge of an ephemeral drainage of Wind Creek. This widely dispersed site is found mainly along the drainage floodplain and first

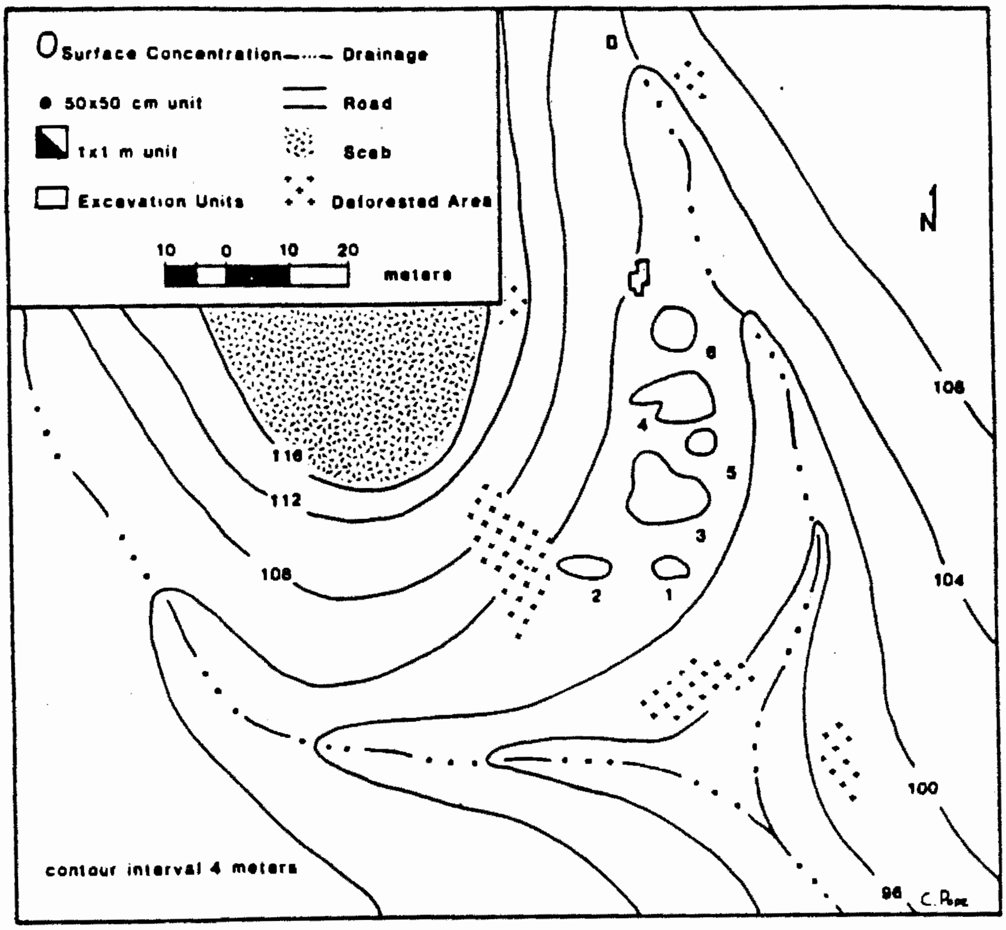


Figure 23. Site map 35GR-162.

terrace, with some cultural material occurring on an escarpment overlooking the lowland terrace. The topography of the site area slopes gradually to the south. Scab escarpments occur on the west and east. Just south of the site proper the ephemeral drainage joins another, larger ephemeral drainage of Wind Creek.

The current vegetation of the site consists of open Ponderosa pine, juniper, and sagebrush, with stringers of juniper and ponderosa pine around the edges. The soils of the site consist of moderately deep loess, intermixed with colluvium. They comprise three broad and one narrow vertical stratigraphic levels (Figure 24).

Stratigraphic level 1 consisted entirely of a brown to dark brown duff level, and was approximately 10 centimeters thick. Stratigraphic level 2 was composed of silty sand approximately 10 centimeters thick. This level was not found in all excavation units. The third stratigraphic level was a silt/sand/ash level about 13 centimeters thick. The fourth stratigraphic level consisted of a dark humic sand/silt extending from about 30 centimeters below ground surface to bedrock, which was encountered 60 to 70 centimeters below ground surface. Large pieces of bedrock basalt were found throughout the excavation units were probably eroded from the scab escarpments above the site.

Cultural Material

The excavation at site 35GR-162 was conducted within two excavation blocks. Recovered cultural material consisted of projectile points, bifaces, modified flakes, cracked and battered cobbles, drills, cores, groundstone (pestles and grinding slabs), burins, hammerstones, and debitage (Table 9). One hundred sixty three tools, 5290 flakes, and 211 bone fragments were recovered from the excavation.

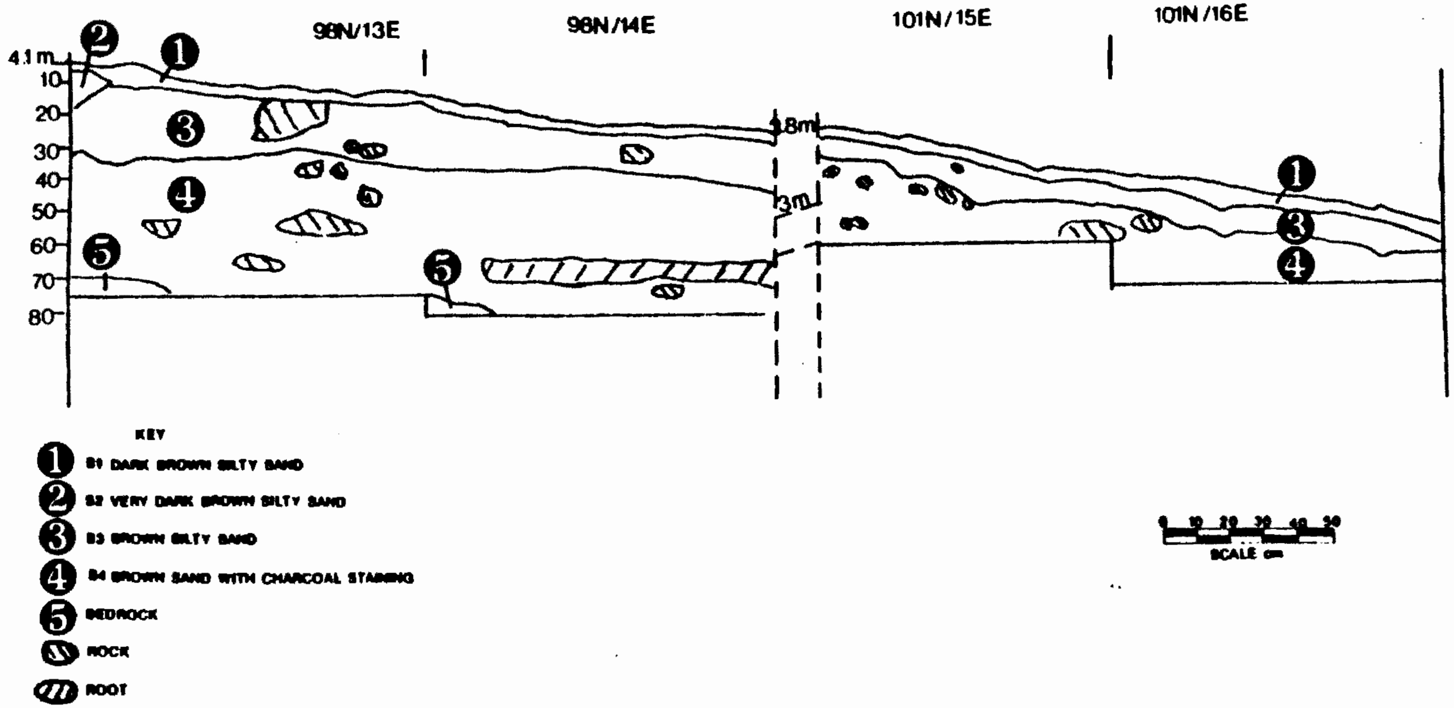


Figure 24. Stratigraphic profile of the north wall of unit 1 of 35GR-162.

Table 9. Summary of Lithics: 35GR-162[a]

Level	PP	BIF	BC	AB	DL	COR	GS	UF	HH	BU	MN	PE	HS	B	FL	Total[b]
Surf	7	2				4	1								368	14
1	7	6	2				2	2				1			817	20
2	5	9	2			2	4	6				2			915	30
3	5	14	1			1	3	4		1		1	1		995	31
4		13	1		1	1	7	3			2	1			959	29
5	6	7				1	6	8					1		690	29
6	3	1				2	1	2			1				473	10
7		1						2							73	3
8								1								1
9																
10	1															1
Total	34	53	6		1	11	24	28		1	3	5	2		5,290	163

a-tools from both excavation and testing phases are included but the reported flakes from the excavation phase only
b-total excludes flakes
PP-projectile points BIF-bifaces COR-cores B-beads
BC-battered or cracked cobbles
AB-sandstone abraders
DL-drills
UF-utilized flakes
HH-historic material
BU-burins
PE-pestles
HS-hammerstones
FL-Flakes
Cultural component 1-surface through level 1 (10cm)
Cultural component 2-level 2 through 4 (40cm)
Cultural component 3-level 5 to 6 (60cm)
Cultural component 4-level 7 to bedrock (100 cm)

A cluster analysis of the cultural material and excavation levels (Figure 25) indicated the presence of four site components. Cultural Component I extended from 0 to 10 cm below ground surface. Cultural Component II extended from 10 to 40 cm below ground surface, and Cultural Component III extended from 40 to 60 cm below ground surface. The fourth cultural component extended from 60 to 70 cm below ground surface. Components I-III date within Period 4 (2000-4000), while Component IV is assigned to Period 5 (1500-2000 BP).

Site activity in Cultural Component I apparently consisted largely of hunting, and tool manufacture and repair, with low to moderate amounts of plant processing. Six large mammal bones were recovered from the excavations of this component. This site activity is indicated by the large amounts of projectile points and cores, and low occurrences of groundstone.

During Component II times, site activities shifted to tool manufacture and repair, and butchering, with low amounts of hunting and plant processing. This is inferred from the presence of large amounts of bifaces, a decrease in the number of projectile points, the occurrence of cores and utilized flakes (scrapers), and an increase in groundstone and the appearance of battered cobbles. One hundred sixty two pieces of animal bone were recovered from this component. The bones were predominantly from large mammals, though some medium and a few small sized animals were also represented. Component 3 and 4 activities shifted to plant processing, with some butchering and hunting indicated. This activity is inferred from the rapid decline in bifaces and projectile points and the continuation of groundstone, and scrapers. The number of animal bones decreased to 35 in Component III and 12 in Component IV. Component III contained predominantly large mammal bones, while Component IV contains predominantly large and medium sized animals.

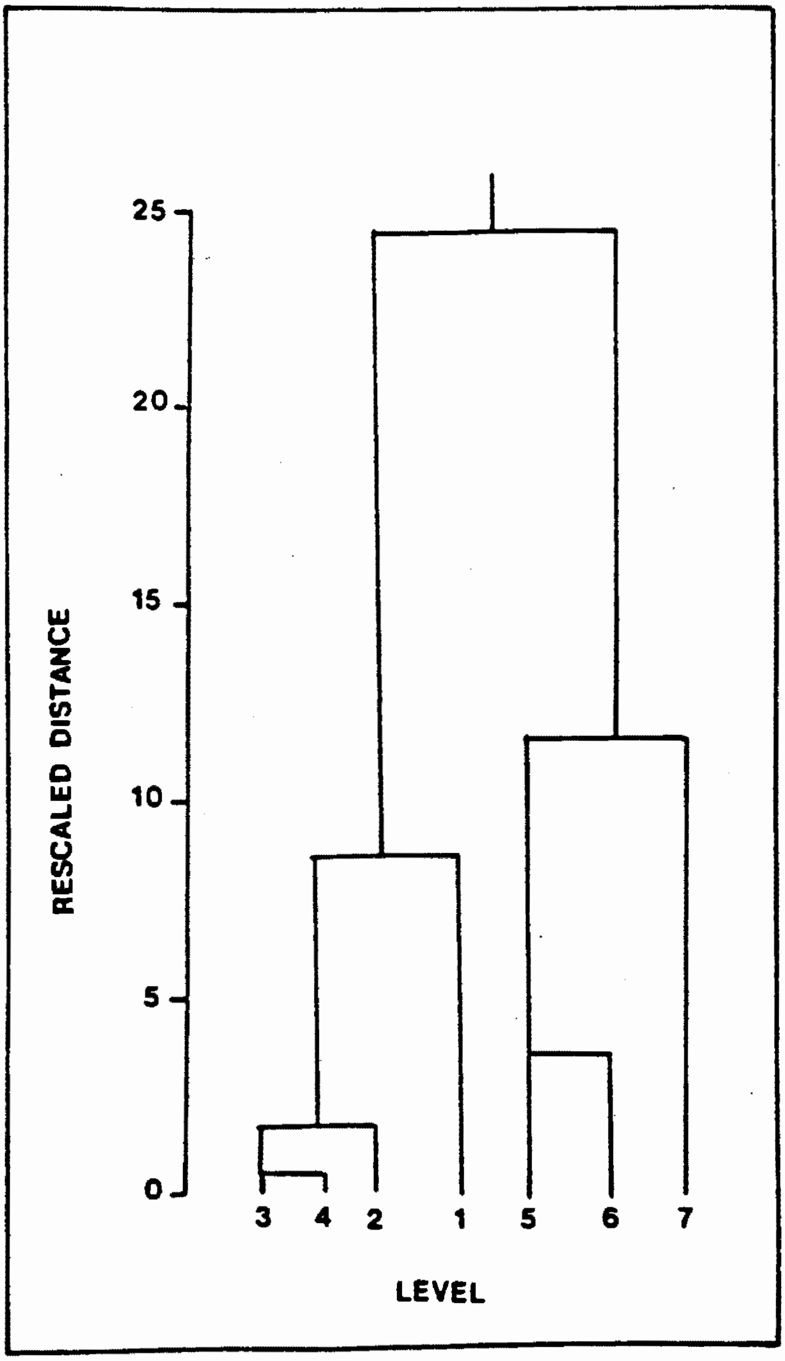


Figure 25. Cluster analysis of cultural material in levels 1-7 at 35GR-162.

Site 35GR-159

Location

Site 35GR-159 (Figure 26) is located on the western edge of an ephemeral drainage of Wind Creek. The site is localized along the first terrace, extending up slope to the west. The on site vegetation consists of juniper and ponderosa pine. The topography of the site area subsumes the ephemeral drainage flowing north to south, with a narrow flood plain and scab escarpments to the west.

The soils of the site consist of poorly sorted to extremely poorly sorted brown to dark brown silty sand. There are three broad stratigraphic levels (Figure 27). Stratigraphic Level 1 consisted of the upper 10 to 15 centimeters of the site. This level consisted predominantly of sand and smaller amounts of silt, gravel and clay. Stratigraphic Level II ranged to 40 centimeters below ground surface. This level increased in sand and clay content. Stratigraphic Level III went from 40 cm to bedrock. This level consisted predominantly of sand with smaller amounts of clay and silt. The excavation units on the slope encountered bedrock at approximately 60 centimeters below ground surface, and on the terrace at about one meter below ground surface.

Cultural Material

The excavation at site 35GR-159 was contained within two excavation blocks. Cultural material consisted of debitage, projectile points, bifaces, groundstone, utilized flakes, and cracked cobbles. Two site components were identified at this site (Figure 28). Component I occurred on the surface to approximately 60 centimeters below ground surface. Component II has been identified as occurring from 60 centimeters below ground surface to bedrock, and is associated

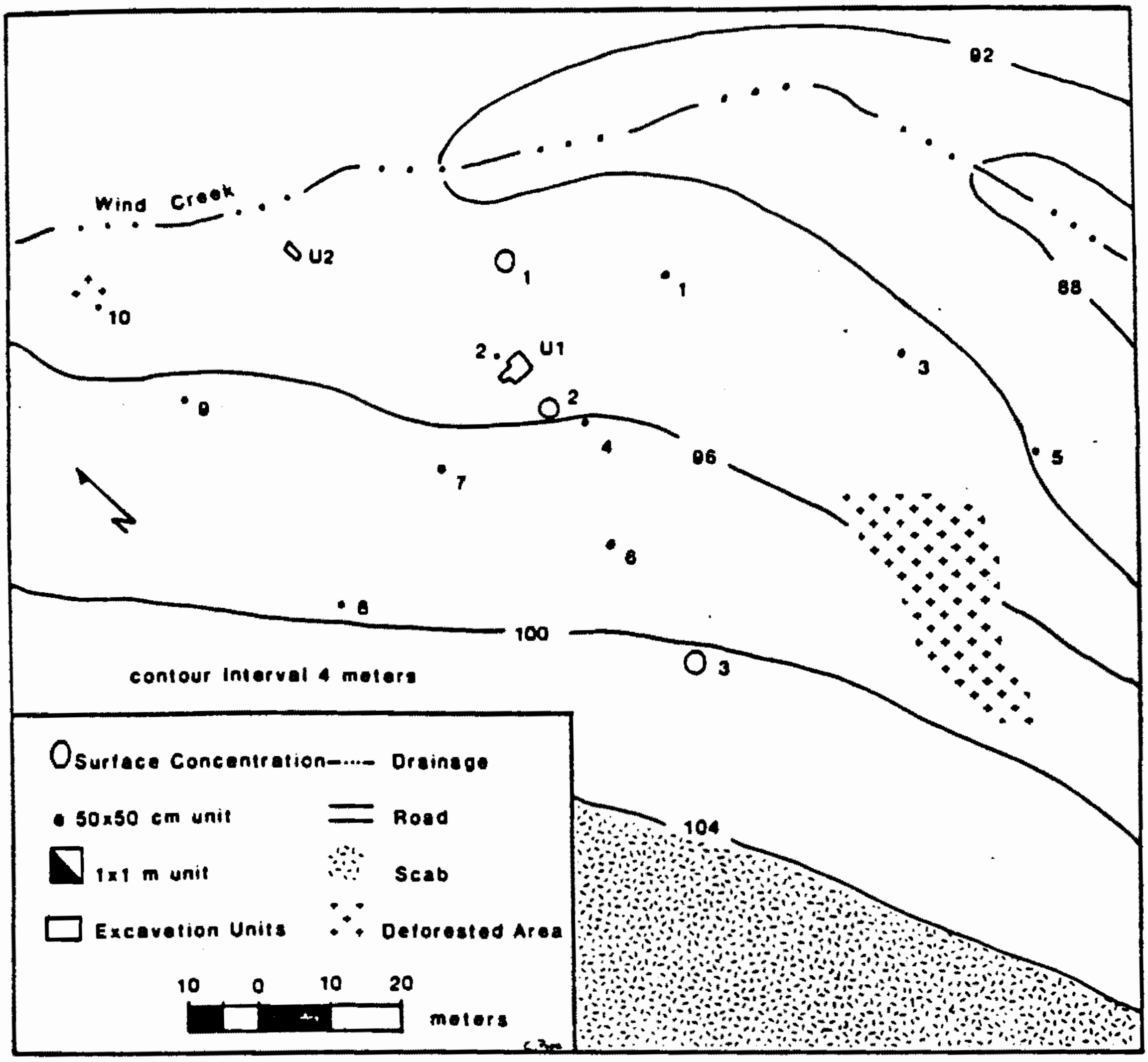


Figure 26. Site map 35GR-159.

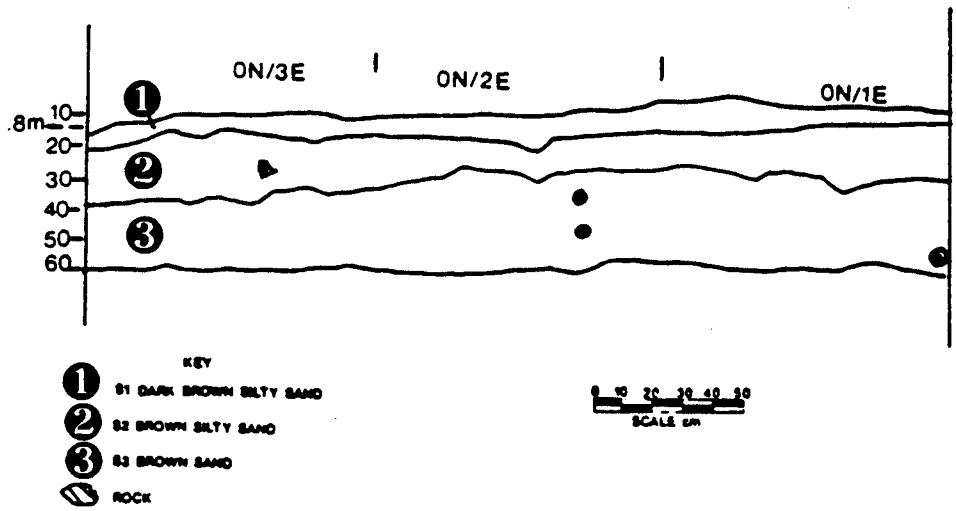


Figure 27. Stratigraphic profile of the south wall of unit 1 of 35GR-159.

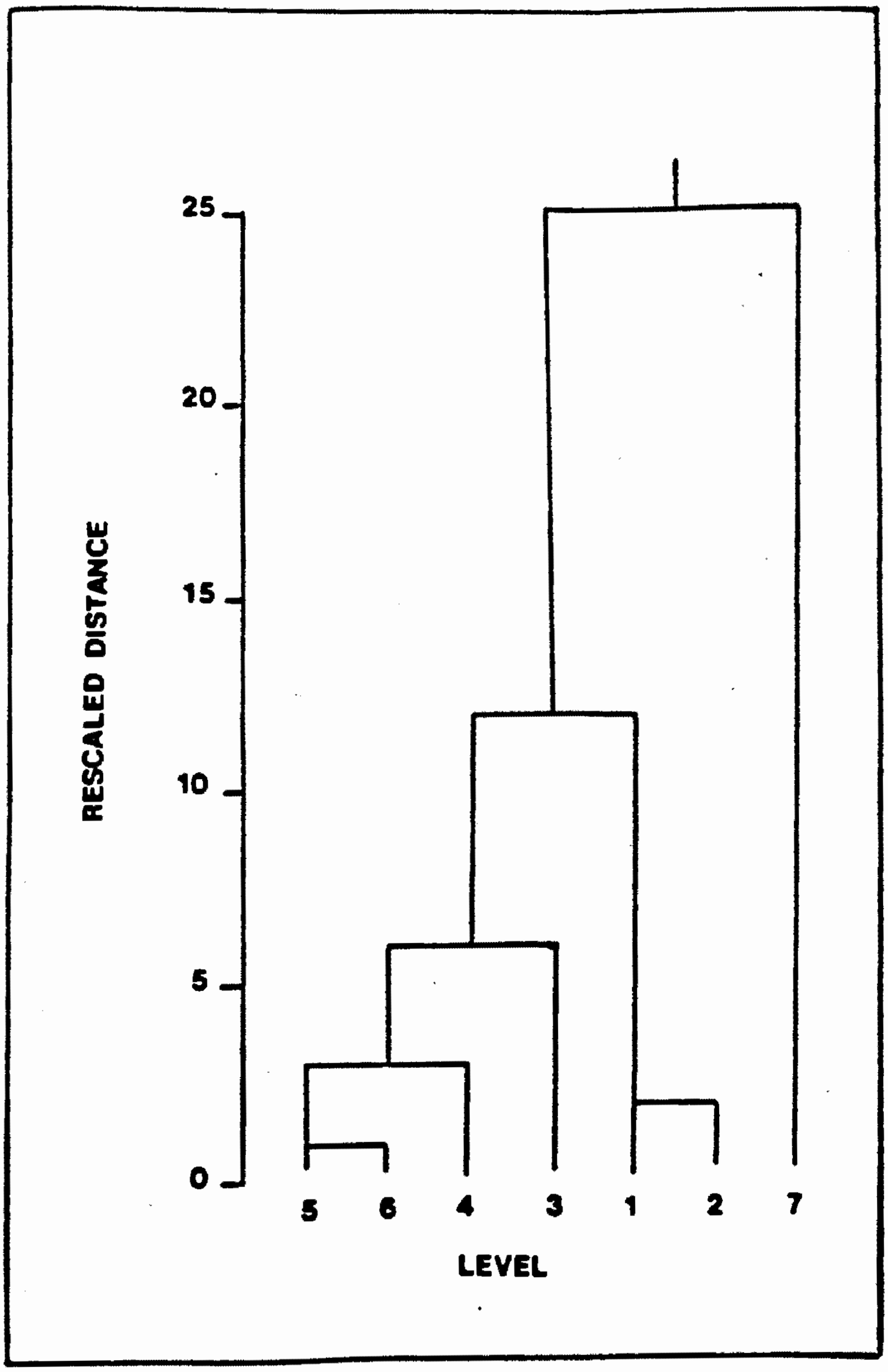


Figure 28. Cluster analysis of cultural material in levels 1-7 at 35GR-159.

with Period II. The two site components contained 12 tools, four bone fragment, and 2238 flakes (Table 10). Component I is assigned to Period 6 (800-1500 BP), while Component II belongs to Period 4 (200-4000 BP).

Component I may be characterized as containing debitage and bifaces, with small amounts of projectile points, grinding slabs, and utilized flakes. In Component II there is a decrease in cracked cobbles Component I at this site represents a limited activity tool manufacture area, with

Table 10. Summary of Lithics: 35GR-159[a]

Level	PP	BIF	BC	AB	DL	COR	GS	UF	HH	BU	MN	PE	HS	B	FL	Total[b]
Surf															5	
1	3						1	2							787	6
2	1	5													830	6
3		4													396	4
4			1												172	1
5															48	
6																
7																
Total	4	9	1				1	2							2,238	17

a-tools from excavation and testing are included but only flakes from excavation
b-total excludes flakes
PP-projectile points BIF-bifaces COR-cores B-beads
BC-battered or cracked cobbles
AB-sandstone abraders
DL-drills
UF-utilized flakes
HH-historic material
BU-burins
PE-pestles
HS-hammerstones
FL-flakes
Cultural component 1-surface bedrock (70 cm)

small amounts of hunting and plant procurement. Component II represents limited activity tool manufacture.

Site 35GR-148

Location

Site 35GR-148 (Figure 29) is located on the eastern edge of a sagebrush scab, extending into open ponderosa pine, juniper, and sagebrush. On the far western edge of the scab is an ephemeral north-to-south flowing drainage of Wind Creek, which joins another west-to-east flowing drainage just south of the site. The soils of the site consist of poorly sorted sand, and small amounts silt, comprising two broad stratigraphic levels (Figure 30).

Cultural Material

The excavation was conducted within three excavation blocks. Cultural material consisted of pestles, projectile points, bifaces, drills, cores, grinding slabs, cores, cracked cobbles, debitage, utilized flakes, manos, beads, and hammerstones (Table 11). Four site components were identified at this site (Figure 31). One hundred two animal bones, 88 tools, and 3204 flakes were recovered. Site 35GR-148 dates predominantly to Period 4 (2000-4000 BP), though Component II is assigned to Period 5 (1500-2000 BP).

Component I extended to 20 centimeters below ground surface, and contained projectile points, bifaces, battered cobbles, drills cores, grinding tools and a bead. Hunting, tool manufacture, and small amounts of plant processing are indicated, as well as small amounts of

Table 11. Summary of Lithics: 35GR-148[a]

Level	PP	BIF	BC	AB	DL	COR	GS	UF	HH	BU	MN	PE	HS	B	FL	Total[b]
Surf	3	3						1							55	7
1	2	7						1			1	1			574	12
2	1	4	5		1	2	2	1			1	1		1	744	19
3	8	5	1	1		4	4	1	1			1	1	1	961	28
4		4	1			1	1	2							376	9
5	1	2			1							1			172	5
6	2	3						2							157	7
7							1								44	1
8								1							40	1
9															58	
10															12	
11															11	
Total	17	28	7	1	2	7	8	9	1		2	4	1	2	3,204	88

a-tools from excavation and testing are included but only flakes from excavation
b-total excludes flakes
PP-projectile points BIF-bifaces COR-cores B-beads
BC-battered or cracked cobbles
AB-sandstone abraders)
DL-drills
UF-utilized flakes
HH-historic material
BU-burins
PE-pestles
HS-hammerstones
FL- flakes
Cultural component 1-surface through level 2 (20cm
Cultural component 2-level 3 (30cm)
Cultural component 3-level 4 (40 cm)
Cultural component 4-level 5 to bedrock (110cm)

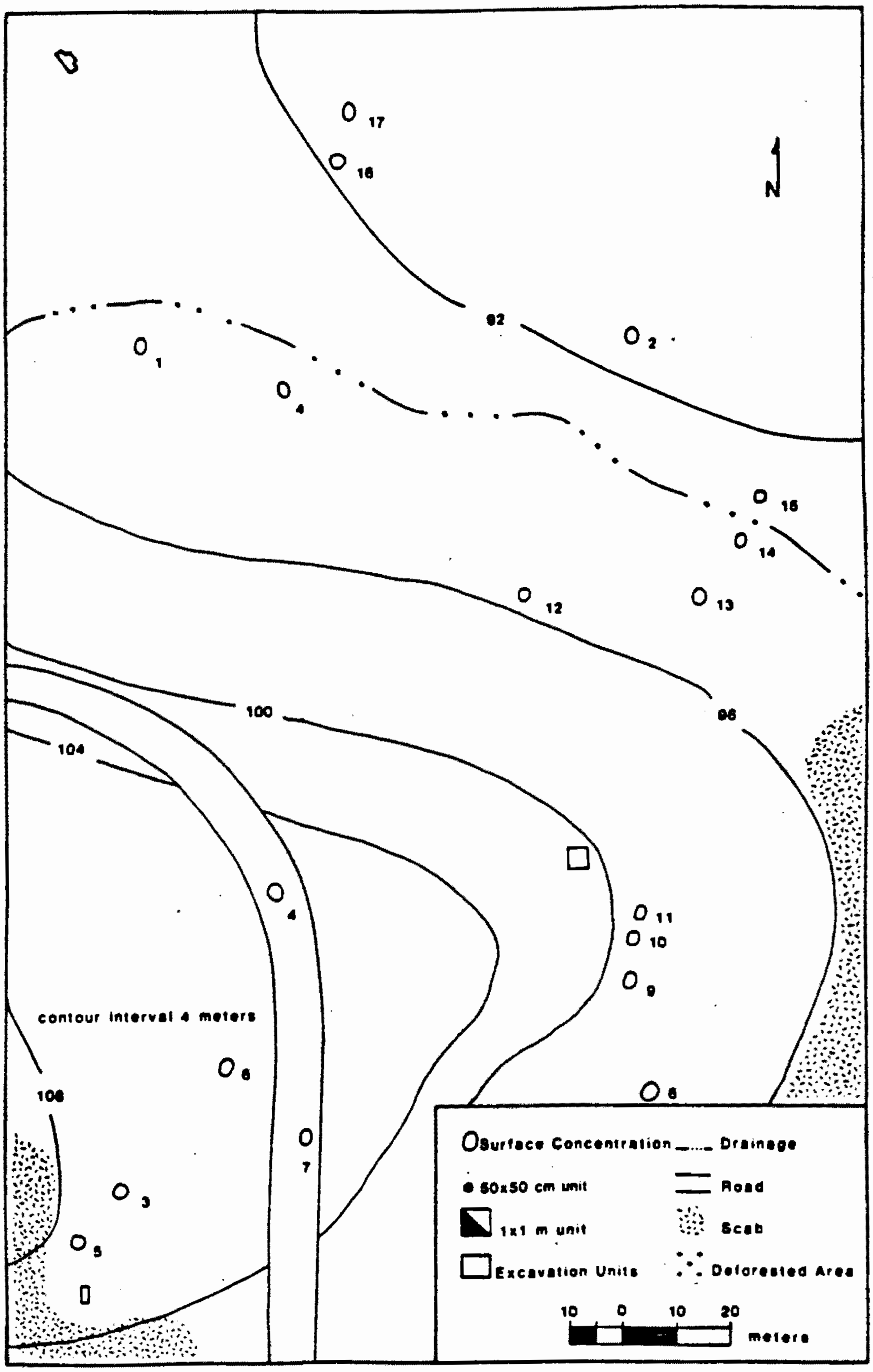


Figure 29. Site map 35GR-148.

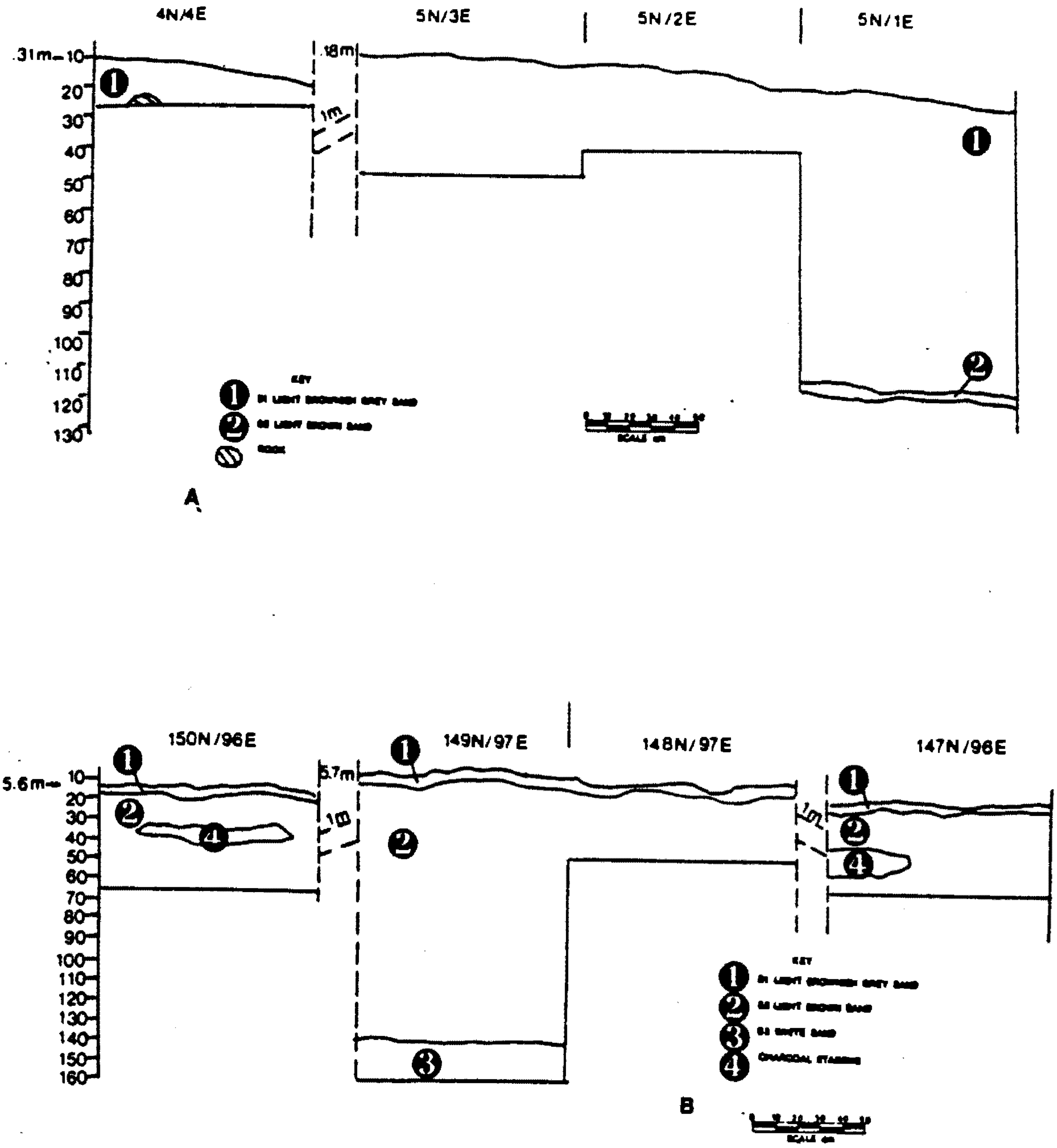


Figure 30. Stratigraphic profile of 35GR-148. A: north wall of unit 1;
B: east wall of unit 2.

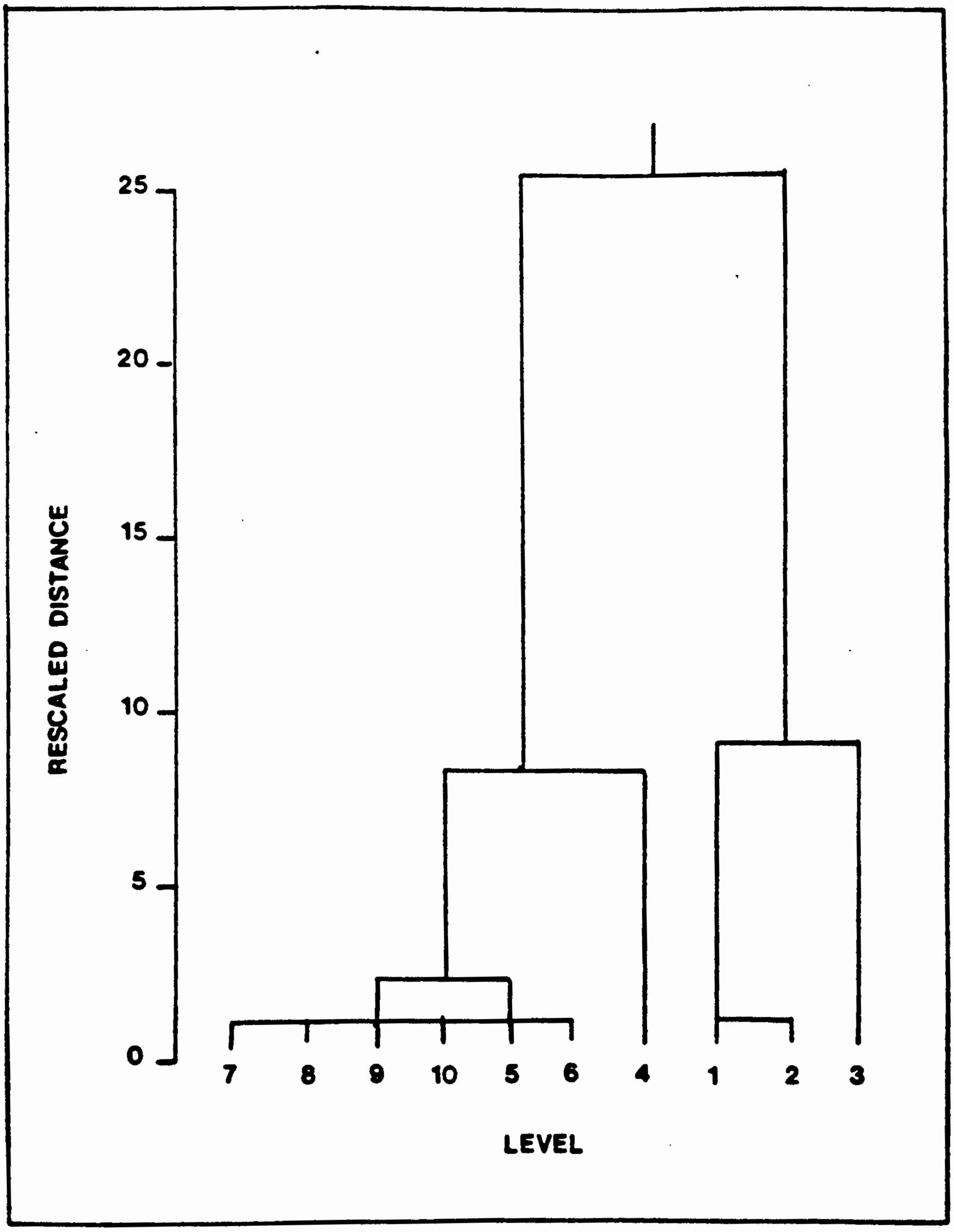


Figure 31. Cluster analysis of cultural material in levels 1-10 at 35GR-148.

trade. Twenty six animal bones were recovered from this component, predominantly from large sized mammals.

Component II extended from 20 to 30 cm below ground surface. Projectile points, bifaces, and grinding tools increased, while battered cobbles decreased. One sandstone abrader and one bead were found. Hunting activities, tool manufacture, and plant processing all increase in this component, and small amounts of trade are indicated. Twenty eight animal bones were recovered from this component, predominantly of large sized mammals.

Component III extended from 30-40 cm below ground surface. No projectile points were found in this component, and there was a decrease in cores and grinding tools. Hunting, tool manufacture, and plant processing activities all decrease in this component. Seventeen animal bones were found in this component predominantly of large sized mammals.

Component IV extended from 40 to 100 cm below ground surface. The tools included small amounts of projectile points, bifaces, grinding tools, utilized flakes, and a drill. Small amounts of hunting, and plant processing are indicated. No cores were found in this component, and no tool manufacturing is indicated. Thirty two animal bones were found in this component, predominantly of large sized mammals.

All of the components at site 35GR-148 contained hunting and tool manufacturing materials, with small amounts of plant processing indicated. Limited to moderate activity is indicated at this site.

Site 35GR-147

Location

Site 35GR-147 (Figure 32) is an extensive activity area located on an ephemeral drainage of Wind Creek. The site occurs along the western edge of the drainage with the majority of cultural material located near the confluence of two additional drainages. Located on the site proper, near excavation Unit 1, is an historic cabin. The cabin reportedly is associated with the historic Yreka-Canyon City Gold Trail, but no evidence of the trail was encountered.

The topography of the site area consisted of a moderately wide stream terrace, sloping from south to north, with cultural material located on the terrace and extending up-slope to the west. The soils of the site consisted of brown to dark brown poorly sorted silty sand, comprising two stratigraphic levels (Figure 33).

Cultural Material

The excavation was conducted within three excavation blocks. Cultural material consisted of pestles, flakes, projectile points, bifaces, drills, cores, groundstone, utilized flakes, hammerstones, debitage, and pieces of tin (Table 12). The tin fragments were probably associated with the historic cabin. A surface collection of the site area identified an historic dump, consisting of numerous solder-tip cans. Twenty -three animal bones, 92 tools, and 2100 flakes were recovered from this site.

Three site components were identified at site 35GR-147 (Figure 34), all assignable to Period 4 (2-4000 BP) Component I extended from ground surface to 20 cm below ground surface. The tools in this component consisted predominantly of bifaces and flakes, with a moderate

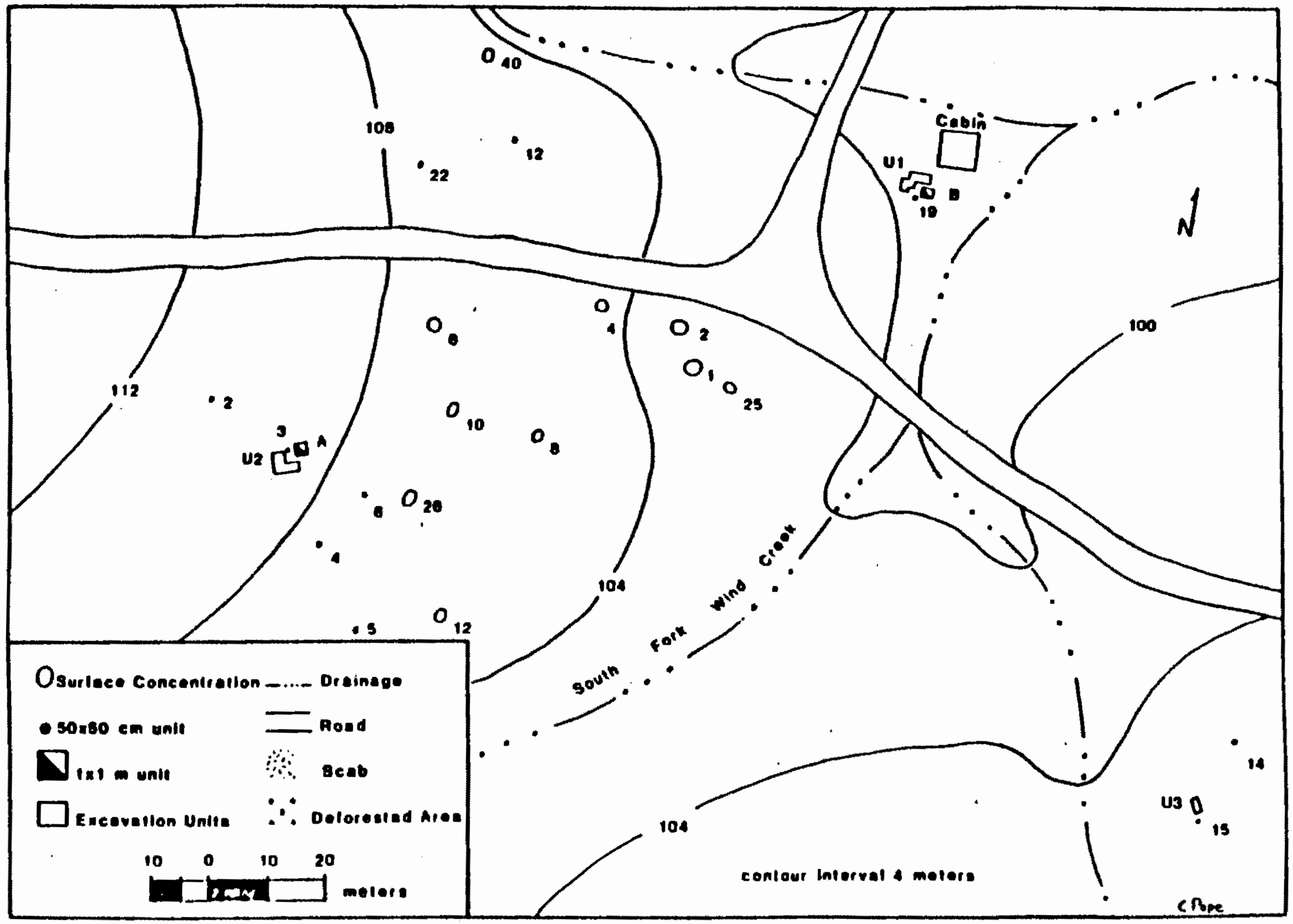


Figure 32. Site map 35GR-147.

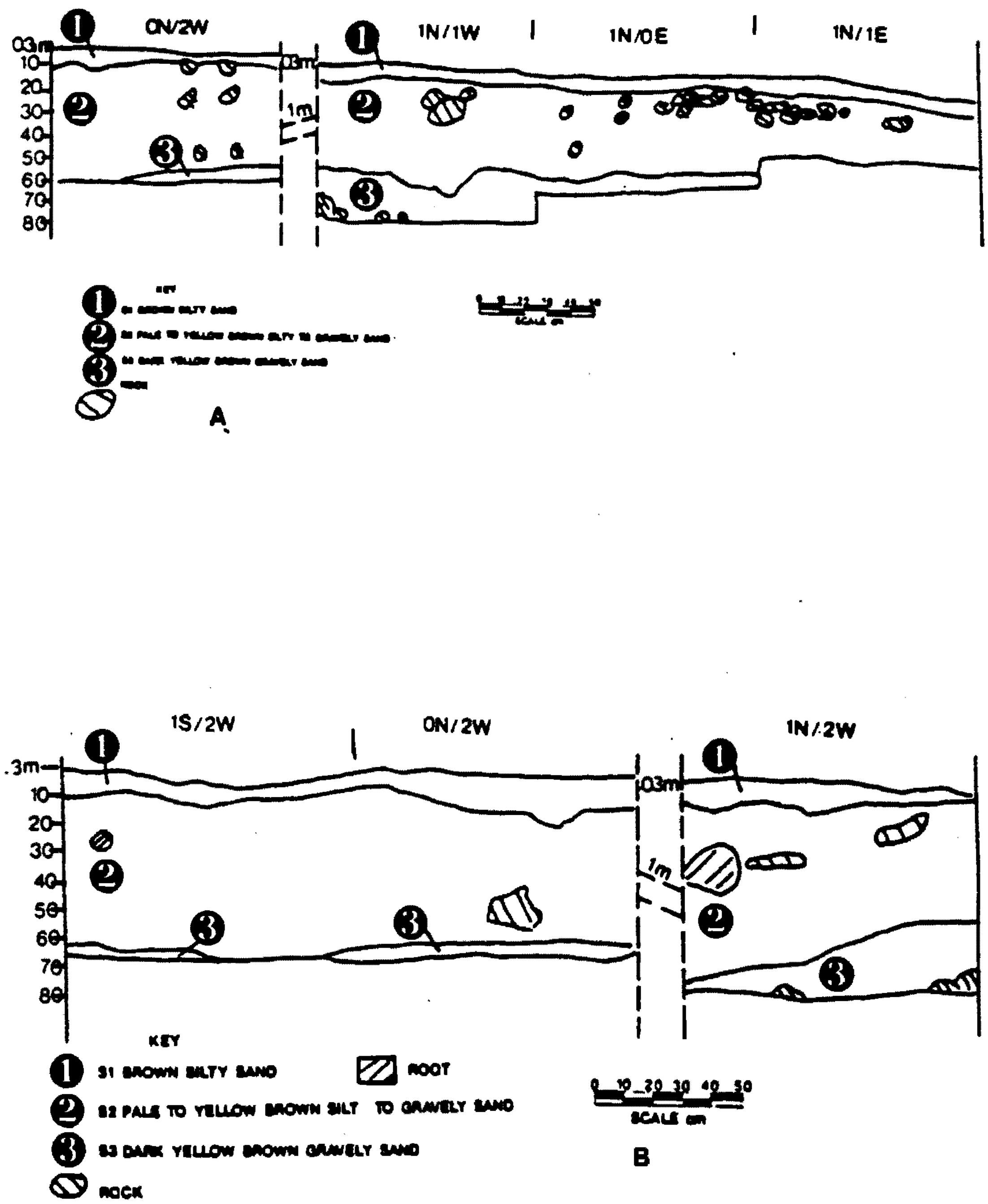


Figure 33. Stratigraphic profile of 35GR-147. A: north wall of unit 1; B; west wall of unit 1.

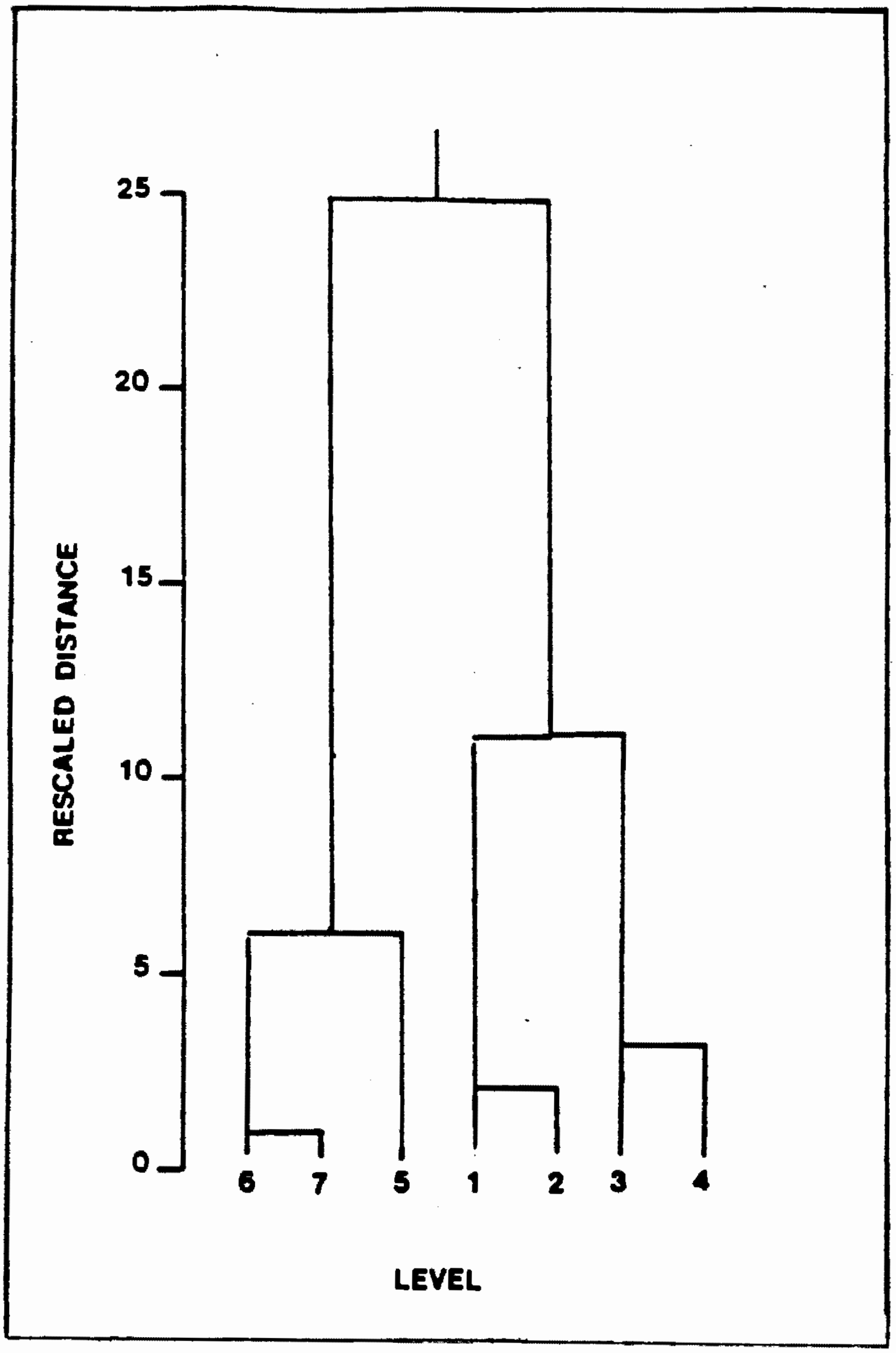


Figure 34. Cluster analysis of cultural material and levels for 35GR-147.

Table 12. Summary of Lithics: 35GR-147[a]

Level	PP	BIF	BC	AB	DL	COR	GS	UF	HH	BU	MN	PE	HS	B	FL	Total[b]
Surf	5	6			2	1	1					1			39	16
1	4	6						5	1						471	16
2	5	11						2	1						540	19
3	2	12						4							427	18
4	2	10						1							316	13
5	1	3				1		1					1		193	7
6		1				1									93	2
7		1													21	1
Total	19	50			2	3	1	13	2			1	1		2,100	92

a-tools from excavation and testing are included but only flakes from excavation
b-total excludes flakes
PP-projectile points BIF-bifaces COR-cores B-beads
BC-battered or cracked cobbles
AB-sandstone abraders
DL-drills
UF-utilized flakes
HH-historic material
BU-burins
PE-pestles
HS-hammerstones
FL- flakes
Cultural component 1-surface through level 2 (20cm)
Cultural component 2-level 3 through level 4 (40cm)
Cultural component 3-level 5 to bedrock (70cm)

number of projectile points, and small numbers of grinding slabs and historic material. Nine animal bones were recovered from this component.

Component II consisted largely of bifaces and flakes with a moderate amount of utilized flakes and extended from 20 to 40 cm below ground surface. Seven animal bones were recovered from this component.

Component III contained predominantly bifaces and flakes. The third component extended from 40 to 70 cm below ground surface, and seven animal bones were recovered from it.

Wind Creek Cultural Material

Projectile Points

Sixty-seven projectile points were recovered from the excavations at the Wind Creek sites. These projectile points were included in the analysis of central Oregon projectile points reported in Chapter IV. Fifteen of the 22 recognized central Oregon projectile point types were found in the Wind Creek sites (Figure 35, Table 13).

Type 1 projectile points (n=2) were similar to Desert tri-notched points. These projectile points fall within Periods VII and VI (0-1500 BP) and were found in levels 2 and 3 at 35GR-162.

Type 3 projectile points (n=6) were similar in form to small corner-notched points with expanding to straight stems. These projectile points fall within Periods VII, VI, and V (0-2000 BP) and were found both on the surface, and in levels 1, 3, and 6 at site 35GR-162; in level 2 at site 35GR-148; and in levels 2, and 5 at 35GR-147.

Type 4 projectile points (n=1) were similar in form to medium side-notched projectile points. These points fall within Periods III and II (4000-7000 BP) and were found in level 6 of 35GR-162.

Type 5 projectile points (n=1) were small basally notched projectile points. These points fall within Periods VII, VI, and V (0-2000 BP) and were found on the surface at 35GR-162.

Table 13. Summary of Wind Creek Projectile Point Data.

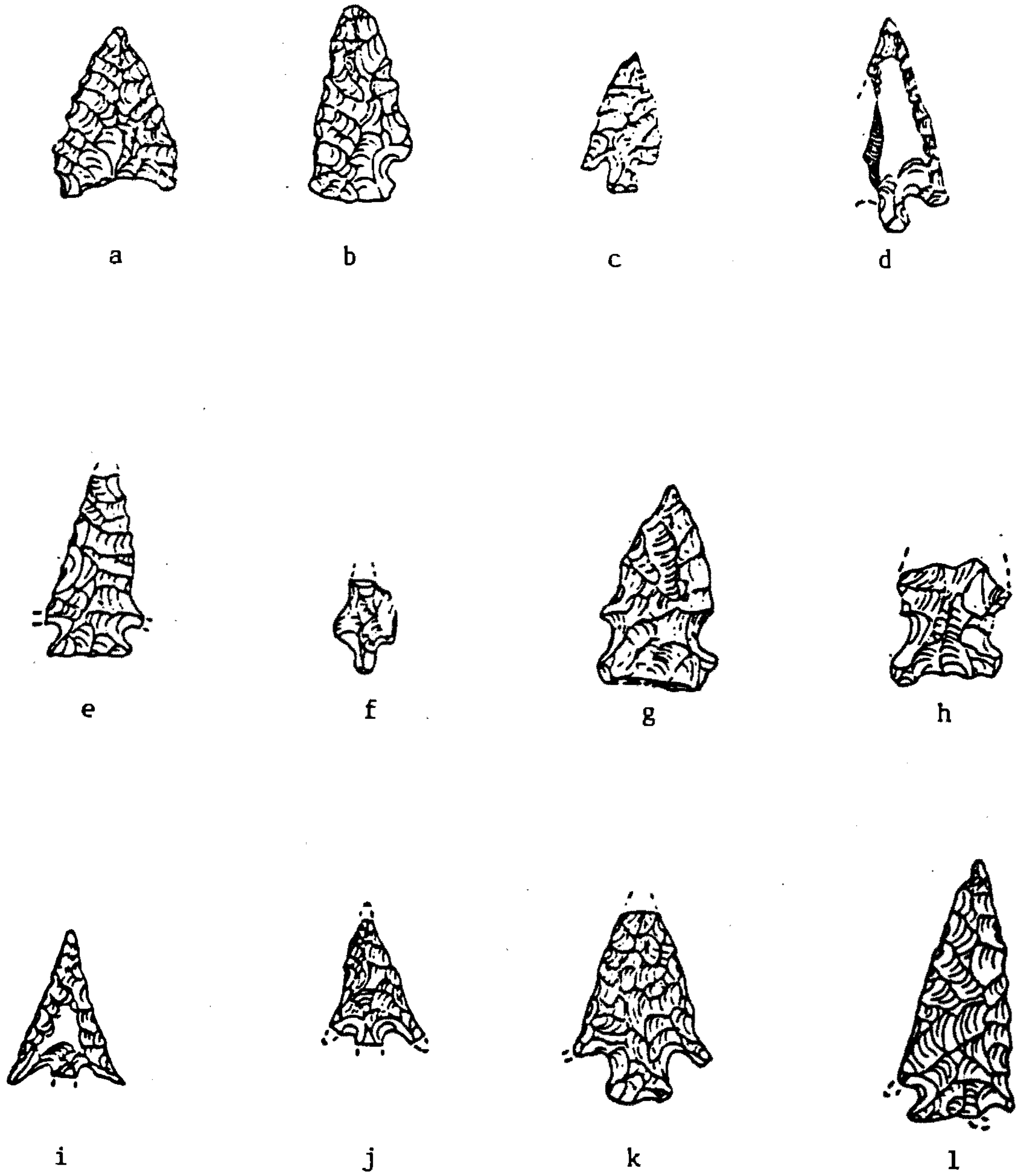
C#	Site	Lev	Comp	Type		Projectile Point Description						
						Notch	NT	BT	Break	Rew	Flaking	
2072	148	S	1	U		SN	BN	CC	I,BF	B,N	R	
2074	148	1	1	U		CN	BN	CC	I,LM,T	AT	MF,SF	
2076	148	2	1	U		SN	BN	CC	N,RE	AL,WH	R	
2080	148	3	2	8		CN	BN	CC	N,RE	AL,WH	R,SF	
2082	148	2	1	6		CN	BN	CC	I,BT	B,E	R	
2071	148	S	1	6		CN	BN	CC	I,TP,T,LM	N	R,HT	
2075	148	3	2	14		CN	BN	ID	I,TP	N	R	
2081	148	3	2	14		CN	BN	CC	PR,E,T	N	R	
3137	148[a]	6	3	18		CN	BN	ST	N,RE	WH,AL	R	
3134	148[a]	5	3	9		SN	BN	CV	I,LM	C	R	
2079	148	1	1	14		CN	BN		I,B		R,MF	
2073	148	2	1	3		ST	NN	ST	I,TP,T	AT,T	R	
2078	148	3	2	12		ST	ST		N	WH,AL	R	
2077	148	3	2	14		CN	BN	CC	I,TP	AB,T,E	R	
2551	162	S	1	5		BN	NN		I,B,T	AT,AL	R	
2552	162	S	1	U		BN	BN		I,B	N	R,MF	
2573	162	1	1	12	ST	BN	ST		I,TP,T	MF,SF,HT		
2557	162	2	1	8	SN	BN	CC		N,RE	AL,WH	R	
2561	162	6	3	U	SN	NN			I,MB	C	R	
2565	162	3	2	3	CN	BN	ST		I,T,TP	AB,AL	R,SF	
2554	162	1	1	8	SN	BN	CC		N,RE	WH,AL	HF,MF,SM	
2555	162	S	1	11	SN	BN			I,TP,T	C	R,SM	
2575	162	1	1	U	CN	BN	ID		I,TP,E,T	C	R	
2577	162	3	2	19	SN	BN	ID		I,TP	AB,NO	R,LP	
2578	162	3	2	U		BN			I,BF	N	R	
2566	162	S	1	3	CN	BN	CC		I,E,TP	AB	R	
2574	162	2	1	14	CN				I,PB,T	C	CL,CF	
2576	162	2	1	1		BN	ST		I,T	C	R	
2559	162	1	1	13	SN	BN	ID		I,TP,T,E	C	R,MF	
2568	162	1	1	U	SN				I,E,B	C	R	
2569	162	1	1	U	SN	BN	ST		I,BF	AB	R	
2570	162	2	1	19	SN	BN	CC		I,TP	C,AN	R	
2581	162	3	2	1	SN	BN	CC		I,B	C	R	
3205	162[a]	5	3	U	SN	BB	CC		B	AT,AB	R	
2575	162	1	1	U	SN		ST			N,RE	C	R
2563	162	5	3	18	SN	BN	ID		HI,BF	AL	R,MF	
2580	162	6	3	4	SN	BN	ID		I,BF	AB	R,SF	
2582	162	6	3	18	SN	BN	ID		N	N	MF,R	
3198	162[a]	10	3	12	SN	BN	ST		N	N	MF,R,SF	
2572	162	5	3	18	CN	BN	ST		I,TP,T	AB,AL	R	

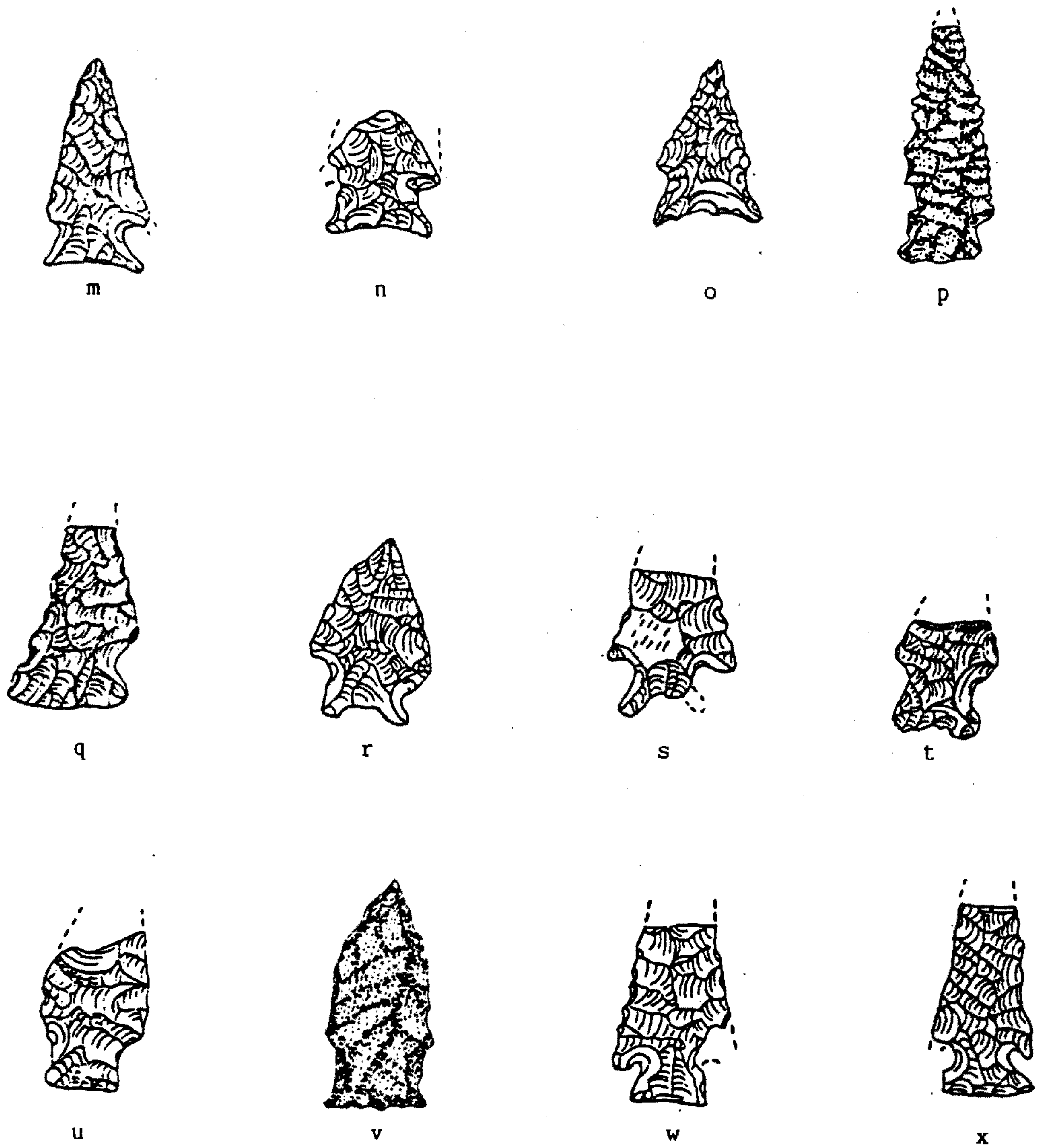
Table 13. (Continued)

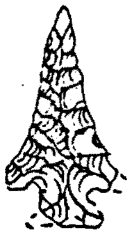
C#	Site	Lev	Comp	Type	Projectile Point Description Notch	NT	BT	Break	Rew	Flaking
2567	162	2	1	15	CT			I,TP	C	R,SF
2553	162	S	1	U		BN	ST	I,TP		PF
2560	162	5	3	U	CN			I,B	N	R,MF
2562	162	5	3	9	SN	BN	ST	I,T	C	R,P
2564	162	3	2	12	ST	BN	ST	I,TP	AB,T	R
2566	162	1	1	3			ST	I,TP		R
2550	162	S	1	U	CN	BN	CC	I,BF	AT	R
2279	147	S	1	15	CT	BN		N,RE	C	R
2270	147	S	1	U	CN			I,TP,B	C	R
2280	147	1	1	8	CN	BN		I,B,T	N	R,MF
3123	147[a]	2	1	3	BN	NN	ST			R,SF
2273	147	S	1	U	ST	BN	ST	I,TP,T	C	R
2277	147	2	1	3	ST			I,BF	AT	R,SF
3116	147[a]	3	1	U	CN	BN	ID	I,E,T	C	R
2274	147	1	1	7	CN	BN	ST	HI,BF	N	R
2271	147	S	1	U	CN	BN	ID	I,E,T	C	R,LP
2278	147	4	2	14	SN	BN	ST	I,T,PB	AB	R
2281	147	2	1	6	CN	BN	ST	I,TP	AB,NO	R
3121	147[a]	5	3	3	SN			I,PB,T	AL	R
2272	147	S	1	11	CN	BN	ID	I,TP,T,E	N	MF
3107	147[a]	4	2	U	CN	BN	ID	N,RE	AB,AL	R,LP
3170	147[a]	4	2	11	BN	BN		I,BT	N	R,MF
2272	147	S	1	11	BN	NN		PR	N	R
2336	159	1	1	11	CN	BN	ID	I,T,E	AL	MF
2338	159	2	1	8	CN	BN	CC	I,B	AB	R
2337	159	2	1	6	CN	BN	CC	I,B,T	B,E	R
3177	159[a]	2	1	U	SN	BN	CC	I,B	C	R

R-Random B-Base NO-Notches BF-Base fragment I-Impact SN-Side-notch BN-Base notch CC-Concave LM-Lateral margin T-Tang missing AT-At tip MF-Made on flake SF-Step fractures N-None Re-Reworked beyond use AL-On lateral margin WH-While hafted E-Ears MB-Missing Base C-Completely reworked ST-Stemmed TP-Tip missing HT-Heat treated PR-Production related SM-Small pressure flakes HF-Hinge fracture at base LP-Large pressure scars HI-Heavy impact PB-Part of base CL-Collateral flaking CF-Curved flake CV-Cortex AB-At base on one side AN-At notches CT-Contracting stem MS-Mid section PF/Percussion flaked on one side. Pressure on the other P-Parallel flaking
[a]-From the testing phase

Figure 35. Wind Creek Projectile Points. Type 1: a, b; Type 3: c, d, e, f; Type 4: g, h; Type 5: i, j; Type 6: k, l; Type 8: m, n, o; Type 9: p, q; Type 11: r, s, t; Type 12: u, v; Type 14: w, x, y, z; Type 15: aa; Type 18: bb, cc; Type 19: dd, ee, ff; Type 20: gg. (All the projectile points are shown in actual size).


a
b
c
d
e
f
g
h
i
j
k
l


m
n
o
p
q
r
s
t
u
v
w
x


y


z

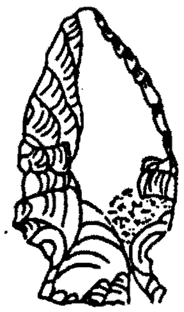

aa

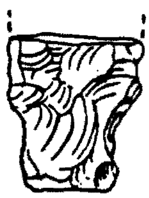

bb


cc


dd


ee


ff


gg

Type 6 projectile points (n=3) were medium corner notched points. These projectile points fall within Periods VII, VI, and V (0-2000 BP). They were found on the surface and in level 2 at 35GR-147; and in level 2 at 35GR-159.

Type 8 projectile points (n=5) were Elko corner-notched types. These projectile points fall within Periods VII-II (0-7000 BP) and were found in level 3 at 35GR-148; in levels 1 and 2 at 35GR-162; in level 2 at 35GR-159; and in level 1 at 35GR-147.

Type 9 projectile points (n=2) were medium side notched points having only one notch. These points fall within Periods III and II (4000-7000 BP). They were found in level 5 at 35GR-162; and in level 5 at 35GR-148 .

Type 11 projectile points (n=5) were split stem points. They fall within Periods IV, and III (2-5000 BP). They were found on the surface and in level 4 at 35GR-147; level 1 at 35GR-159; and on the surface at 35GR-162.

Type 12 projectile points (n=4) were medium stemmed points. These points fall within Period IV (2-4000 BP). They were found in levels 1, 3, and 10 (testing phase) at 35GR-162; and in level 3 at 35GR-148.

Type 14 projectile points (n=6) were medium corner-notched points with slightly rounded bases. These projectile points fall within Periods VI-II (800-7000 BP). They were found in level 4 at 35GR-147; in levels 1 and 3 at 35GR-148; and on the surface at 35GR-162.

Type 15 projectile points (n=2) were contracting stem points. These projectile points fall within Period IV (2-4000 BP) and were found in level 2 at 35GR-162; and on the surface at 35GR-147.

Type 18 projectile points (n=4) were large corner notched points with a large expanding stem. These projectile points fall within Periods VI-II (800-7000 BP). They were found in levels 5 and 6 at 35GR-162; and in level 6 at 35GR-148.

Type 19 projectile points (n=2) were large side-notched points. These projectile points fall within Periods III and II (4000-7000 BP), and were found in levels 2 and 3 at 35GR-162.

Type 20 projectile points (n=1) were large stemmed points. These projectile points fall within Periods III and II (4-7000 BP), and were found on the surface of 35GR-147.

Groundstone

Groundstone artifacts recovered from the Wind Creek archaeological sites consisted of pestles, manos, grooved hammerstones, and grinding slabs. All of these artifacts were manufactured from basalt river cobbles, quartzite, or decomposing bedrock basalt. One groundstone piece had a hole worn in one surface.

Grinding Slabs

Two types of grinding slabs were recovered from the excavations. The first type consisted of flat, oval, pieces of bedrock basalt with smoothly worked worn edges, resulting either from grinding or scraping. Only one example of this type was found, in component II at site 35GR-159 , where it was turned upside down. This also was the only piece of groundstone recovered from this site, and it was found in association a large number of flakes, small amounts of bifaces, and utilized flakes, suggesting that this piece of groundstone was part of a hunting or tool manufacture repair assemblage.

The other type of grinding slabs consisted of large and generally thick pieces of bedrock basalt with single worked surfaces and no edge modification. Many of these pieces were found turned upside down, and some of these pieces recovered from site 35GR-162 contained evidence of a red pigmentation. Significantly, pieces of red ocher were found at this site.

None of the 34 pieces of grinding slabs recovered from the Wind Creek sites exhibited evidence of heavy use. Seventy percent (n=24) of the specimens were from site 35GR-162, twenty-four percent (n=8) were located at site 35GR-148, and one each were recovered from site 35GR-159, and 147.

Grinding slabs were found in levels 1 through 6, and on the surface at sites 35GR-162; levels 2,3,4, and 7 at site 35GR-148; on the surface at site 35GR-147; and in level 1 at site 35GR-159.

Pestles

Nine pestles were recovered from the Wind Creek excavations. Five of these were recovered from site 35GR-162, three were recovered from site 35GR-148, and one was found at 35GR-147. The pestles recovered from site 35GR-162 were found in levels 2,3, and 5. The pestle from site 35GR-147 was found on the surface.

All the pestles recovered were made of bedrock basalt, with one or two pointed ends, both exhibiting use. All except one of the pestles recovered were fragmentary.

Manos and Hammerstones

Five manos and four hammerstones were recovered from the excavations. The manos were all of one type, small flat stones exhibiting wear generally on multiple sides and on the edges.

Manos were found I levels 1, 2, 4, and 6 at site 35GR-162.. One type of manos was identified exhibiting wear generally on multiple sides, and on the edges. Two types of hammerstones were identified. Type I hammerstones exhibited battering on one or both ends, and were ungrooved. Type II hammerstones exhibited battering on both ends, and were fully grooved. Only one example of a type II hammerstone (manufactured of quartzite) was found, at site 35GR-148 in level 3. Two of the hammerstones were found at site 35GR-162 (levels 3 and 5), and one each was found at sites 35GR-147 (level 5), and 35GR-148 (level 5).

Shaft Straighteners

Two grooved sandstone artifacts were found at site 35GR-148, one during the testing phase, and one during excavations. Found in component I, they were categorized as arrow shaft straighteners and indicated the use of the bow and arrow, and/or tool manufacture and repair, as an activity of the site.

Other Artifacts

The category of Other Artifacts included, historic material, beads, and cracked cobbles. All the artifacts within this group represented anomalous material that occurred only sporadically within the excavations.

The historic material consisted of cans, pieces of tin, wire and glass. All this material occurred within the top 20 centimeters, and was restricted to sites 35GR-147 and 148. At site 35GR-147 a cabin was located on the site proper, associated with the Eureka Canyon City Gold Trail. Cans were found on the surface near the cabin, and several pieces of tin, along with nails and glass were found in an excavation unit near the cabin.

The cracked cobbles were derived from basalt river cobbles. No source of river cobbles could be found near the sites, but similar artifacts occur in sites within the region. Source of river cobbles are located near John Day and along the Crooked River, indicating that the cobbles were transported to the Wind Creek sites. Thirteen cracked cobbles were found. Of these, none were found at site 35GR-147, or 35GR- 150. Five cracked cobbles (38.4%) were found at site 35GR-148, in levels 2, 3, and 4. Seven (53.8%) were found at site 35GR-162, in levels 1, 2, 3, 4, and 7. One cobble (7.6%) was found at site 35GR-159 in level 1. These cracked cobbles could have been used as choppers in animal or plant processing.

The Other category included two trade beads. One of the specimens was of rolled copper, and one was a white ceramic bead. Both of these beads were found during the testing phase at site 35GR-148, in levels 1and 2.

Bifacial Flaked Lithic Specimens

A large number of biface artifacts were recovered from the Wind Creek excavations. A preliminary examination of the bifacially flaked lithics (Scott 1986c) indicated that later stages of biface reduction (stages 3-5) were the most common (Table 14). The majority of bifaces recovered from the Wind Creek sites were broken; most of the breakage patterns appear to be related to production failures, and are indicative of bending fractures. These production related breaks probably resulted from the reduction of preforms, rather than the reduction of biface cores. Further, there appear to be more pressure and percussion flaked bifaces than bifaces that are percussion flaked only, indicating that the initial reduction phases of biface manufacture in general

Table 14. Summary of Bifacial Manufacturing Stages Represented at the Wind Creek Sites

Site #	Cat #	Man.S.	Le.	Co.	Per.	Fl.	BK.	Comments
148								
	2094	3-4	4	3	1	P	B,PR,T	Asymetrical
	2098	4-5	5	3	1	P	U,SM,T	
	2186	3-4	3	2	1	P	PE,PR	Little flaking on one side[a]
	2188	4	3	2	1	P	U,SM,T	Undetermained if heat treated
	2193	4-5	4	3	1	P	IM,T	Finished edges
	2708	4-5	1	1	1	P	U,SM,T	
	2709	2-3	4	3	1	P/	B,PR,T	Thick crudely flaked, possible core
	3132	4	2	1	1	P	PE,PR,T	Made on a thin flake
	3135	3-4	4	3	1	P	PE,PR,M	Barely flaked on one face
	3138	3	6	3	1	P	IM,M	Thick for its size
	3139	4	4	3	1	P	IM,T	
	3144	4	5	3	1	P	U	
	3145	4	2	1	1	P	PE,PR,T	Thin even edges
	3146	2-3	5	3	1	P/	B,PR,L,	Barely flaked thick
Total	14	3.7[b]						
147								
	2285	4-5	5	3	1	P	U,SM,T	
	2286	4	3	1	1	P	U,T	Thick for size,steep fractures
	2293	2	3	1	1	P/	B,PR,T	Thick crudely flaked
	2299	3	7	3	1	PX	U,BS	Crudely flaked, thin preform
	2801	3-4	2	1	1	P	U,L	Thick for size
	2802	3	2	1	1	P	IC,T	Thick for size, even edges[c]
	2803	4-5	4	2	1	P/	IC,PR	Very thin, possible preform
	2805	3	6	3	1	P	B,PR,T	Very thin
	2806	5	4	2	1	P	V,T	Step fracture near tip
	2810	2	4	2	1	P/	U,T	Crudely flaked, uneven edges
	2814	4	4	2	1	P	PE,PR,T	Somewhat asymetrical
	2815	2	4	2	1	P/	B,PR	Uneven edges[d]
	2816	4-5	1	1	1	P	B,PR,M	Finely flaked, edges unfinished
	2817	4	S	1	1	P	PE,PR,BS	Appears finished
	2818	4	S	1	1	P	B,PR,V	Thin, step fracture
	2822	2-3	S	1	1	P/	B,PR,M	Thick, crudely flaked, core ?
	2824	2	2	1	1	P/	U,PR,L	Thick, roughly flaked
	2826	5	S	1	1	P	B,PR,M	Thin, well flaked, preform?

Table 14. (Continued)

Site #	Cat #	Man.S.	Le.	Co.	Per.	Fl.	BK.	Flaking and Breakage Description Comments
	2829	2	4	2	1	P/	B,PR,T	Rough, thick, uneven edges
	2819	4	2	1	1	P	B,PR,T	
	2820	5	2	1	1	P	V,B,PR,M	Finely flaked[e]
	2823	2-3	3	1	1	PX	B,PR,BS	Thick, asymetrical, uneven edges
	2834	3-4	3	1	1	P	IM,T	Edges crunched
	2804	2	3	1	1	P	L	Chert, heat treated?
	2808	4	4	2	1	P	B,PR,T	Asymetrical at tip
	3101	5	2	1	1	P	UR	Thick for size[f]
	3102	3	4	2	1	P	IM,L	
	3103	4-5	3	1	1	P	IC,B,T	Unfinished edge, crunched
	3104	4	3	1	1	P	B,PR,T	Somewhat thick
	3105	3	3	1	1	P	PR,L	Thick,worked only on one side[g]
	3112	4	4	2	1	P	B,PR	Thin, even edges,step fractures
	3124	3	S	1	1	P/	B,IM,,M	Either impact or bending frac.
	3125	3	S	1	1	P	B,IM,L	Thick, impact or bending frac.
	3126	3	S	1	1	P	IM,L	Thick, but finished?
Total	34	3.47[b]						
162								
	2453	2-3	3	2	2	P/	PE,PE,T	Thick,crude,uneven flaked,step f.
	2459	2-3	4	3	3	P/	B,PR,BS	Uneven edges, step fracture
	2465	3	1	1	1	P	PE,PR,T	Asymetrical,thin, uneven edges
	2468	1-2	2	1	1	P	B,PR	Cortex,barely flaked
	2475	4	5	3	3	P	B,PR,BS	
	2489	4	5	3	3	P	B,PR,T	May be exhausted projectile point
	2583	4	5	3	3	P	B,PR,BS	
	2584	2-3	2	1	1	P/	B,PR	Very thick for width
	2588	3	2	1	1	P	B,PR,M	Thick, not regularly flaked
	2599	3	2	1	1	P/	B,PR,C	Thick, edges uneven
	2660	3-4	4	3	3	P	U,T	Thick, uneven edges
	2661	4-5	3	2	2	P	U,SM,T	
	2662	4-5	4	3	3	P	U,SM,T	
	2663	4-5	4	3	3	P	U,SM,T	
	2677	3-4	4	3	3	PX	B,PR,T	Thin for a biface preform
	2680	3-4	3	2	2	P/	Pe,PR,T	Thick uneven edges
	2686	4-5	3	2	2	P	B,PR,T	Thick

Table 14. (Continued)

Site #	Cat #	Man.S.	Le.	Co.	Per.	Fl.	BK.	Comments
	2689	3	3	2	2	P	PE,PR,BS	Barely flaked on one side
	2344	4	3	2	2	P	B,PR,BS	Projectile point?
	2463	3-4	3	2	2	P	IC,T	Used tool, edges worn
	2483	4-5	S	1	1	P	B,PR,T	
	2591	3-4	3	2	2	P	IM,T	Thick
	2682	4	2	1	1	P	PE,PR,L	
	2688	4	3	2	2	P	IC,T	Thick,used
	2694	4-5	1	1	1	P	B,PR,BS	Small frg.
	2462	2-3	4	3	3	P	W	Basalt,lancelot shaped
	2473	3	4	3	3	PX	W	Large flakes removed, core?
	3200	4	6	3	3	P	IM,L,T	
	3201	5	4	3	3	P	IM,BS	Stemmed biface, hafted knife?
	3202	5	6	3	3	P	IM,BS	Contracting stem, used artifact
	3203	5	2	1	1	P	IM,M	Used artifact
	3204	3	7	3	3	P	B,IM,BS	Uneven edges, step fractures
Total	32	3.67[b]						
159								
	2340	3	1	1	1	P/	PR,L	Thick, knapper hit too close to edge
	2341	3	1	1	1	PX L	PE,B,PR,	Edges uneven,thick
	2343	2-3	2	1	1	P/	B,PR,BS	Thick, cortex
	2346	4-5	2	1	1	P	U,SM,T	
	3174	5	2	1	1	P	IC,B,M	Very thin, finely flaked
	3176	3-4	2	1	1	P/	IC,T	
Total	6	3.58[b]						

CAT #-catalog number MAN.S.-manufacture stage LE-level CO-component PER-period FL-flaking description BK-breakage description W-whole UR use related V-very thin P-pressure flaked PX-percussion flaked P/Percussion-pressure flaked BS-base B-bending fracture PR-production related break T-tip SM-small U-undetermained PE-perverse break IM-impact M-midsection L-lateral margin break IC-inclusion caused a-heat treated b-average c-not heat treated d-improper platform preparation e-several series of pressure flakes removed f-stemmed biface hafted knife g-knapper hit too far into edge were carried out at other site locations, such as quarries. Analysis of the debitage should support this hypotheses if a higher percentage of interior flakes than cortext flakes are found at the sites.

The analysis of the bifacial material (Scott 1986c) began by separating the bifaces from the remainder of the lithic collection. One hundred forty eight artifacts were recorded as bifaces. Of these bifaces, 51 were tip fragments. Twenty eight were mid sections (missing the tip and base), 58 were fragments (larger than tips), and one was a completebiface secimen. One hundred forty two bifaces were manufactured from obsidian; there were only 4 from crypto-crystalline silica, 1 of basalt, and 1 of ignimbrite. Three of the 4 crypto-crystalline silica bifaces were recovered from site 35GR-147, in levels, 3, 5, and 6. The fourth specimen came from the testing of site 35GR-150, level 1. The basalt biface was recovered from site 35GR-162 level 3, and the ignimbrite biface was recorded at site 35GR-162, level 6.

Five stages of manufacture were used to classify the artifacts, with four overlapping categories, for a total of nine groups. The five initial categories are similar to what Sharrock (1966) and Callahan (l979) have used to classify stages of biface manufacture. The stages are described by Callahan (1979). Stage 1 involves obtaining the raw material, and might involve spalling of cores to obtain flakes. Evidence of Stage 1 manufacture would be in the form of chunks of raw material, or bifacially spalled cores. Stage II manufacture involves the initial edging of the bifaces. During this stage the core blanks or spalls edge is shaped. Stage III involves primary thinning where a lenticular cross section is obtained by means of driving flakes from the edges to the middle of the biface. Stage IV manufacture involves secondary thinning during which a flattened cross section is obtained. Stage V involves shaping and retouching the biface.

Of the 148 bifaces, 96 (64.4%) could be classified into stages of manufacture. These artifacts consisted of fragments, mid sections or whole bifaces. Fifty two (45.6%) were considered too fragmentary to group, and represented tip or base fractures, of which 39 (75%) could be related to bending fractures, and 13 (25%) to perverse fractures. Of the 96 bifaces that could be grouped into stages 54 (56.2%) shared production related breakages, 16 (17%) were caused by impact, 8 (8.5%) hhad breakage caused by inclusions, and 16 (17%) were uninterpretable.

Site 35GR-162 contained 53 bifaces, 27 (53%) of which were able to be sorted according to the stated procedure. The mean stage of manufacture varied between 3.1 in Component 1, to 3.6 in Component 2, and 3, with a site average of 3.4. Forty one percent (n=22) of the bifaces were found in Component 3, 26% percent (n=14) in Component 2, and 32% (n=17) in Component 1, indicating a large increase in biface manufacture at the site between components 1 and 3.

Site 35GR-159 contained 12 bifaces, 4 (33%) of which could be sorted according to the stated procedures. None of the bifaces sorted were found in Component 2, and the average stage of manufacture for Component l was 3.2. Sixty seven percent (n=8) of the bifaces occurred in Component 1, and 33% (n=4) in Component 2, indicating a decrease in tool manufacture between the earlier and later components.

Site 35GR-148 contained 28 bifaces, 8 (28.5%) of which could be sorted according to the stated procedures. The mean stage of manufacture ranged from 3.2 in Component 1, to 3.7 in Components 2 and 3, for a site average of 3.6. Fourteen (50%) of the bifaces occurred in Component 1, 5 (17.8%) in Component 2, and nine (32.1%) in Component 3.

Site 35GR-147 contained 49 bifaces, 25 (51%) of which could be sorted. The mean biface manufacture stage ranged between 3.7 in Component 1, to 2.8 in Component 2, to 3.4 in Component 3, for a site average of 3.5. Twenty three (46.9%) of the bifaces occurred in Component 1, 12 (24.4%) in Component 2, and 14 (28.5%) in Component 3, indicating a large amount of bifaces being manufactured in Component 1, decreasing in Components 2, and 3. Component 2 at this site contained the only distinct deviation in average stage of biface manufacture (2.8) indicating possibly lower biface manufacture here at this time, or a sampling bias.

Mean stages of biface manufacture remained relatively stable through the various site components, indicating no change over timein lithic procurement patterns at the Wind Creek sites. Bifacial material was generally brought into all the sites in a preform stage, with repairs and reduction sequences being performed at the sites. The distribution of cores does not follow the same pattern as that of the bifacial specimens. Rather, cores are found in the same pattern as projectile points, grinding slabs and cracked cobbles, indicating that the primary use of cores at the Wind Creek sites was not for the manufacture of bifacial artifacts.

Debitage

The debitage from the Wind Creek archaeological sites consisted of five broad categories of material, obsidian, ignimbrite, quartzite, crypto crystalline silica, and petrified wood. The analysis proceeded by sorting the debitage into material types, size graded categories, and stages of flake manufacture. The size graded categories ranged from less than 1 cm to greater than 5 cm., and the stages of flake manufacture included primary, secondary, interior, flake fragments, and angular waste and potlids. A 10% sample of the debitage was then selected and further analyzed (Scott 1986c) by classifying the sample into biface thinning initial, biface thinning intermediate, and biface thinning advanced. Evidence of lipping and thinning was examined as well as platform preparation and evidence of flake scar detachment, hinges and pressure flakes, angular waste, cortex, and flake fragments were also evaluated (Table 15).

Table 15. Summary of Wind Creek Sites Debitage Sample Characteristics

Site # Obs Bas Ccs	Bti	Btint	Bia	Li	Th	Pp	Sc	Hi	Pr	Aw	Cor	Ff	Total
147	19	151		4	2	25	3	1	18	4	8		235
		2											2
		3[a]			1[a]				2[a]				6
Total	19	156		4	3	25	3	1	20	4	8		243
148	21	58	23	9		22			16	4		45	198
	1	1			13								15
		1[a]			8[c]	1[b]			2[a]	9[d]	1[b]	1[a]	23
Total	22	60	23	9	21	23			18	13	1	46	236
159	14	25	18	6	6[c]	18		1	16	1	2	61	168
Total	14	25	18	6	6	18		1	16	1	2	61	168
162	5	11	21		1[f]	11	2		13			26	90
		1			22[g]					6			29
										1[b]			1
Total	5	12	21		23	11	2		13	7		26	120

Table 15. (Continued)

Site # Obs Bas Ccs	Bti	Btint	Bia	Li	Th	Pp	Sc	Hi	Pr	Aw	Cor	Ff	Total
Total	59	245	62	19	7[h]	76	5	2	63	9	10	132	91
	1	4			34[i]					6			45
		4[a]			9[j]	1[b]			4[a]	10[k]	1[b]	1[a]	30
Total	60	253	62	19	50	77	5	2	67	25	11	133	764

BTI-biface thinning-initial BTINT-biface thinning intermediate BIA-biface thinning adv.
LI-lipped TH-thinning PP-platform preparation SC-scar detachment HI-hinge
PR-pressure AW-angular waste COR-cortex FF-flake fragment
OBS-obsidian CCS-chert BAS-basalt
a-heat treated b-not heat treated c-5 heat treated, 3 not heat treated d-6 are heat treated, 3 are not heat treated e-3 of the 6 are alternate flakes f 1 obsidian alternate flake g-8 of 21 are alternate flakes h-4 of 6 are alternate flakes i-22 are alternate flakes j-6 of 9 are heat treated
k-6 of 10 are heat treated

There were 13,333 flakes recovered from the Wind Creek excavations (Tables 16, 17). Of these flakes 78.7% (n=10,499) were obsidian, 2.8% (n=376) were crypto-crystalline silica, 14.2% (n=1901) were basalt, and 4% (n=541) were ignimbrite. Petrified wood (n=1projectile point), and quartzite (n=15) amounted to less than 1 % of the total. Site 35GR-162 contained 39.9% (n=5329) of the flakes, followed by site 35GR-148 with 24% (n=3202), 35GR-159 with 17.6% (n=2351), and site 35GR-147 with 15% (n=2106) . When the total flakes for each site are divided by the total tools, the highest ratio of flakesto tools is at site 35GR-159 (.005), followed by site 147 (.04, site 148 (.02), and site 162 with a ratio of .01 tools per flake.

The distribution of crypto-crystalline silica flakes was greatest in site 35GR-148, with lower amounts in sites 35GR-147 and 35GR-162 Basalt ratios were very high in site 35GR-162, and moderately high in 35GR-148. Petrified wood was only found in site 35GR-162, and comparitively large amounts of ignimbrite were found only in site 35GR-159.

A higher proportion (36.8%,n=3870) of the total obsidian flakes was recovered from site 35GR-162. The highest proportions of crypto-crystalline silica (42.5%, n=160) were recovered from site 35 GR-148 and site 35GR-162. The quartzite came predominantly from sites 35GR-162 (60%, n=9) and 35GR-148 (40%, n=6), while the vast majority of ignimbrite (76.8%, N=416) came from site 35GR-159.

Of the total flakes, 1.5% (n=204) were classified as primary flakes, 5% (n=656) as secondary flakes, 17.9% as interior flakes (n=2313), 64.1% (n=8261) as flake fragments, 3.3% (n=437) as angular waste, and 6 (.04%) as potlids. As Table 17 shows, little variation existed between sites in the proportion of primary and secondary flakes, while some minor variations existed within the category of interior flakes. Site 35GR-162 contained 30.3% (n=1623) interior flakes, while the remaining sites fluctuated between 17.2% (n=388), and 23.5% (n=756). Flake

Table 16. Summary of Debitage Raw Material Occurrence at the Wind Creek Sites[a]

Site #	Obsidian (col.%) (row%)	Chert (col.%) (row%)	Basalt (col.%) (row%)	Petrified Wood (col.%) (row%)	Quartzite (col.%) (row%)	Ignimbright (col.%) (row%)	Total (col.%)
147	1,982	53	65	0	0	6	2,106
	(18.8)	(14.0)	(3.4)			(1.1)	(16.2)
	(94.1)	(2.5)	(3.0)			(.2)	
148	2,768	160	243	0	6	25	3,202
	(26.3)	(42.5)	(12.7)		(40.0)	(4.6)	(24.6)
	(86.4)	(5.0)	(7.6)		(.2)	(.8)	
159	1,879	19	37	0	0	416	2,351
	(17.8)	(5.0)	(1.9)			(76.8)	
(18.1)							
	(79.9)	(.8)	(1.5)			(17.6)	
162	3,870	144	1,211	1	9	94	5,329
	(36.8)	(38.2)	(63.7)	(100)	(60.0)	(17.3)	(41.0)
	(72.6)	(2.7)	(22.7)	(.01)	(.1)	(1.7)	
Total	10,499	376	1,556	1	15	541	12,988
row%	(80.8)	(2.8)	(11.9)	(.007)	(.11)	(4.1)	

[a] col.%-column percentage
row%-row percentage

Table 17. Summary of Debitage Types

Site #	Primary (row%) (col%)	Secondary (row%) (col%)	Interior (row%) (col%)	Fragment (row%) (col%)	Angular (row%) (col%)	Potlid (row%) (col%)	Total (col%)
147	20	92	546	1,397	49	2	2,106
	(.9)	(4.3)	(25.9)	(66.3)	(2.3)	(.09)	(16.2)
	(9.8)	(14.0)	(16.4)	(16.6)	(11.2)	(40.0)	
148	20	135	756	2,128	159	4	3,202
	(.6)	(4.2)	(23.6)	(66.4)	(4.9)	(.1)	(24.6)
	(9.8)	(20.5)	(22.8)	(26.4)	(36.3)	(60.0)	
159	17	75	388	1,825	46	0	2,351
	(.7)	(3.1)	(16.5)	(77.7)	(1.9)		(18.1)
	(8.3)	(11.4)	(11.7)	(21.7)	(10.5)		
162	147	354	1,623	3,022	183	0	5,329
	(2.7)	(6.6)	(30.4)	(56.7)	(3.4)		(41.0)
	(72.0)	(53.9)	(48.9)	(36.0)	(41.8)		
Total	204	656	3,313	8,372	437	6	12,988
(row%)	(1.5)	(5.0)	(25.5)	(64.4)	(3.3)	(.04)	

Primary-primary flake. Secondary-secondary flake. Interior-interior flake
Fragment-flake fragment. Angular-angular waste. row%-row percentage
col%-column percentage

fragments also exhibited variation, with sites 35GR-159 containing 76.5% (n=1720), sites 35GR-147 and 35GR-148 around 65%, and site 35GR-162 some 56.8% (n=3041) flake fragments. Little variation existed within the distribution of angular waste, and potlids were found only in small amounts, only in site 35GR-148.

The analysis performed by Scott (1986c) indicated a low occurrence of initial biface thinning flakes, and low occur-rences of intermediate biface thinning flakes, except in site 35GR-147 where 64.1% (n=156) of the sample flakes were intermediate thinning flakes. Low occurrences of advanced thinning flakes were found in all sites. Very little angular waste was found in all sites, while no flake fragments were found in the sample from site 35GR-147, but large amounts came from site 35GR-159.

Site 35GR-147 contained a sample of 240 flakes. The initial and advanced stages of biface reduction were emphasized here, with few flake fragments and proportionately large numbers of pressure flakes. Component 1 contained a large number of intermediate stage biface thinning flakes, the proportion increasing slightly in component II. In component III the intermediate stage flakes continued to be predominant, with increases in platform preparation flakes.

Site 35GR-148 contained a sample of 236 flakes. All phases of biface reduction were represented, in addition to heat treated and untreated chert flakes, possibly suggesting two different types of chert material present at the site. This site contained a large number of chert flakes in comparison to other sites. Lipped bifacial flakes were found indicating that the knappers were "hitting into" the edges of their bifaces (Scott 1986c:2). Component 1 contained a large proportion of intermediate stage bi-facial thinning flakes. Component II decreased in Intermediate stage fakes, and increased in flake fragments and initial biface thinning flakes. Flake fragments continued into component III, with large increases in advanced bifacial thinning.

Site 35GR-162 contained a sample of 120 flakes with moderate amounts of flake fragments. Proportionally large numbers of basalt flakes occurred, many of which were large alternate thinning flakes, indicating the working of sizable pieces of tabular basalt, or river cobbles. The late stages of biface reduction were emphasized at this site. One chert flake occurred in the sample for this site and was not heat treated.

Site 35GR-159 contained a sample of 168 flakes. All phases of biface reduction were represented, and only obsidian and ignimbrite flakes were found in the sample. The flakes contained numerous examples of platform preparation, indicative of biface reduction. The presence of alternate biface obsidian thinning flakes suggested that tabular pieces of obsidian were utilized at this site. A large number of flake fragments were found in the sample. Component I contained a large number of flake fragments, continuing into component II, where intermediate stage biface flakes increased.

In summary, Scott (1986c) states that most of the flakes in the Wind Creek debitage sample were related to Intermediate stages of biface reduction. The high occurrence of platform preparation flakes indicates that bifaces were being prepared for the removal of flakes. These flakes may have been used as blanks which could then be reworked into other tools, as evidenced by the occurrence of flakes containing the original flake scar detachment on their dorsal surface. Pressure flaking occurred at all sites, and chert was both heat treated, and untreated. Only small amounts of angular waste are present in the samples, indicating that the raw material was brought to the sites generally in a refined condition.

Conclusions

The Wind Creek sites represent limited to moderate activity loci that were visited repeatedly over a long period between about 4000 BP and historic times. These lithic dominated archaeological sites contain proportionately large quantities of obsidian flakes, with smaller amounts of lithic tools including bifaces, projectile points, grinding slabs, manos, and occasionally drills, cores, scrapers, and occasional evidence of trade in the form of trade beads. Typically they contain no clearly definable cultural features, though tools, charcoal, fire-cracked rock, and lithic debitage indicate that various activities were carried out by their occupants.

Excavations at the Wind Creek sites have yielded components that fall within central Oregon periods 6 (800-1500 BP), 5 (1500-2000 BP), and 4 (2000-4000 BP). Fifteen styles of projectile points were found in the sites, including small, medium and large side-notched, corner-notched, and stemmed points, in addition to medium sized split stem and small basal notched projectile points. Radiocarbon dates indicate a 4000 year occupation span for the set of sites as a whole, and source analysis of obsidian from the sites identified 12 chemically discrete sources (see Appendix C). The majority of the obsidian toolstone found at the Wind Creek sites was procured from the area east of Seneca, Oregon. Obsidian hydration analysis identified an estimated hydration rate of 2.98 $microns^2$/thousand years for the Whitewater Ridge source, and an estimated 3.18 $microns^2$/thousand years for the remaining sources at the Wind Creek sites.

Activities at site 35GR-159 were oriented around biface manufacture, other activities are indicated by a small amount of recovered bone, and small amounts of other tools. If cultural features were constructed at this sites they were of short duration and easily destroyed by natural processes. Activity at 35GR-159 appears to have been oriented around the manufacture of tools. This activity was largely confined to bifacial reduction, with evidence of other activities related to subsistence, indicated by the groundstone artifacts, projectile points, utilized flakes and battered cobbles. A grinding slab found at the site was flat, portable, and oval, with worked smooth edges, and no indentation on the surfaces. This type of groundstone slab would have been used for the rolling or crushing of seeds, rather than a pounding activity that would require a trough or indentation to catch the seeds. The lack of substantial cultural features at the site suggests short term occupation by small groups moving through the area, probably on a seasonal basis. This site was dated to 880 BP.

Activities at 35GR-147 appear to suggest a longer duration of occupation, and more geographically extensive than site 35GR-159. Activities at this site were predominantly oriented towards tool manufacture, probably of bifaces, but a number of grinding slabs, often turned upside down, suggests that plant processing was important here. The geographic placement of 35GR-147 also suggests that its occupants were concerned with plant resources.

Activities at both 35GR-148, and 35GR-162 appear to be have been longer term, and these sites may represent base camps, probably of a seasonal nature. A full range of activities was represented as demonstrated by a large number of tool types (n=14), including hunting, tool manufacture, and plant procurement. While some non-portable artifacts are found at 35GR-147, proportionally larger amounts of groundstone (also turned upside down) were found at 35GR-148 and 35GR-162. Cultural features such as firepits, and charcoal stained soil were found at these two sites, but still in limited amounts. These two sites were both extensive, with site 35GR-148 being located in extremely sandy soil.. Site 35GR-148 contained the only evidence of trade in the form of two trade beads, presumed to be historic. Four cultural components were found at each of these sites with dates ranging from 1690 to 4004 BP.

Thus, the two task specific sites found at Wind Creek were predominantly related to tool manufacture, while the two base camps were places where more kinds of activities were centered. The large amount of nonportable groundstone found at the latter two sites indicates that plant procurement was a major activity focus of the base camps.

The record provided by the Wind Creek sites suggests that in this upland region, occupation may have been predominantly seasonal and short-termed, extending over a period of thousands of years. Clearly all the evidence currently available from both the Wind Creek excavations and surface survey in the surroundinjg area , suggests that sedentary, long-term occupation sites are rare, or non-existent in the uplands. The Wind Creek sites appear to exemplify a portion only of the annual round of the region's prehistoric ocupants, who seemingly must have had their more permenant bases in the adjacent lower-lying areas.

CHAPTER VI

SETTLEMENT PATTERNS

Introduction

To understand the archaeology of the central Oregon region an analysis of human settlement patterns and their persistence or change through time is critical. In this chapter, data on a sample of 1150 prehistoric archaeological sites recorded between 1978 and 1992 from the Ochoco National Forest are analyzed. The data collected from these sites have been entered into a computerized data base system, and the results of a multifaceted quantitative distributional analysis are presented below in an account of central Oregon prehistoric settlement patterns. The archaeological sites are classified according to the numbers and types of artifacts present, and environmental and physiographic variables directly related to the distribution of sites across the landscape are examined. A glimpse of toolstone procurement patterns in the region is also offered, through a brief analysis of obsidian artifacts made of stone geochemically traced for specific geological sources.

Archaeological Site Data

The archaeological data on which this settlement analysis is based was collected by the Forest Service between the years of 1978 and 1992. All of the surveys conducted were related to timber management activities, and used standard archaeological survey techniques. Project areas were designated and surveyed using transects varying in width between 15 and 30 meters. While areas recieving direct impact from Forest Service activities were the prime target of the surveys a representative sample of all project areas was surveyed. Information concerning environmental features, attributes, and locations of all archaeological sites encountered was recorded. Most of the Forest area has been surveyed, and some areas have been resurveyed due to overlapping project boundaries, and multiple Forest Service activities. The survey data represents fourteen years of data collection, and thus, should represent a full range of prehistoric sites found on the forest land

The site forms were entered into an Ochoco National Forest cultural resource database system and the variables include a variety of locational, environmental, structural and management data pertaining to each recorded site location. Eleven of the variables recorded in the overall data base contain settlement data relevant to the objectives of this study, and were chosen for the present analysis. These variables, treated individually below, included site catalog number, district, elevation, slope, distance to water, site size, landform, water source, overstory vegetation, flaked stone type, and other artifact type. In the following pages the variables are briefly discussed and relevant descriptive data are summarized quantitatively in accompanying graphs and charts.

Site Catalog Number

This was a numerically coded sequential variable. The largest number was 1150. Every archaeological site used in the analysis was assigned a site catalog number.

District

District was a numerically coded variable ranging from 1 to 5. Value 1 was the Big Summit district. One hundred eighty six (186), or 16.2% of the sites were recorded in this district. Value 2 was the Paulina district. Two hundred eighty four (284), or 24.7% of the sites were recorded here. Value 3 was the Prineville district. One hundred thirty one (131), or 11.4% of the sites were recorded here. Value 4 was the Snow Mountain district. Four hundred forty six (446), or 38.8% of the sites were recorded here. Value 5 was the Crooked River National Grasslands. One hundred three (103), or 9% of the sites were recorded here.

Elevation

Elevation was a numerically coded variable pertaining to the elevation of the sites in feet above sea level. Site elevations, rounded to the nearest hundred feet, ranged from 1000 to 7100 feet above sea level. Figure 36 displays the elevations of all recorded archaeological sites and Figure 37 divides the site elevation data by forest service districts.

As may be clearly seen in Figure 36, the majority of archaeological sites within the study area as a whole were found between 4000 and 6000 feet above sea level. Analysis of the data shown in Figure 37 indicates that elevation patterns differ by geographical district. On the Prineville and Snow Mountain Districts the majority of archaeological sites are found between 5000 and 6000 feet above sea level. The Big Summit and Paulina Districts contain significant percentages of sites between 4 000 and 5000 feet above sea level. sea level. Finally the majority of sites on the Grassland District are found between 3000 and 4000 feet above sea level. This indicates that the Big Summit, Snow Mountain, Paulina, and Prineville Districts were quite distinct in the kinds of environments that each made available for human use.

The elevation variable was further divided into low, medium, and high elevation categories based upon the life zone concept (see Figures 36 and 37). Low elevation was associated with the Upper Sonoran zone and ranged from the lowest recorded site on the forest, at 2400 ft, to 3500 ft. The medium range of elevation extended from 3500 to 5000 ft above sea level, and was associated

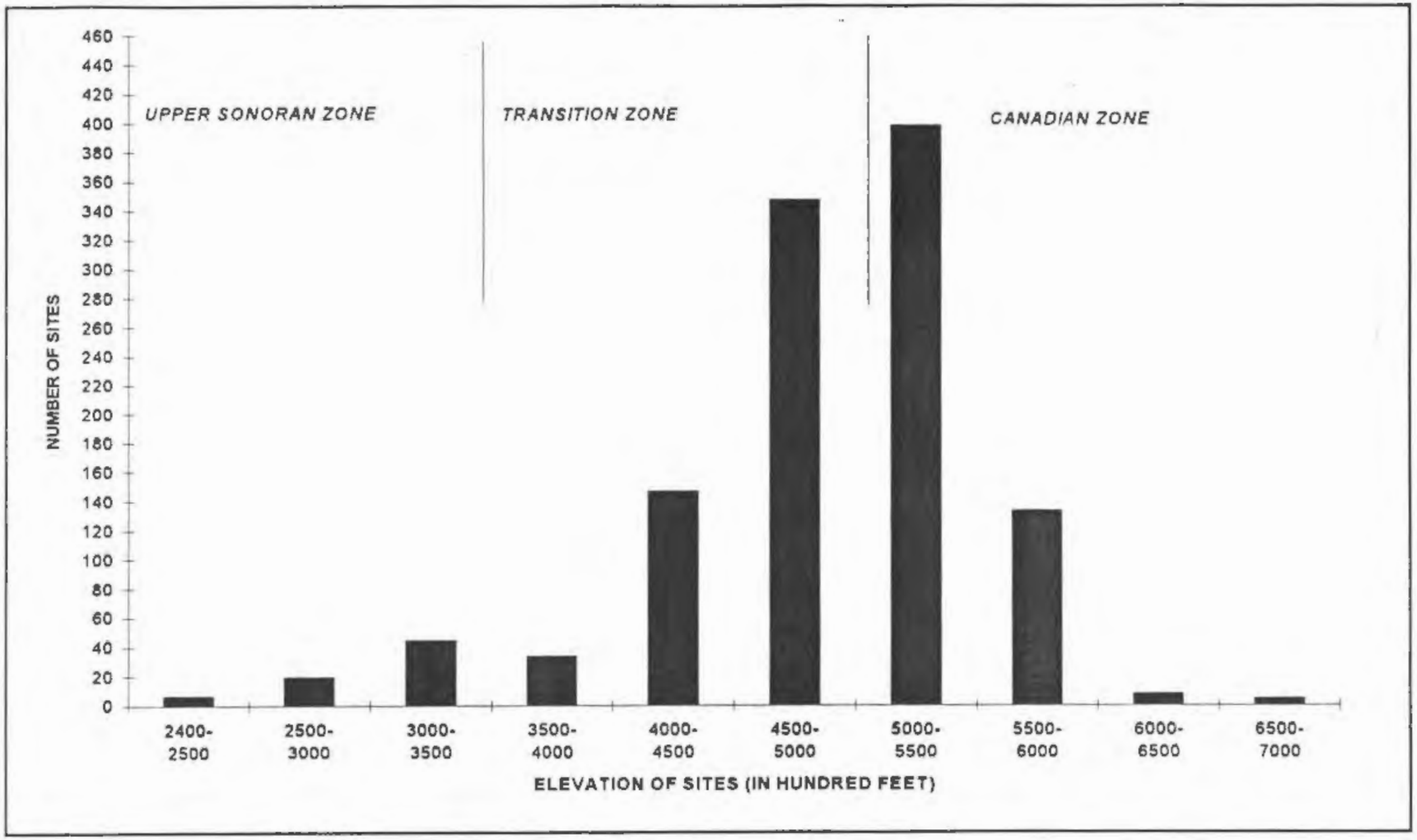


Figure 36. Elevation of Central Oregon Archaeological Sites.

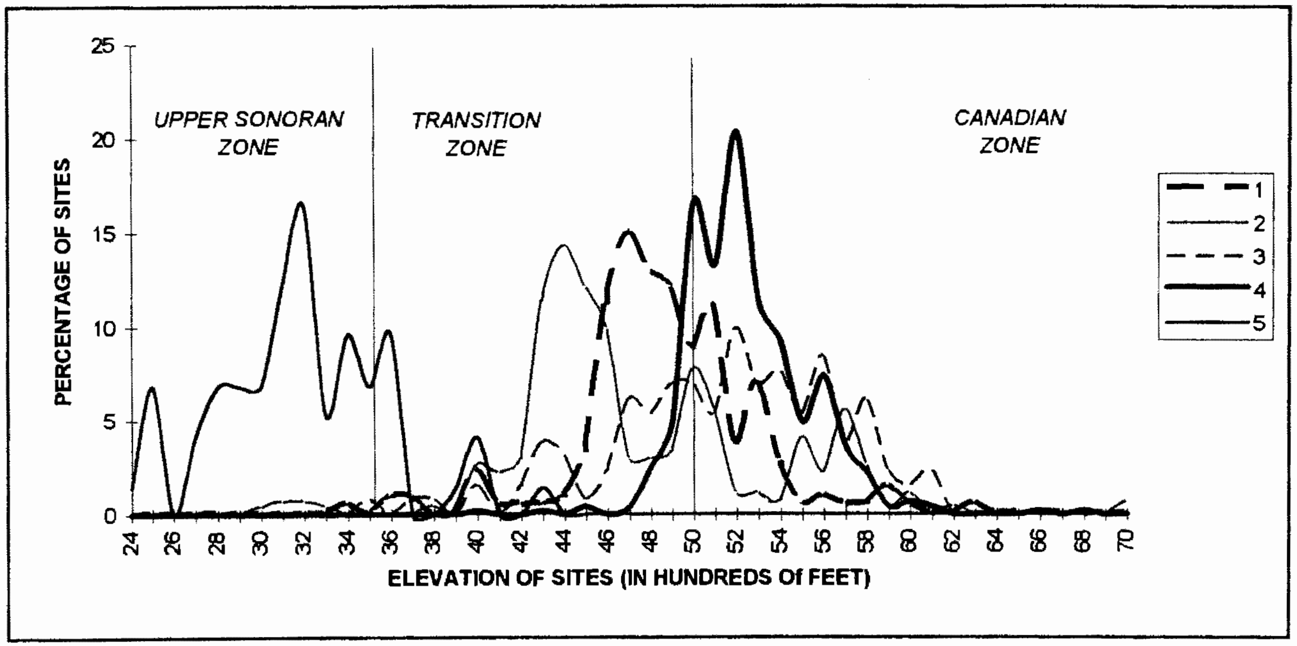


Figure 37. Elevation of central Oregon archaeological sites divided by forest service districts.
1 = Big Summit, 2 = Paulina, 3 = Prineville, 4 = Snow Mountain, 5 = the Grasslands.

with the Transition zone. The high range of elevation was associated with the Canadian zone and ranged from 5000 to 9000 feet above sea level. Through an examination of contour maps (scale of 1:500,000) it was determined that approximately 7.6% of the forest area was located within the Upper Sonoran zone, 46.3% within the Transition zone, and the remaining 46.1% within the Canadian zone.

Of the sites used in this analysis, seventy six (76), or 7.4 % of the sites, were located in the Upper Sonoran zone. Five hundred seventy eight (578), or 56.8% of the sites, were located in the Transition zone. The remaining three hundred and sixty four (364), or 35.8% of the sites, were located in the Canadian zone. Notably, the number of sites found within each zone is closely proportional to the amount of forest land that exists in that zone. Although, the Transition life zone contained a somewhat greater percentage of sites in relation to the amount of land in the study area (Figure 38) correspondingly, the Canadian zone contained a somewhat smaller percentage.

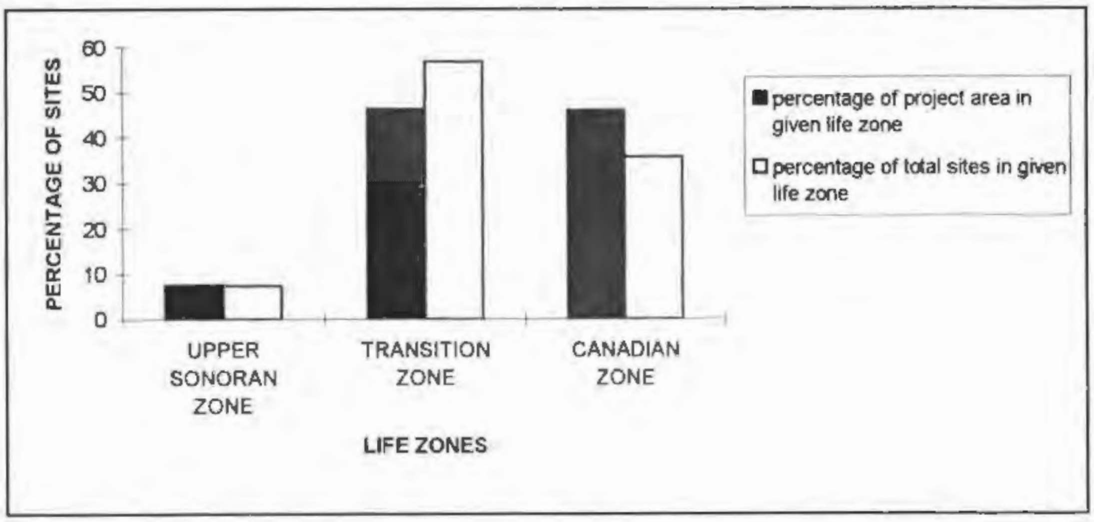


Figure 38. Comparison of percentages of land area and percentages of archaeological sites within the project area.

Water Distance

Distance to water was a numeric coded variable pertaining to the distance of the recorded archaeological site to the nearest water source. This variable ranged from 0 miles (for cases where water was on the site) to 7 miles. When the distance from water variable was examined it became apparent that the great majority of sites were found close to water (Figure 39). In the analysis, distance from water was divided into immediate, near, and far categories. Sites in immediate proximity to water ranged from 0 to .01 miles (15.8 meters) from the source. Archaeological sites classified as near water ranged from .01 miles to .20 miles (321 meters) from the source. Any site

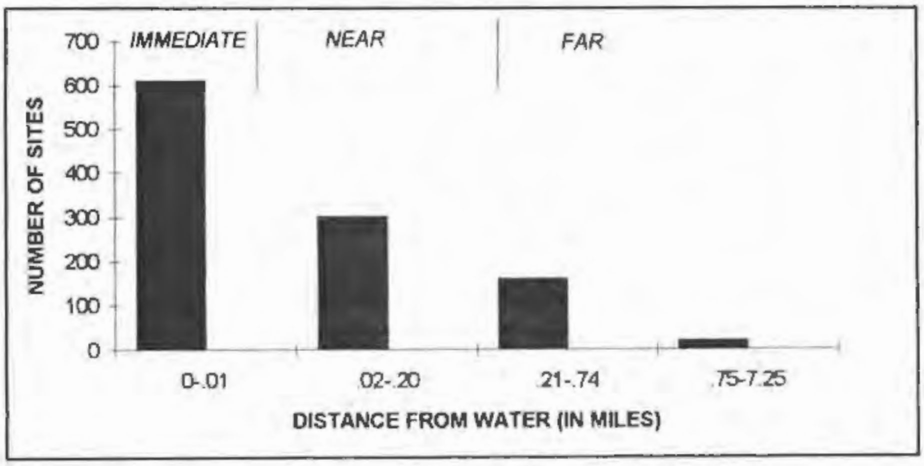


Figure 39. Distribution of distances from sites to nearest source of water.

that was more than .20 miles from a water source was classified as far from water. Six hundred eight (608), or 60 percent, of the sites, were found to lie in immediate proximity to water. Three hundred one (301), or 27.7% of the sites, were near water, and one hundred seventy seven (177), or 16.3% of the sites ,were far from water.

Site Size

Site size was numerically coded and referred to the horizontal extent of the site area, measured in acres. This variable ranged from .01 acres to 99.99 acres.

A frequency distribution of site size (Figure 40) indicates that two hundred and eight (208), or 18.1% of the sites, were .01 acres (40.4 m^2) or smaller in size. This area is comparable to a 6.3 meter square. This narrow range of site sizes represents a large number of sites in the data set that clustered within a very small size range. Above .01 acres the range of variation in site size increases for the groups of sites. A second group of sites between .02 acres (80.9 m^2) and 1.33 acres (5384 m^2) in area comprises a medium sized range of sites. This group includes a range of sites comparable to an 8.9 meter square at the lower end, and a to 73 meter square, at the upper end. Some 578 (50.3%) of the sites were included in this size range.. The third group includes a wide range of site sizes, from 1.34 acres to the largest recorded size of 100 acres. This was designated as the large size category. Three hundred and sixty four (364), or 31.6% of the sites, were included in the large size group. The figure shows clearly that the great preponderence of sites in the study area were relatively small, with quite limited numbers of really extensive sites

Landform

Landform was numerically coded and referred to a classification of the type of landform upon which sites were located (Figure 41). The landform variable consisted of 4 categories including sagebrush/open flat, meadow, drainage/bench, and ridge/saddle. Figure 41 shows that

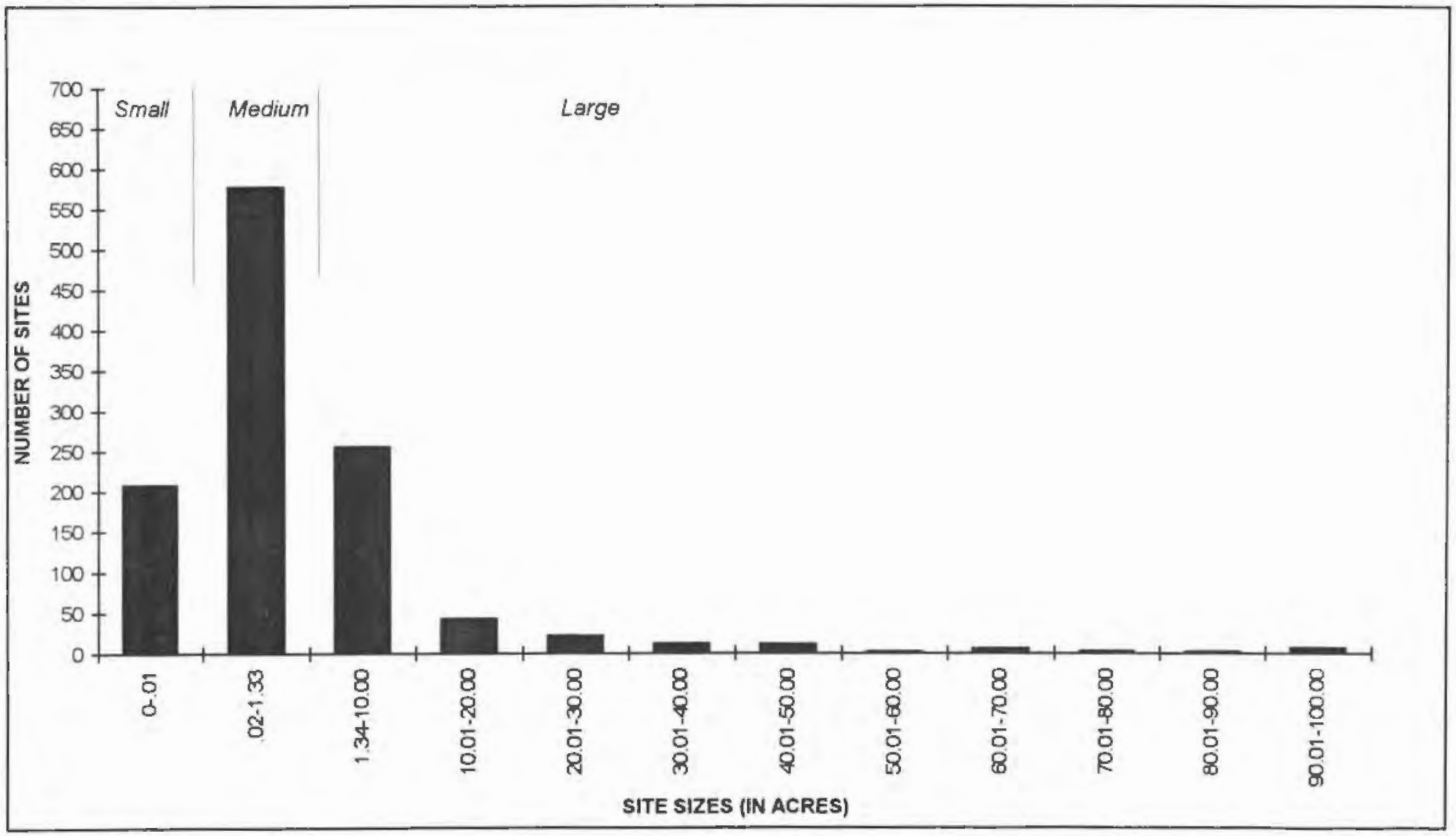


Figure 40. Frequency distribution of site size.

the predominant land form on which sites were located was rolling plains\sagebrush (45.5%). This was followed, at much lower levels by drainages/ benches (23.4%), ridges/saddles (19.0%), and meadows (12.1%). Landform should be directly related to the resources found throughout the study area and the procurement of these resources by human populations. Figure 41 thus suggests that a large amount of the resources that were being procured were located in flat, open areas, currently dominated by a sagebrush overstory. Many of these activities may have been related to the hunting of animals that fed on the grasses and other understory plants.

The prevalence of sites associated with benches and drainages shows that water and distance to water was also a critical variable for the placement of archaeological sites. The sites in

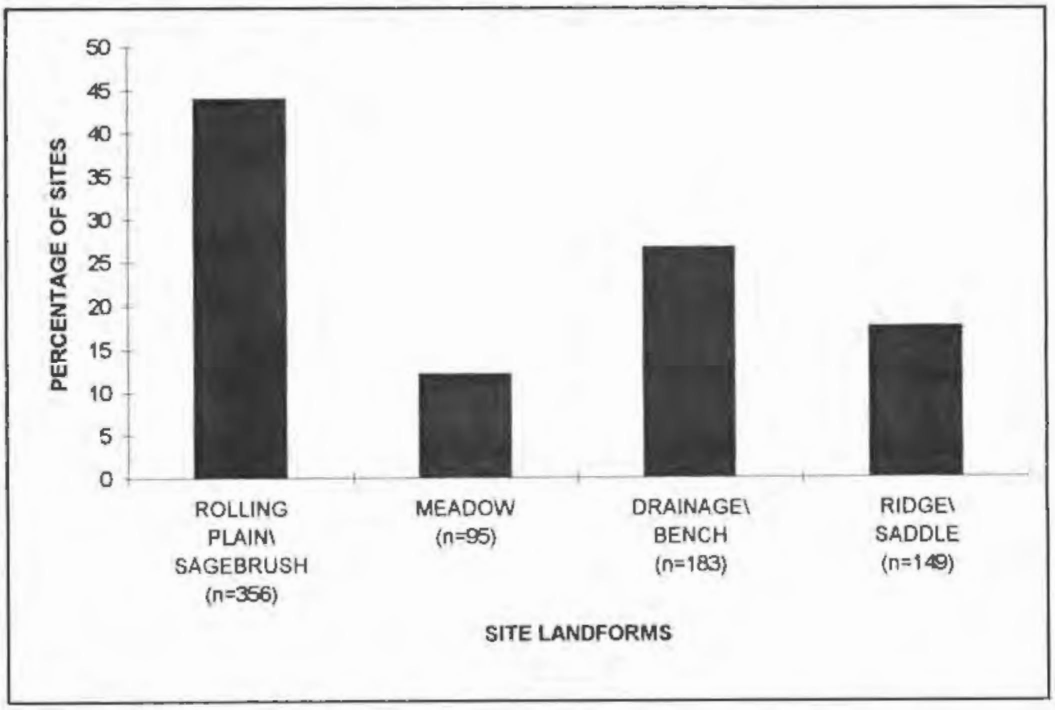


Figure 41. Frequency distribution of sites on different landform.

these last two categories may be related to the procurement of plants that cluster near water, as well as to the importance of water itself for human consumption.

Water Source

Water source was numerically coded and referred to the type of water source nearest to the sites (Figure 42). The types of water sources were recorded as springs or streams/rivers. As may be seen in Figure 42, streams and drainages comprised the majority of water sources in the project area, however springs represent a significantly large minority (30.3%). As isolated points of water, springs would not be the preferred location of sites when compared to the linear nature of streams or rivers. However, springs may represent a secondary source of water, where some plant resources may also be found, as well as game animals.

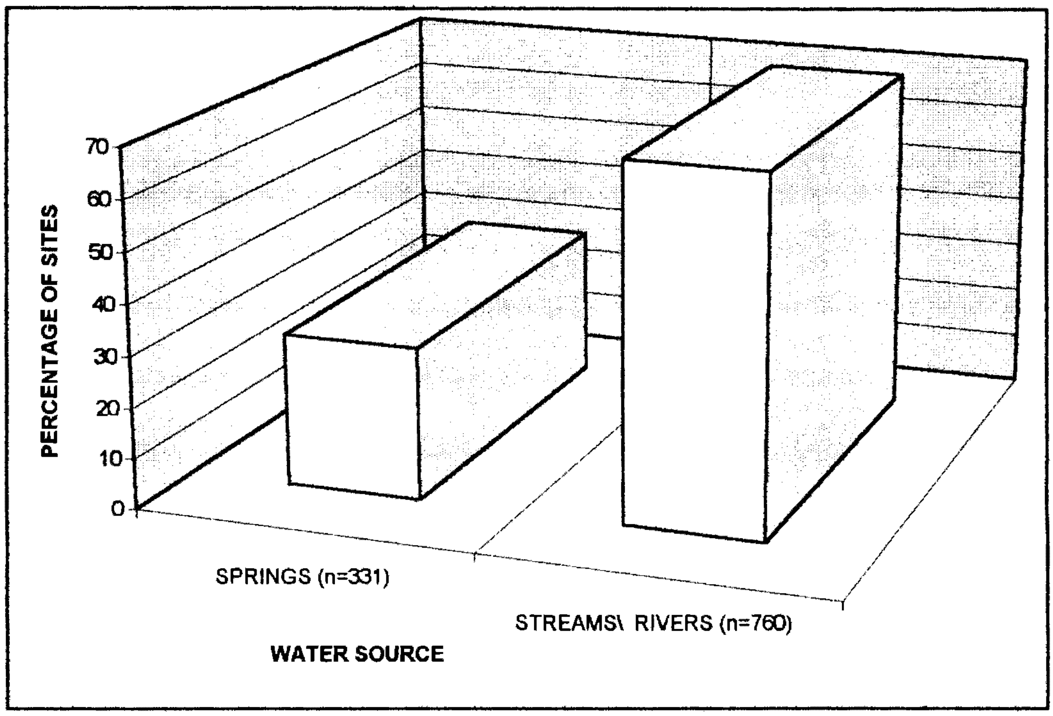


Figure 42. Frequency distribution of the types of water source to nearest archaeological sites.

Overstory Vegetation

Overstory vegetation initially was an alphanumeric variable transformed into a numeric variable for the purpose of this analysis. Six types of overstory vegetation were recorded on archaeological sites (Figure 43) including ponderosa pine, lodgepole pine, fir (white, and Douglas), juniper, mountain mahogany, and alder/aspen. As may be seen in Figure 43, ponderosa pine was by far the most prevalent type of vegetation (73.4%), followed by juniper (21.6%). The other types of overstory vegetation occurred only in about 5% of the sites.

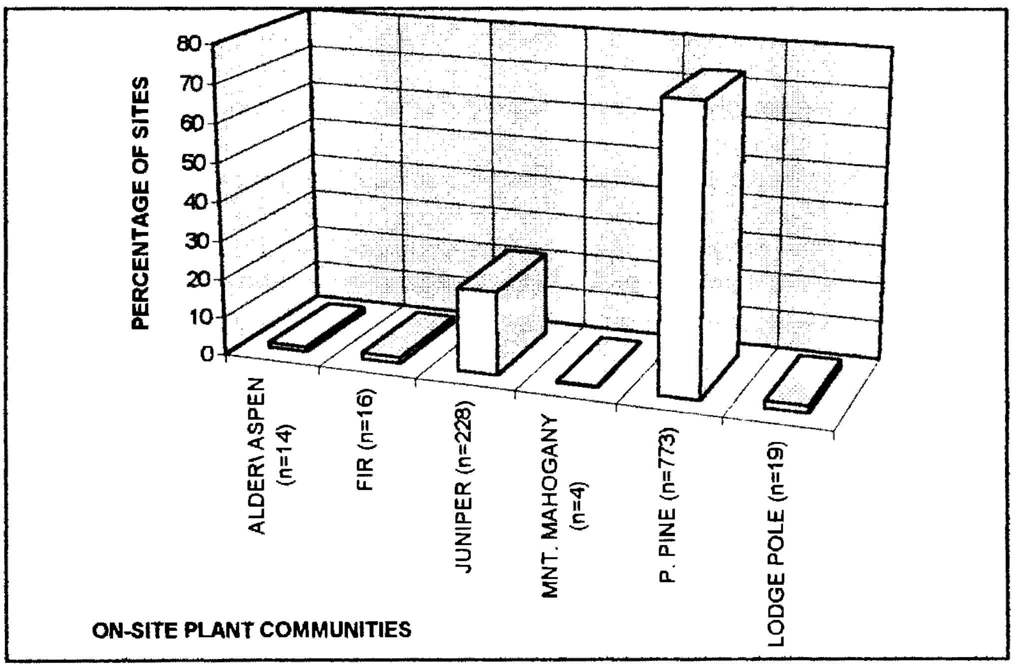


Figure 43. Frequency distribution of site associated overstory vegetation.

Types of Artifacts

The types of artifacts variable consisted of a flaked stone and one other category. Both were alphanumeric variables transformed into numeric format. Flaked stone pertained to the types of flaked stone artifacts observed at each archaeological site, such as flakes, projectile points and bifaces, while the other category consisted predominantly of groundstone artifacts. Up to nine types of artifacts could be recorded for each archaeological site. The artifacts found on archaeological sites formed the basis for the site classification that is discussed later (see p.162 ff.). Three hundred and thirty one (331) of the sites, or 30.3% contained only flakes, while the remainder contained flakes; projectile points, and bifaces in varying, combinations and frequencies (see Table 18).

Site Types

The analysis of archaeological material focused upon the classification of sites into a qualitatively and quantitatively defined typology. One thousand one hundred eighty two (1082) of the total sample of 1150 archaeological sites could be classified into categories on the basis of assemblage composition. Artifacts classes considered in this analysis included flake, scraper, utilized flake, hammer-stone, drill, mano, metate, mortar, pestle, adze, net weight, projectile point, biface, biface blank, chopper, core, burin and spoke shave. For quantitative analysis manos, metates, pestles, and mortars were placed in a general grouping of groundstone. Biface blanks (preforms) and bifaces were grouped as bifaces. Edge modified flakes, burins, and spoke shaves were grouped as flakes. Adzes and hammerstones were grouped as hammerstones, while scrapers, net weights, projectile points, choppers, cores, and drills were not grouped, but treated as individual categories. Net weights were not used in the classification due to a very small sample size (n=1), and this isolated occurrence was discarded from the analysis. For each archaeological site, the presence or absence of each analytical category was recorded. A one was recorded for tool presence and a zero for an absent tool types, with 113 tool combinations recorded (Table 18).

Table 18. Tool Distributions Within Archaeological Sites'

Case	Scrapers	Flakes	Projectile Points	Bifaces	Choppers	Cores	Ground-stone	Hamerstones	Drills	Site Type	Number of Sites	% of Sites	Cumulative %
2	0	1	0	0	0	0	0	0	0	1	331	30.3	30.3
6	0	1	1	0	0	0	0	0	0	1	112	10.2	40.5
31	0	1	1	1	0	0	0	0	0	2	72	6.6	47.1
3	1	1	0	0	0	0	0	0	0	1	50	4.5	51.6
13	0	1	0	0	0	1	0	0	0	1	37	3.3	54.9
28	1	1	1	0	0	0	0	0	0	2	32	2.9	57.8
32	1	1	1	1	0	0	0	0	0	2	32	2.9	60.7
29	1	1	0	1	0	0	0	0	0	2	22	2.1	62
18	0	1	0	0	0	0	1	0	0	1	15	1.3	63.3
42	0	1	0	1	0	1	0	0	0	2	15	1.3	64.6
4	0	0	1	0	0	0	0	0	0	1	14	1.2	65.8
17	0	0	0	0	0	0	1	0	0	1	13	1.1	66.9
46	0	1	1	1	0	1	0	0	0	2	13	1.1	68
51	0	1	1	0	0	0	1	0	0	2	13	1.1	69.1
78	1	1	1	1	0	1	0	0	0	3	13	1.1	70.2
38	1	1	0	0	0	1	0	0	0	2	11	1	71.2
39	0	1	1	0	0	1	0	0	0	2	10	<1	
82	1	1	1	1	0	0	1	0	0	3	10	<1	
9	0	1	0	1	0	0	0	0	0	1	7	<1	
54	0	1	0	1	0	0	1	0	0	2	7	<1	
56	0	1	1	1	0	0	1	0	0	2	7	<1	
43	1	1	0	1	0	1	0	0	0	2	6	<1	
55	1	1	0	1	0	0	1	0	0	2	6	<1	
86	0	1	1	1	0	1	1	0	0	3	6	<1	
34	1	0	1	0	1	0	0	0	0	2	5	<1	
40	1	1	1	0	0	1	0	0	0	2	5	<1	

Table 18. (Continued)

Case	Scrapers	Flakes	Projectile Points	Bifaces	Choppers	Cores	Ground-stone	Hamerstones	Drills	Site Type	Number of Sites	% of Sites	Cumulative %
102	1	1	1	1	0	0	0	0	1	3	5	<1	
10	0	0	1	1	0	0	0	0	0	1	4	<1	
52	1	1	1	0	0	0	1	0	0	2	4	<1	
71	0	1	0	1	0	0	0	0	1	2	4	<1	
74	0	1	1	1	0	0	0	0	1	2	4	<1	
5	1	0	1	0	0	0	0	0	0	1	3	<1	
7	0	0	0	1	0	0	0	0	0	1	3	<1	
8	1	0	0	1	0	0	0	0	0	1	3	<1	
22	1	0	0	0	0	0	0	1	0	1	3	<1	
36	0	1	0	1	1	0	0	0	0	2	3	<1	
37	0	1	1	1	1	0	0	0	0	2	3	<1	
48	0	1	0	0	1	1	0	0	0	2	3	<1	
50	1	1	0	0	0	0	1	0	0	2	3	<1	
66	1	1	0	0	0	1	0	1	0	2	3	<1	
68	1	1	0	0	0	0	0	0	1	2	3	<1	
73	1	0	1	1	0	0	0	0	1	2	3	<1	
105	1	1	1	1	0	1	0	0	1	3	3	<1	
1	1	0	0	0	0	0	0	0	0	1	2	<1	
11	0	1	0	0	1	0	0	0	0	1	2	<1	
15	0	0	0	1	0	1	0	0	0	1	2	<1	
19	0	0	1	0	0	0	1	0	0	1	2	<1	
23	0	1	0	0	0	0	0	1	0	1	2	<1	
35	1	1	1	0	1	0	0	0	0	2	2	<1	
44	0	0	1	1	0	1	0	0	0	2	2	<1	
49	0	1	1	0	1	1	0	0	0	2	2	<1	
58	0	1	1	0	0	1	1	0	0	2	2	<1	
59	0	1	0	1	0	1	1	0	0	2	2	<1	
83	1	0	1	1	1	0	1	0	0	3	2	<1	
85	1	1	1	1	1	0	1	0	0	3	2	<1	
87	1	1	1	1	0	1	1	0	0	3	2	<1	
104	0	1	1	1	0	1	0	0	1	3	2	<1	

Table 18. (Continued)

Case	Scrapers	Flakes	Projectile Points	Bifaces	Choppers	Cores	Ground-stone	Hamerstones	Drills	Site Type	Number of Sites	% of Sites	Cumulative %
112	0	1	1	1	0	1	0	1	1	3	2	<1	
12	1	0	0	0	0	1	0	0	0	1	1	<1	
14	0	0	1	0	0	1	0	0	0	1	1	<1	
20	0	0	0	1	0	0	1	0	0	1	1	<1	
21	0	0	0	0	0	1	1	0	0	1	1	<1	
24	0	0	1	0	0	0	0	1	0	1	1	<1	
25	0	0	0	1	0	0	0	1	0	1	1	<1	
26	0	0	0	0	0	0	1	1	0	1	1	<1	
27	0	0	0	0	0	0	0	0	1	1	1	<1	
30	1	0	1	1	0	0	0	0	0	2	1	<1	
33	1	1	0	0	1	0	0	0	0	2	1	<1	
41	1	0	0	1	0	1	0	0	0	2	1	<1	
45	1	0	1	1	0	1	0	0	0	2	1	<1	
47	1	0	0	0	1	1	0	0	0	2	1	<1	
53	1	0	0	1	0	0	1	0	0	2	1	<1	
57	1	1	0	0	0	1	1	0	0	2	1	<1	
60	1	1	0	0	0	0	0	1	0	2	1	<1	
61	1	1	1	0	0	0	0	1	0	2	1	<1	
62	0	1	0	1	0	0	0	1	0	2	1	<1	
63	1	1	0	1	0	0	0	1	0	2	1	<1	
64	0	1	1	1	0	0	0	1	0	2	1	<1	
65	0	1	0	0	0	1	0	1	0	2	1	<1	
67	0	1	0	1	0	0	1	1	0	2	1	<1	
69	0	1	1	0	0	0	0	0	1	2	1	<1	
70	1	1	1	0	0	0	0	0	1	2	1	<1	
72	1	1	0	1	0	0	0	0	1	2	1	<1	
75	0	1	0	0	0	1	0	0	1	2	1	<1	
76	1	1	0	0	0	1	0	0	1	2	1	<1	
77	0	1	0	0	0	1	0	1	1	2	1	<1	
80	1	1	0	1	1	1	0	0	0	3	1	<1	
81	0	1	1	1	1	1	0	0	0	3	1	<1	
84	0	1	1	1	1	0	1	0	0	3	1	<1	

Table 18. (Continued)

Case	Scrapers	Flakes	Projectile Points	Bifaces	Choppers	Cores	Ground-stone	Hamerstones	Drills	Site Type	Number of Sites	% of Sites	Cumulative %
88	0	1	1	0	1	1	1	0	0	3	1	<1	
89	0	1	0	1	1	1	1	0	0	3	1	<1	
90	1	1	1	1	0	0	0	1	0	3	1	<1	
91	1	1	0	1	0	1	0	1	0	3	1	<1	
93	1	0	1	1	0	0	1	1	0	3	1	<1	
94	0	1	1	1	0	0	1	1	0	3	1	<1	
95	1	1	1	1	0	0	1	1	0	3	1	<1	
96	0	1	0	1	1	0	1	1	0	3	1	<1	
97	1	0	1	1	1	0	1	1	0	3	1	<1	
98	1	1	1	1	1	0	1	1	0	3	1	<1	
99	1	1	1	1	0	1	1	1	0	3	1	<1	
100	0	1	1	0	1	1	1	1	0	3	1	<1	
101	1	1	1	1	1	1	1	1	0	3	1	<1	
103	1	1	0	1	0	1	0	0	1	3	1	<1	
106	0	0	1	1	1	1	0	0	1	3	1	<1	
107	1	0	1	1	1	1	0	0	1	3	1	<1	
108	1	1	1	1	0	0	1	0	1	3	1	<1	
109	1	1	1	1	1	0	1	0	1	3	1	<1	
110	1	0	1	1	1	1	1	0	1	3	1	<1	
111	1	1	1	1	1	1	1	0	1	3	1	<1	
113	1	0	1	1	1	1	1	1	1	3	1	<1	

*. This table shows the distribution of tool types within archaeological sites. A 1 is coded for tool presence and a 0 for absence.

A simple model of site activity has been created, with the artifact data grouped as outlined in Table 19. Residential bases are defined as areas containing all tool types, while limited use areas seen as task specific contain a smaller number of tool types. The activities identified in the model include plant processing, indicated by the presence of groundstone; butchering /hunting, indicated by the presence of projectile points and bifaces; and lithic reduction, indicated by the

Table 19. Sinple Model of Artifacts and Site Activities

Site Function	Types of Artifacts	Activity
Limited Use Plant Processing	Groundstone	Task Specific
Limited Use Hunting/ Butchering	Projectile Points/ Bifaces	Task Specific
Limited Use Lithic Reduction	Cores, Hammerstones, Flakes	Task Specific
Residential Base	Flakes, Scrapers, Projectile Points, Bifaces, Cores, Choppers, Hammerstones, Groundstone, Drills	All Activities

presence of cores, hammerstones, and flakes. In this system, the overlapping functionally defined sets of tool classes indicates multiple-use archaeological sites.

The activity indicated for each type of tool assemblage in the archaeological sample was then measured by creating four activity variables. For both the plant processing and hunting variables a zero, 1 or 2 was recorded, depending upon the classes of hunting and plant processing artifacts present. A zero through 3 was recorded in the lithic reduction variable in accordance with the number of lithic reduction artifact classes found. For the residential base variable a zero through 9 was recorded, depending upon the number of tool classes present.

To determine site patterns the four activity variables were then clustered using a squared Euclidean measure, employing an average linkage method. Figure 44 shows the results of this cluster analysis, identifying three sets of sites: sites containing one or two artifact types, sites containing three or four artifact types and sites containing five to nine artifact types. Inspection of the dendrogram generated by the cluster analysis indicates that there is a wide cross over of tool types among the three site types so that the major distinction between the groups of sites thus defined must be taken to indicate degrees of activity, rather than specific sets of activities. The groups are best identified as Isolated Activity, Moderate Activity, and High Activity sites.

Table 20 shows the distribution of site types thus defined, in terms of activity represented in them, the activities being those defined in terms of the simple model just presented above (see Table 19). Table 20 demonstrates that Isolated Activity sites are characterized by a high correlation with hunting and butchering tools (57.1%), and a moderately high correlation with plant processing tools (33.3%). Only 9.5% of the Isolated Activity tool assemblages are related to lithic reduction. This indicates that Isolated Activity sites were generally dominated by hunting and butchering and plant processing activities, and may be thought of as task-specific activity areas.

Moderate Activity site assemblages are characterized by a high correlation with hunting tools (53%), a moderately high correlation with lithic reduction (33.3%). and a low correlation with plant processing activities (13.6%). Moderate Activity sites may in general be roughly classified as representing hunting and lithic reduction activities.

High Activity sites indicate moderately high correlations with all three types of activities (22.8% plant processing, 43.5% hunting/butchering, and 28.2% lithic reduction). The substantial representation of all types of activities at these sites, indicates that they may be best considered as residential bases.

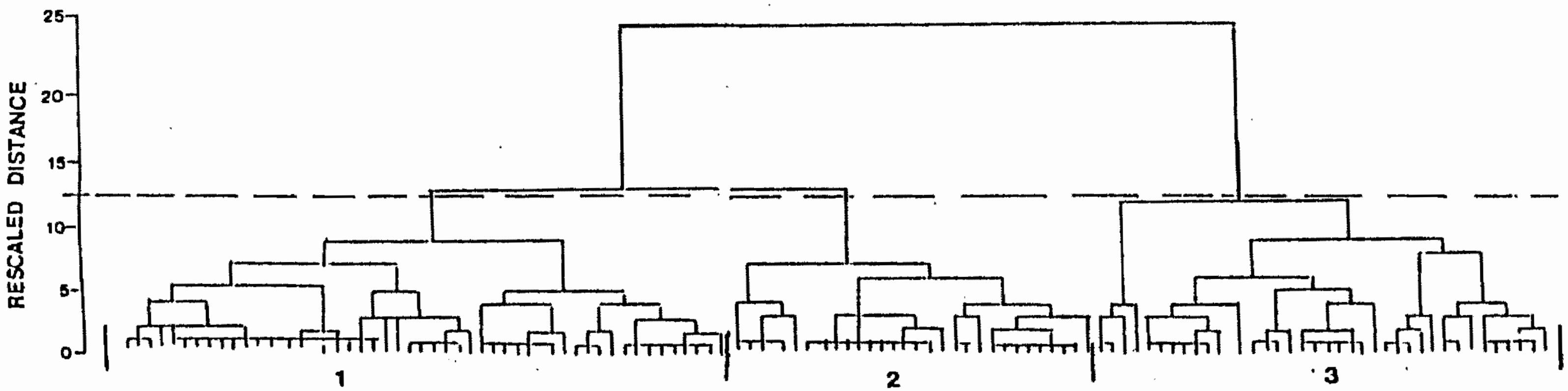


Figure 44. Cluster analysis of site types. This is a cluster analysis of tool types based upon the model presented in Table 19. The tool types were classified by this model using a squared Euclidean measure and an average method.

To assess the reliability of these Site Activity groupings a discriminant function analysis was performed (Table 21). The discriminant analysis compared the means of the three site groups and tool types, placing cases into the group containing the highest discriminant score. Table 21 is a graphic representation of the results of the discriminant function analysis indicating that 99.6 % of the cases of site types contained were correctly predicted. This result indicates that the Site

Table 20. Frequency Correlation of Site Activity Types With Specific Activity Indicators[a].

Type of Site	Plant Processing	Hunting/ Butchering	Lithic Reduction	Total
Isolated Activity	7	12	2	21
	17.5	14.3	4.2	
	.33.3	57.1	9.5	
Moderate Activity	9	35	22	66
	22.5	41.7	45.8	
	13.6	.53.0	33.3	
High Activity	24	37	24	85
	60.0	44.0	50.0	
	28.2	43.5	.28.2	
Total	40	84	48	

[a]The number in the first row under each activity class is the number of site assemblages containing tools indicative of a given activity (cf. Table 19). There were a total of 113 tool combinations in the total analysis, and each combination could contain tools indicative of up to three activities. The second row under each activity class is the column percentage, and the third row is the row percentage.

Activity analysis is a reliable model, yielding groups that are significantly different in statistical terms.

In summary three broad type of activities have been hypothersized, consisting of plant processing, lithic reduction, and butchering/hunting. Evidence of these activities may be observed

Table 21. Results of the Discriminant Function Analysis Between Types of Sites and Tool Types[a]

Actual Group	Number of Cases	Predicted Group Membership 1	2	3
Group 1	694	694	0	0
		100%	0%	0%
Group 2	314	0	310	4
		0%	98.6%	1.3%
Group 3	74	0	74	0%
		0%	100%	0%

[a] This table shows the results of the discriminant function analysis between site type and tool types. The table shows the percentage of each group correctly classified. A 99.6% correct classification was achieved.

in the distribution of tool types within archaeological sites. The cluster analysis of functionally catagorized specimens indicative of these activities shows that many sites reflect overlapping functions even though, generally speaking, three discrete kinds of sites may be identified. Plant procurement occurs predominantly in High Activity residential base camps (60%), but also in Moderate Activity field camps (22.5%), and Isolated Activity areas (17.5%). Hunting (and butchering) occurs in all types of sites but predominantly in High Activity base camps (44%) and, Moderate Activity field camps (41.7%). Finally, lithic reduction occurs in few of Isolated Activity areas (4.2%) , but in high percentages of High and Moderate Activity camps.

Site Distributions

Physiographic Correlates

While environmental variables may fluctuate somewhat through time, the physiographic setting or landform on which archaeological sites occur remains constant. Physiographic correlates thus reflect original patterns of land use, and become critical variables for determining settlement patterns.

Figure 45 shows the frequency distribution of site associated landforms across environmental zones within the study area. It shows that the Upper Sonoran, Transition, and Canadian life zones contain comparable numbers of sites associated with open rolling plains. The figure also shows that these are the preferred site locations, followed by drainages/benches. As elevation increases across the three life zones, the number of sites associated with meadows and ridge/saddles increases, while the percentage of sites associated with rolling plains remains constant and the percentage of sites associated with drainages/benches decreases. The elevation changes in site-associated landform appear to reflect topographic changes with increasing altitude, though this is an impression only, not fully controlled for in the existing database.

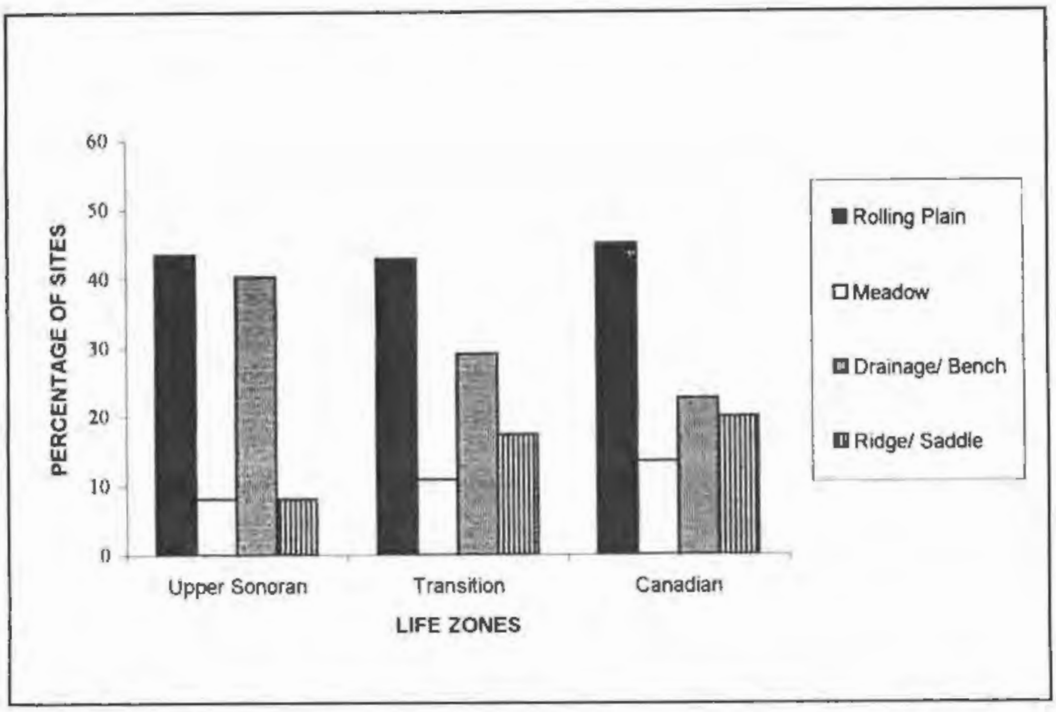


Figure 45. Frequency distribution of site-associated landforms within life zones. Of the recorded sites, 783 contained landform data.

A sample of the sites (approximately 100) also contained data on plant resources growing on or in the immediate vicinity of the sites at the time that they were recorded. The plant resources considered to culturally sensitive included balsamroot, biscuitroot, camas, onion, berries, and bitterroot. Bitterroot and biscuitroot were dropped from the following analysis due to very small sample sizes, but the other plant data proved usable.

Figure 46 shows the percentage of sites with culturally sensitive plants recorded and the percentage of land area and sites within each life zone. This figure indicates that the majority of

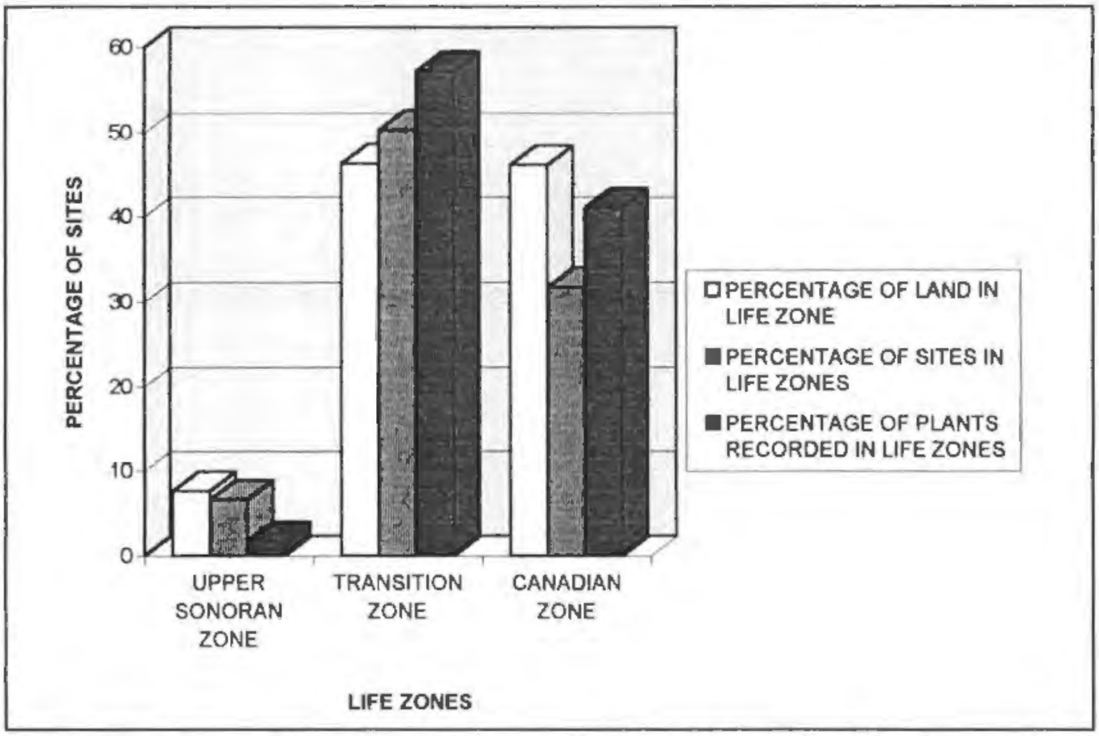


Figure 46. Percentage of land, recorded plant types, and archaeological sites in each life zone within the study area.

sites with culturally sensitive plants recorded occur in the Transition zone, with a decrease in the Canadian zone. The percentage of such plants recorded in sites is highest in the Transition zone, indicating that the Transition zone probably contains significantly greater percentages of culturally sensitive plant resources than do the other two zones.

If the types of plants within each zone are analyzed (Figure 47) it appears that camas and balsamroot have near equal distributions in the Canadian and Transition zone, while recorded sites containing berries and onion have a greater occurrence in the Transition zone. Sites containing biscuitroot occur only in the Transition zone, but the sample size here is very small.

Figure 48 indicates that rolling plains and ridge/saddles are the most important locations for sites associated with balsamroot and onion. Sites associated with camas and berries occur most

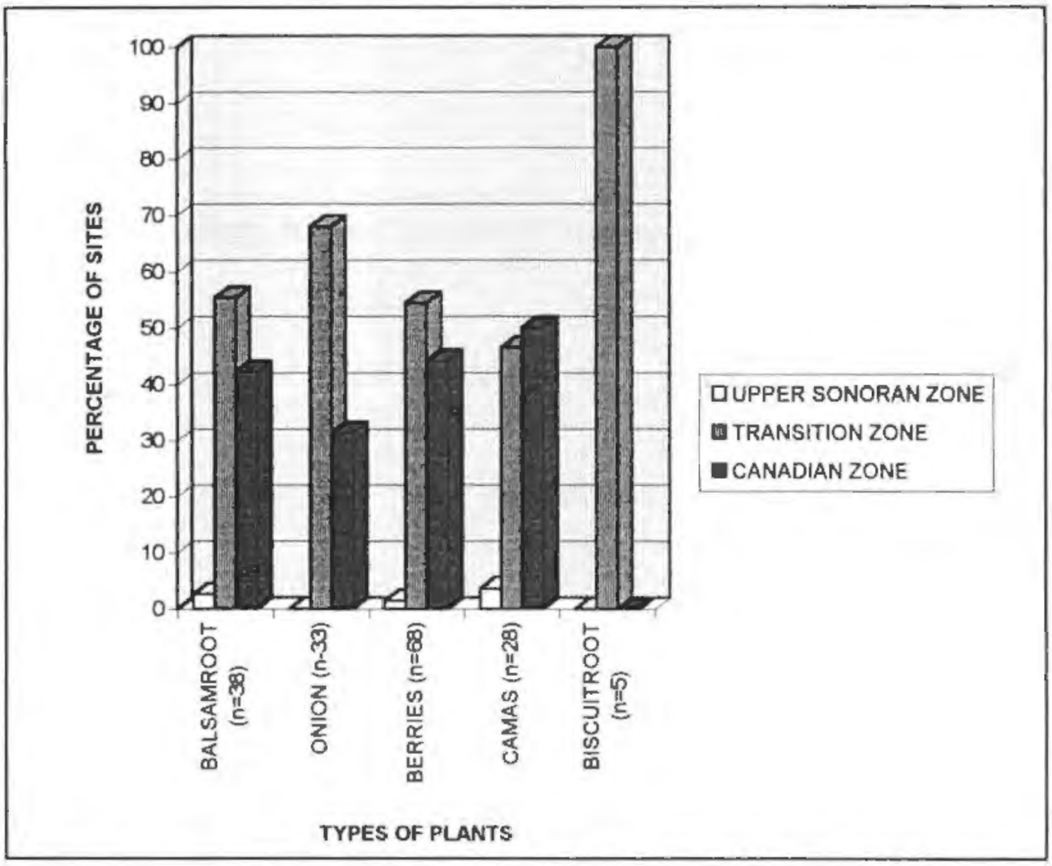


Figure 47. Distribution of three life zones and the presence of recorded plants at archaeological sites.

frequently on rolling plains and drainages/benches. Although the number of sites associated with meadows is small, camas was obviously an important resource in such settings.

Streams\rivers are the preferred location of archaeological sites within all landform types (Figure 49), but springs have a increasing importance in meadows and on ridge/saddles. This

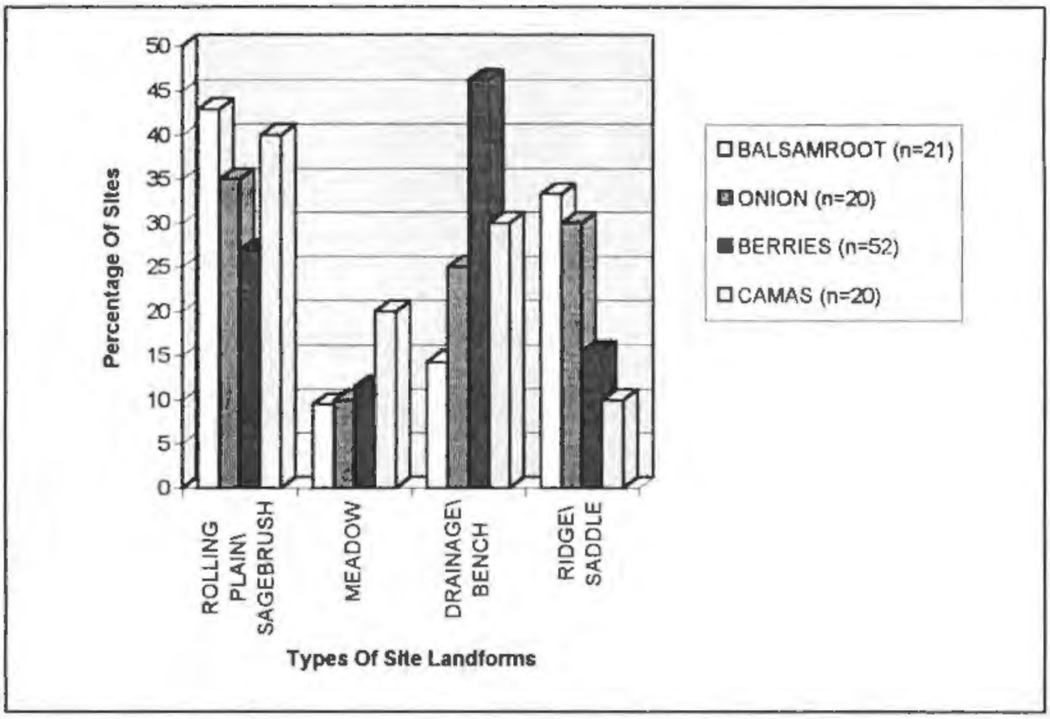


Figure 48. Frequency distribution of site-associated landforms and types of edible plants recorded on-site.

analysis indicates that type of water source, site distance from water, associated landform and associated plant types are critical variables determining the placement of sites

An examination of site size (Figure 50) indicates that small sites (less than .01 acres) have their highest rate of occurrence on ridges/saddles. Medium sized sites (between .02 and 1.33 acres) are most common in rolling plains/sagebrush, while large sites (greater than 1.33 acres in size) are most common in meadows and drainage/benches. As Figure 50 clearly shows, however, sites of all sizes are well represented across all landforms, and on all landforms the small, medium and large sites occur in the same quasi-normal distribution pattern.

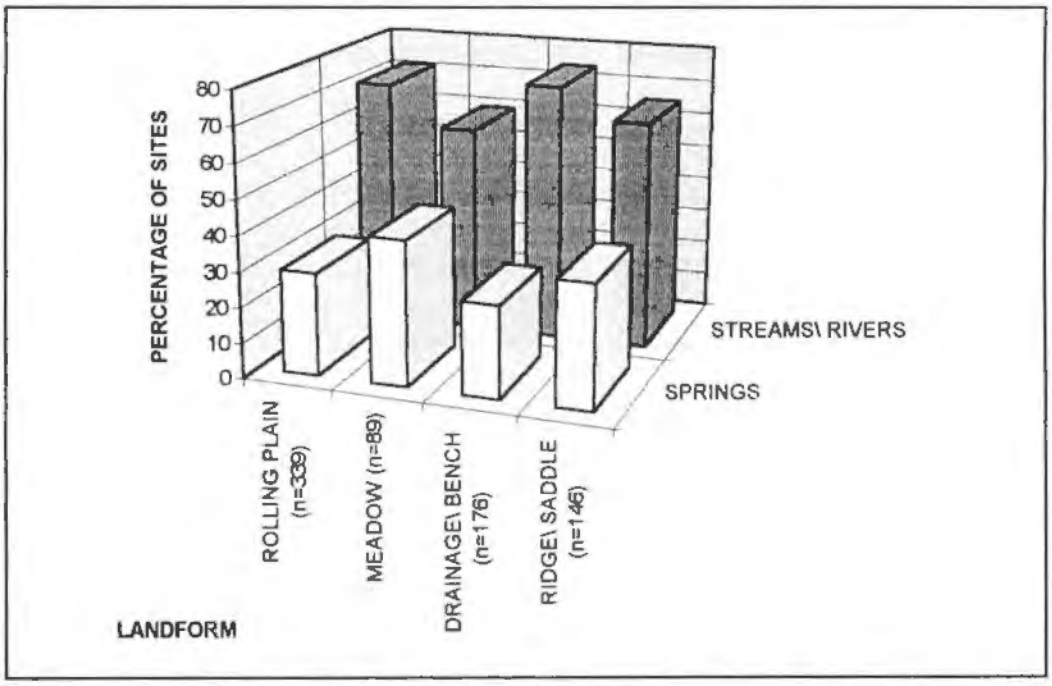


Figure 49. Distribution of nearest water source type and associated site landforms.

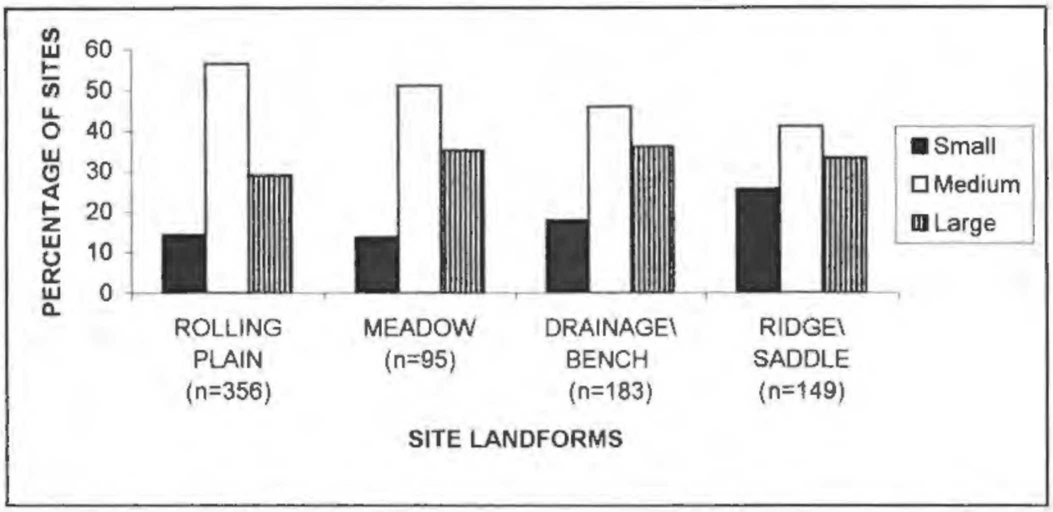


Figure 50. Distribution of small, medium, and large sites by landforms on which they occur.

If the degree of site activity is considered (Figure 51), Isolated and Moderate Activity sites occur largely in rolling plains/sagebrush, while High Activity sites occur in equally high amounts in drainage/bench areas and rolling plains/ open sagebrush. As the degree of activity increases the percentage of sites associated with meadows and drainages increases, while the percentage associated with rolling plains decreases, and the percentage associated with ridge/saddles remains constant. Comparable relationships may be seen when comparing site size and degree of activity (Figure 52). As level of activity increases so does site size; clearly, a major determinant of site size is simply the level of activity (that is the number of kinds of activities) taking place on a given site.

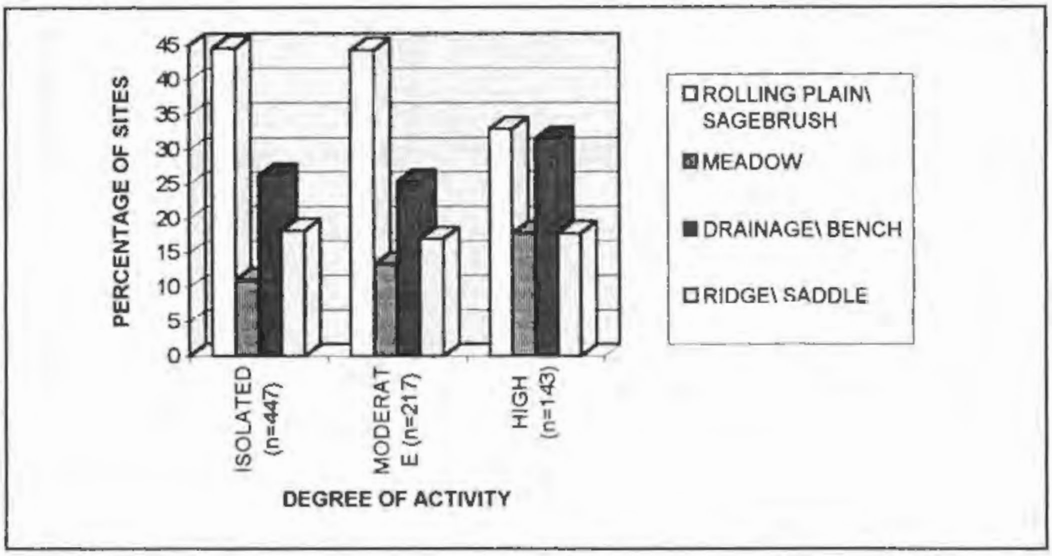


Figure 51. Frequency of sites manifesting different levels of activity, as distributed across four landform types.

The relationship between site activity and size may be further evaluated by examining the culturally significant plants found at sites. Figure 53 indicates that large sites are found most commonly where currently growing plants consist of onion, berries, and camas. Medium

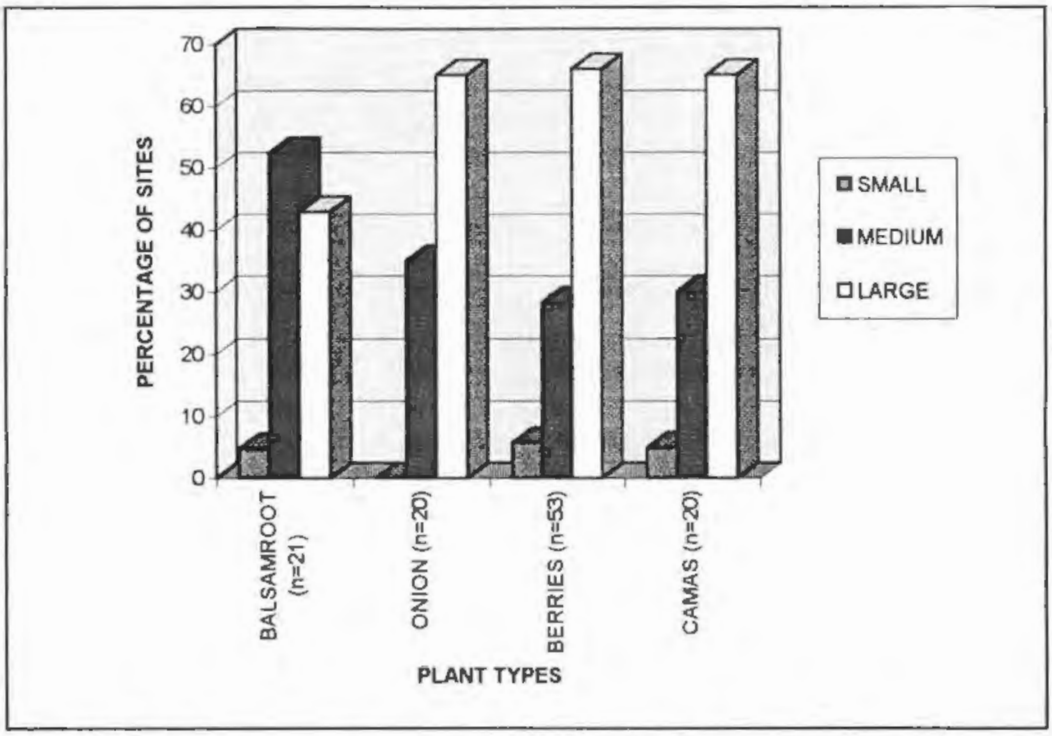


Figure 52. Presence of types of edible plants observed on sites, in relation to site size.

sized sites are associated largely with balsamroot, and small sites occur least frequently with culturally significant plants, occurring most frequently with balsamroot, berries and camas. When the degree of activity at these sites is considered, large amounts of Isolated and Moderate Activity sites are the predominant types associated with edible plants, with High Activity infrequently associated (Figure 54). This is strong evidence for interpreting the Isolated and Moderate Activity sites of the study area as related to plant food gathering.

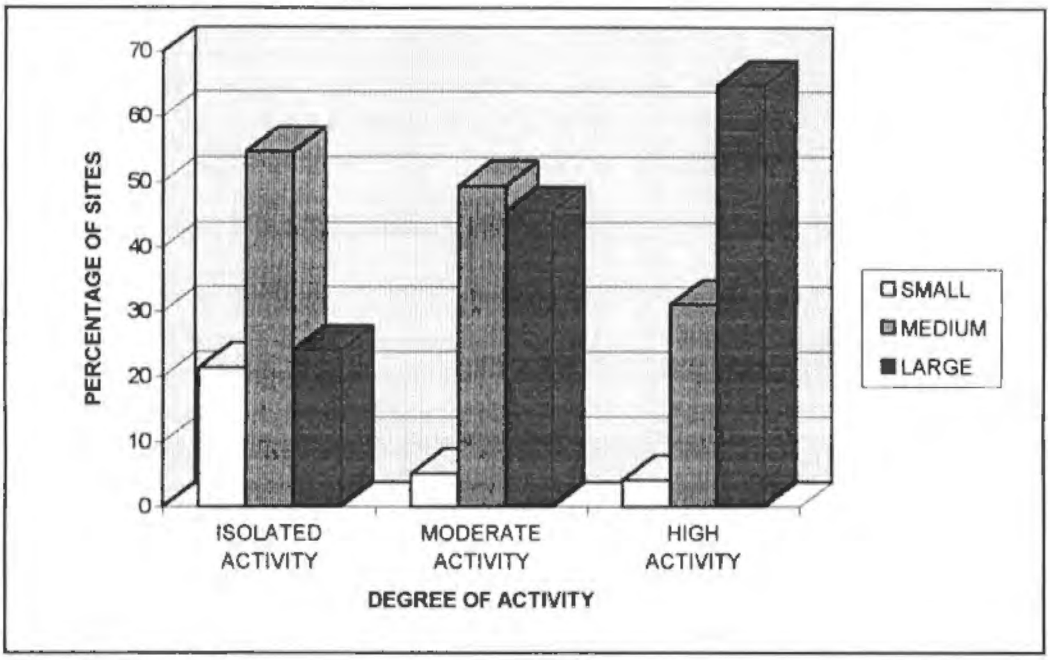


Figure 53. Isolated, Moderate, and High Activity sites in relation to site size.

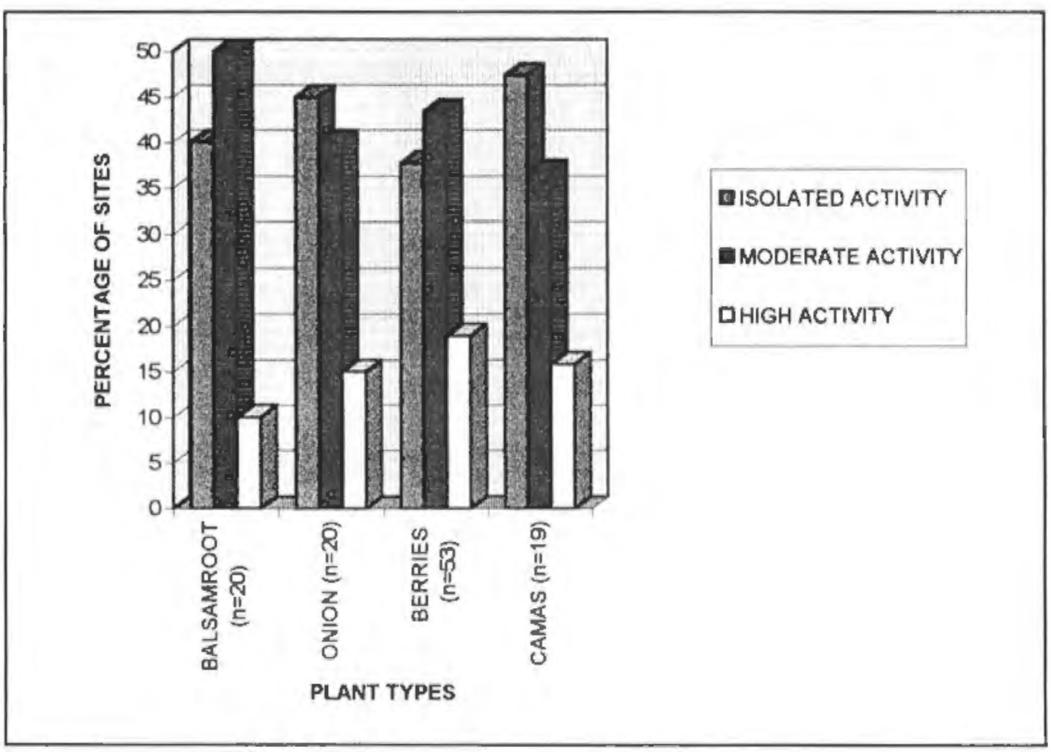


Figure 54. Presence of types of edible plants as recovered from a sample of Isolated, Moderate, and High Activity sites.

Spatial Relationships Among Sites

Once the general environmental relationships between the archaeological sites have been discussed it is possible to consider the relationships among the sites themselves, and to examine how patterns of site distributions may have remained stable or changed through time.

To examine the spatial relationships between sites the township, range, and section data recorded for each site location were utilized. Each site was given an x / y spatial coordinate based upon these data (Table 22). For each Ochoco National Forest district a true distance/site matrix was computed. Each matrix was then clustered using a Euclidean cluster measure and single linkage method, resulting in a nearest neighbor analysis for the sites (Appendix F). Appendix G identifies the sites found within each cluster along with their relavent variables.

Figure 55 shows the clusters thus developed on a grid computed according to the above method, and Figure 56 shows the same data transformed unto a map of the Big Summit District. District 1 (Big Summit) contained 7 clusters of sites. The first cluster was located south of Big Summit Prairie. The second was located to the north and east of Big Summit Prairie, separated from the first cluster by Deep Creek, which flows into the Crooked River. The third cluster was a small group on the northern edge of Big Summit Prairie. The fourth cluster was a small group west of Big Summit Prairie. Cluster 5 was a small group to the north of cluster 4. Cluster 6 was a small group located on the northern edge of the district, and cluster 7 was a small group located on the western boundary of the district along Marks and Ochoco Creeks. As the data show, Big Summit Prairie is the focal point of site density, with one large group (Cluster 1) to the south and another (Cluster 2) to the northeast. Cluster 2 contains sites located at a higher elevation along the Ochoco Divide, while Cluster 1 is concentrated around the North Fork of the Crooked River.

Table 22. Computation Used to Obtain X/Y Coordinate Measurements for Site Locations Based Upon Township Range and Section Locaional Data [a]

Computation for X/Y coordinates of the sections:

if (section ge 1 and section le 6) subb=.166
if (section ge 7 and section le 12) subb=.332
if (section ge 13 and section le 18) subb=.498
if (section ge 25 and section le 30) subb=.830
if (section ge 31) subbb=.996

if (section eq 1 or section eq 12 or section eq 13 or section eq 24
or section eq 25 or section eq 36) subba=.996
if (section eq 2 or section eq 11 or section eq 14 or section eq 23
or section eq 26 or section eq 35) subba =.830
if (section eq 3 or section eq 10 or section eq 15 or section eq 22
or section eq 27 or section eq 34) subba = .664
if (section eq 4 or section eq 9 or section eq 16 or section eq 21
or section eq 28 or section eq 33) subba = .498
if (section eq 5 or section eq 8 or section eq 17 or section eq 20
or section eq 29 or section eq 32) subba = .332
if (section eq 6 or section eq 7 or section eq 18 or section eq 19
or section eq 30 or section eq 31) subba =.116

Computations for X/Y coordinates for Townships
and Ranges:

compute north=township + subbb
compute east=range + subba
The township and range coordinates were then multiplied by 6
to obtain a true distance (since each township is a six mile square).

---

[a] When graphing the coordinates they need to be graphed in reverse order since township numbers increase from north to south.

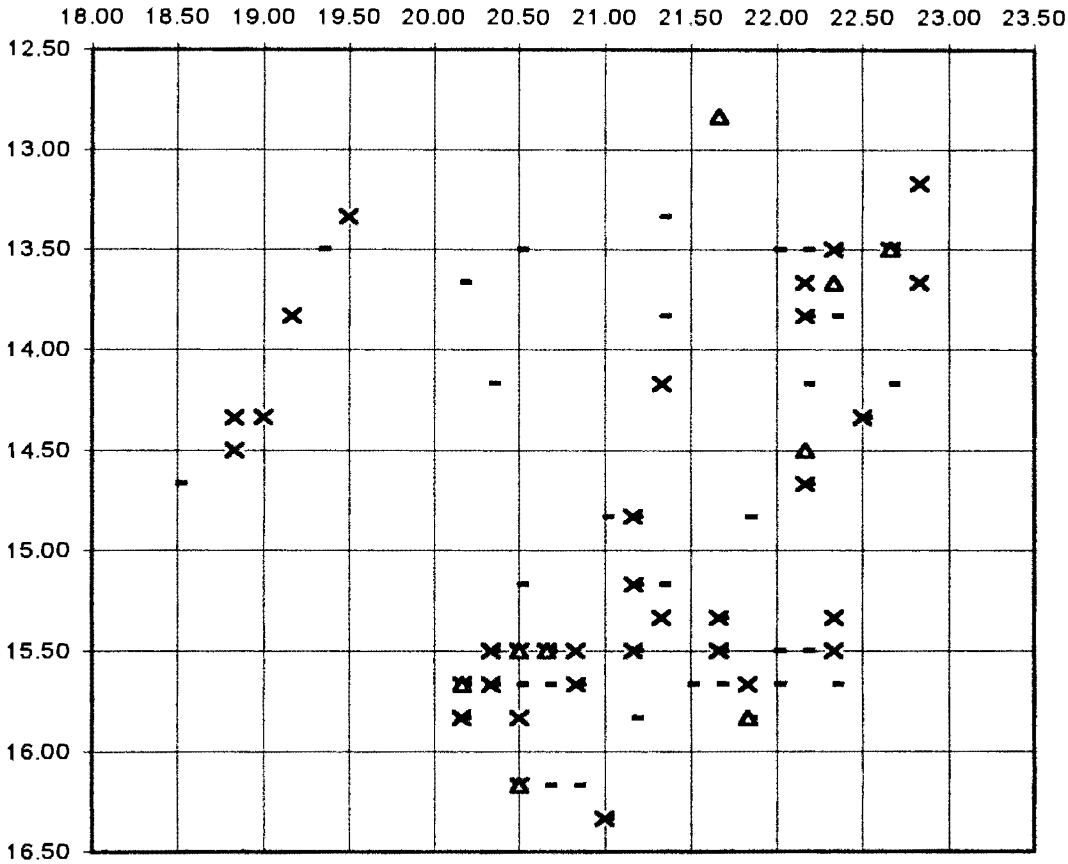


Figure 55. Spatial distribution of archaeological sites on the Big Summit District. A dash indicates an Isolated Activity site, an x indicates a Moderate Activity site, and a triangle indicates a High Activity (residential) site. Combined symbols indicate that both of the site types shown exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

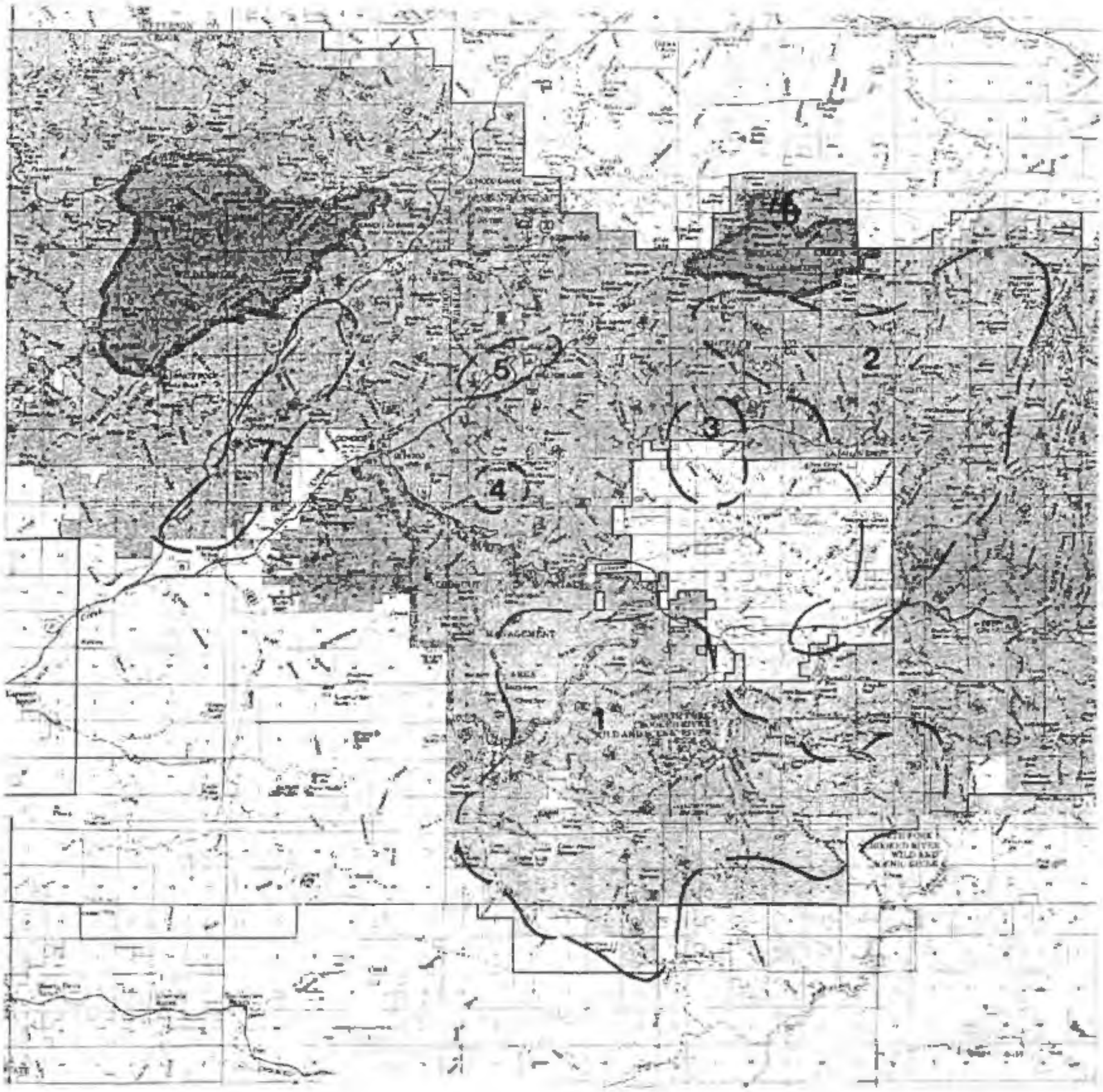


Figure 56. Map showing distribution of archaeological site clusters on the Big Summit District.

Inspection of the site type distribution shown in Figure 55 indicates that the High Activity areas are located predominantly in clusters 1 and 2 (see also Figure 56). Isolated Activity areas are scattered throughout the district in essentially a random pattern, while Moderate Activity areas show more tendency to cluster. The high activity areas are highly clustered, to the extent that no High Activity areas exist west of Big Summit Prairie. Big Summit Prairie has been ethnographically described as an important place to congregate in the spring for gathering roots, thus making this an important location for placement of activity sites. The North Fork of the Crooked River is an important travel route into the district, making this also an important factor in site placement. The pattern can be readily understood in terms of the foregoing analysis, which showed Isolated and Moderate Activity sites to be prominently associated with root grounds and other plant foods, while High Activity sites were probably residential bases from which task groups would range out.

District 2 (Paulina) contained 10 clusters of sites (Figures 57 and 58). Cluster 1 was a large group of sites located in the southeast portion of the district in the Hardscrabble Ridge area. This area, just west of the North Fork of the John Day River, and north of the South Fork of the Crooked River, has large concentrations of plant resources. It is in this group that the Wind Creek sites occur (see Chapter V). Most other site clusters occur either on the high elevation Ochoco Divide or along tributaries of Deep Creek and Jackson Creek, both of which flow south into the North Fork of the Crooked River. The important attractors of site placement on this district are the North Fork of the John Day River , the South Fork of the Crooked River, Jackson Creek, Deep Creek, the Ochoco Divide, and Little Summit Prairie, around which Cluster 6 is located.

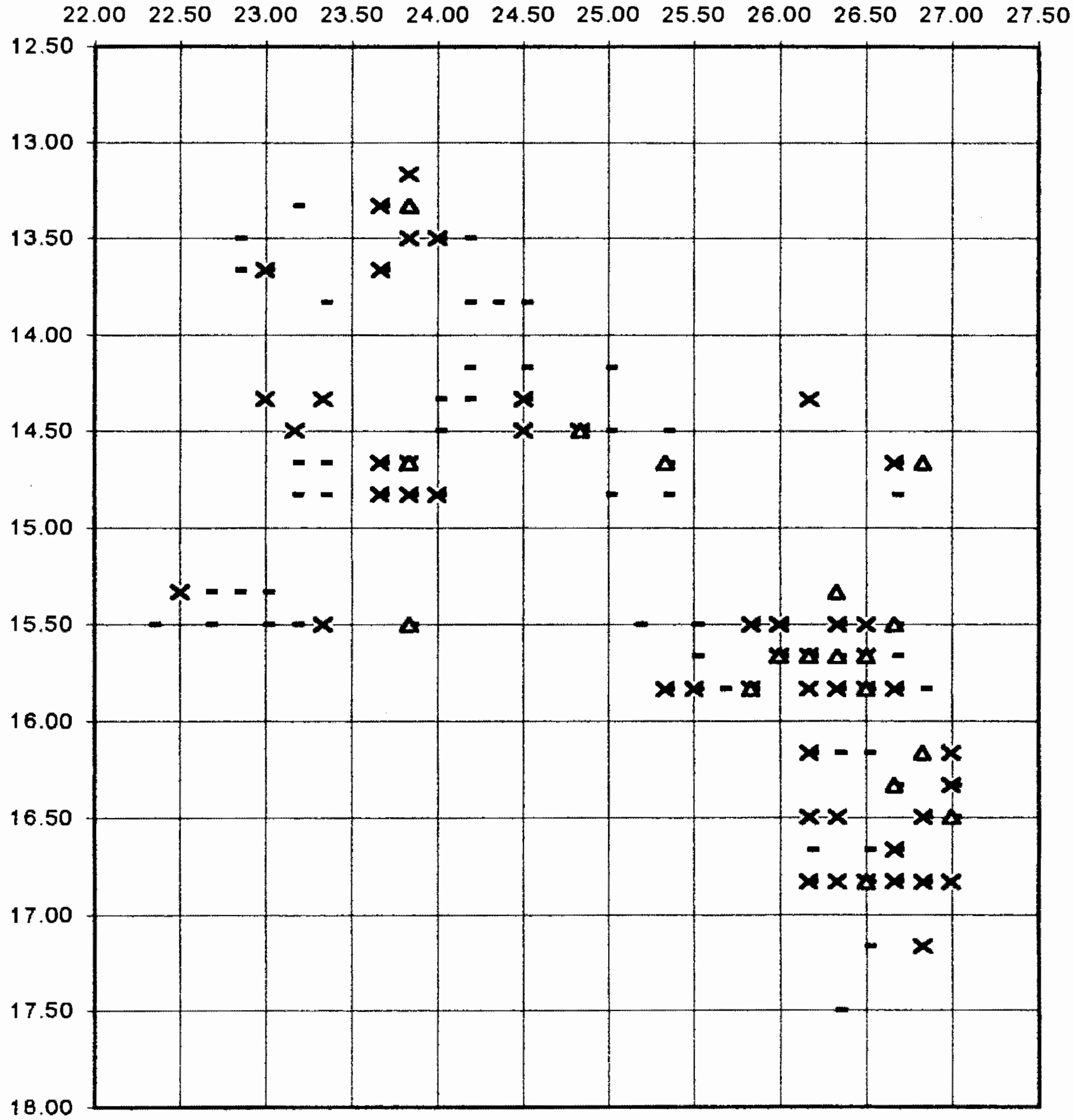
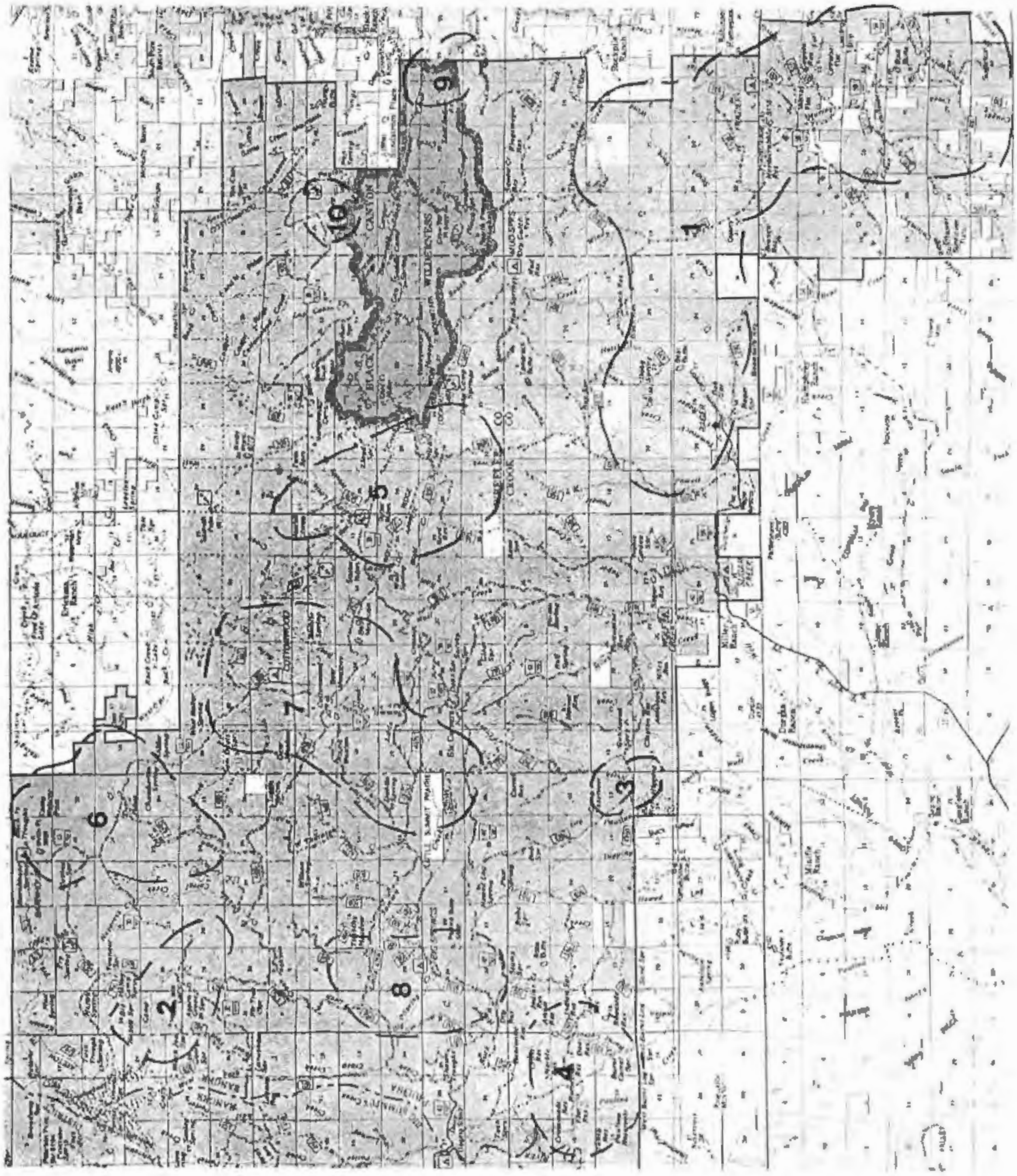


Figure 57. Spatial distribution of archaeological sites on the Paulina District. A dash indicates an Isolated Activity site, an x indicates a Moderate Activity site, and a triangle indicates a High Activity (residential) site. Combined symbols indicate that both of the site types shown exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

Figure 58. Map showing distribution of archaeological site clusters on the Paulina District.


1
2
3
4
5
6
7
8
9
10
BLACK
CANYON
WILDERNESS

Inspection of Figure 57 indicates that Isolated Activity areas tend to be dispersed around High Activity sites, which again makes sense in terms of task forces ranging out from base camps to conduct hunting and gathering activities.

District 3 (Prineville) was split into north and south portions, due to the large distance between these two parts of the district (Figures 59, 60, 61 and 62). The northern portion exhibited five site clusters, consisting of one large and four small site groups. Cluster 1, the large group, was located near Little McKay Creek, while the smaller clusters 2, 3, 4 , and 5 were centered around springs. The southern portion of District 3 was divided into seven clusters. Cluster 2 was a group of sites centered around the Antelope Flat area and clusters 1,3,4,5,6, and 7 were interspersed throughout the area. Inspection of Figures 59 and 61 indicates the same random dispersal of Isolated Activity sites as seen in the preceding districts. In the south half of the Prineville district the same pattern as noted above occurs, but there is no corresponding High Activity area found in the northern portion of the Prineville district. Why this should be is not clear, but it is worth noting that the sample size for this area is quite small.

District 4 (Snow Mountain) contained seven clusters of sites (Figures 63, 64). Cluster 1 was located in the northwestern portion of the district, centered around Silver Creek and Howard Valley. Silver Creek is a major drainage running through the district, flowing southeast and south into Harney Lake. Cluster 2 was located in the western portion of the district centered around Sawmill Creek, which flows southeast into Silver Creek. Cluster 1 was separated from cluster two by Silver Creek. Cluster 3 was located in the northern portion of the district around Snow Mountain, Burnt Cabin Creek, and the upper reaches of Emigrant Creek. Emigrant Creek flows southeast into Cricket Creek, which forms the eastern boundary of the district. Cluster 4 was

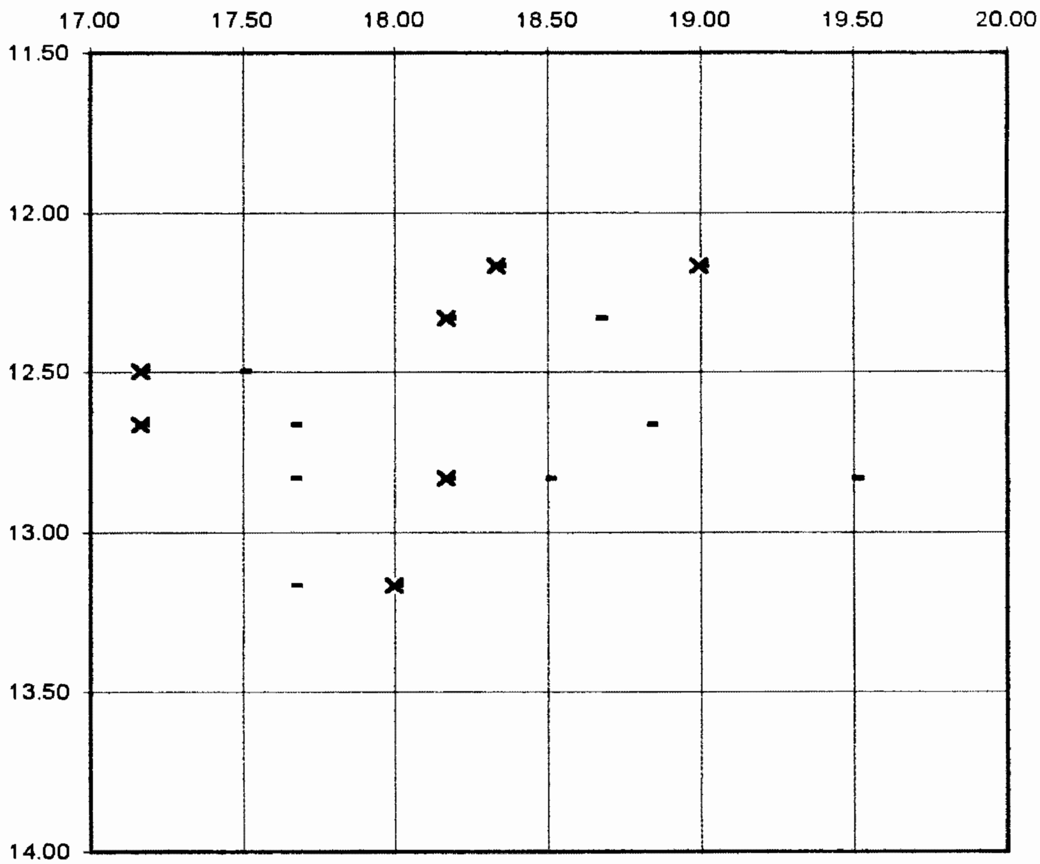


Figure 59. Spatial distribution of archaeological sites on the north half of the Prineville District. A dash indicates an Isolated Activity site, and an x indicates a Moderate Activity site. There were no High (residential) Activity areas located in this study unit. Combined symbols signify that both site types shown exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

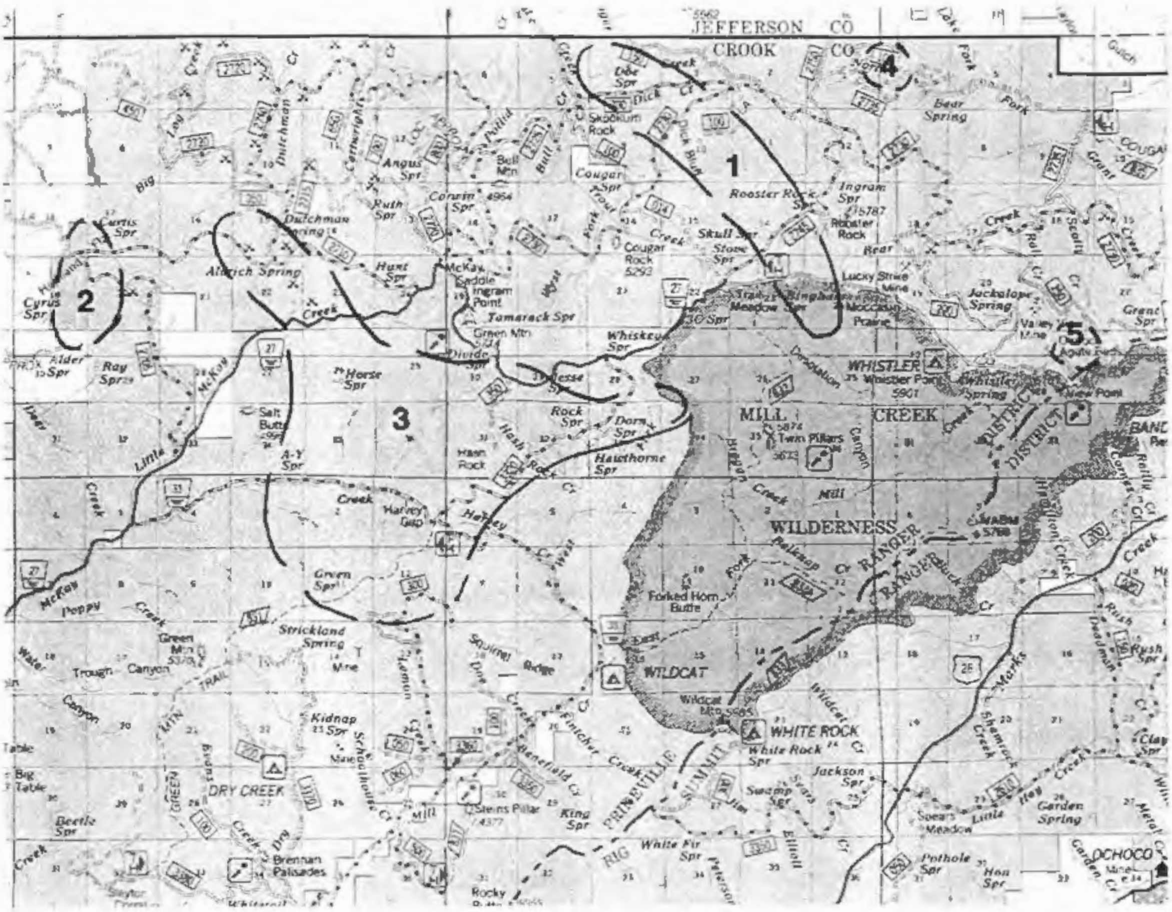


Figure 60 Map showing the distribution of archaeological site clusters on the north half of the Prineville District..

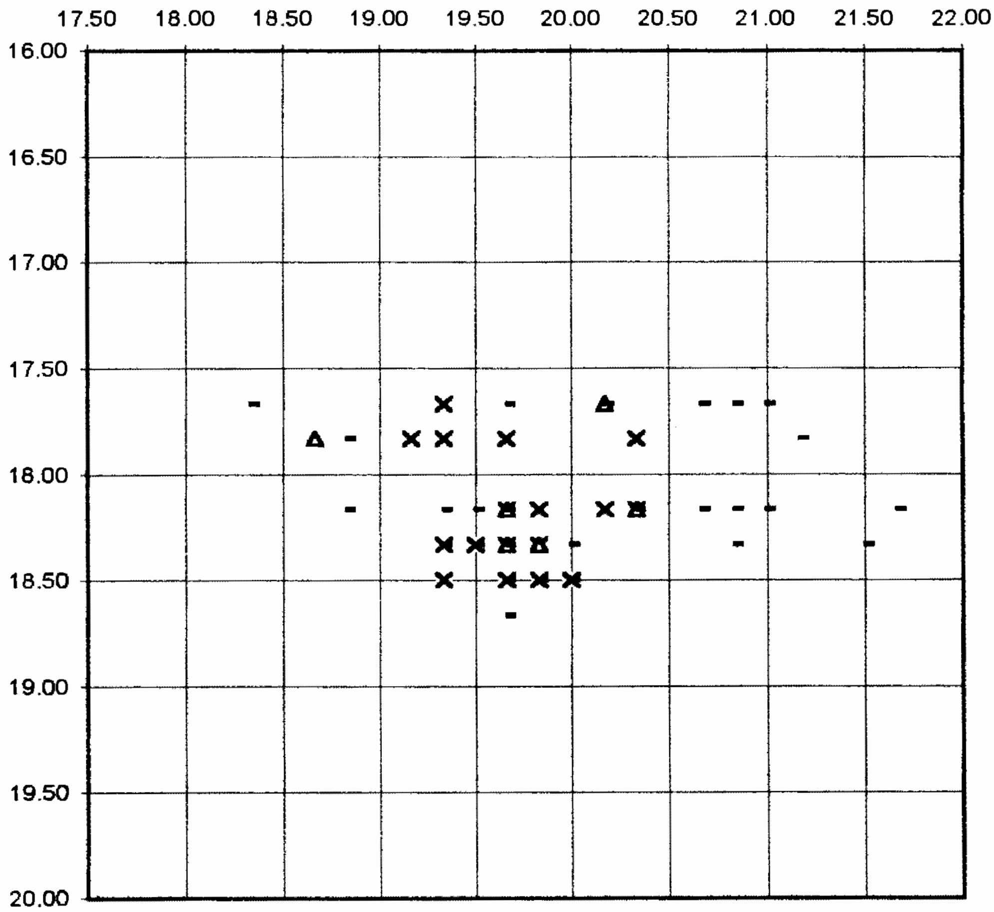


Figure 61. Spatial distribution of archaeological sites on the south half of the Prineville District. A dash indicates an Isolated Activity site, an an x indicates a Moderate Activity site, and a triangle indicates a High (residential) Activity site. Combined symbols signify that both site types shown exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

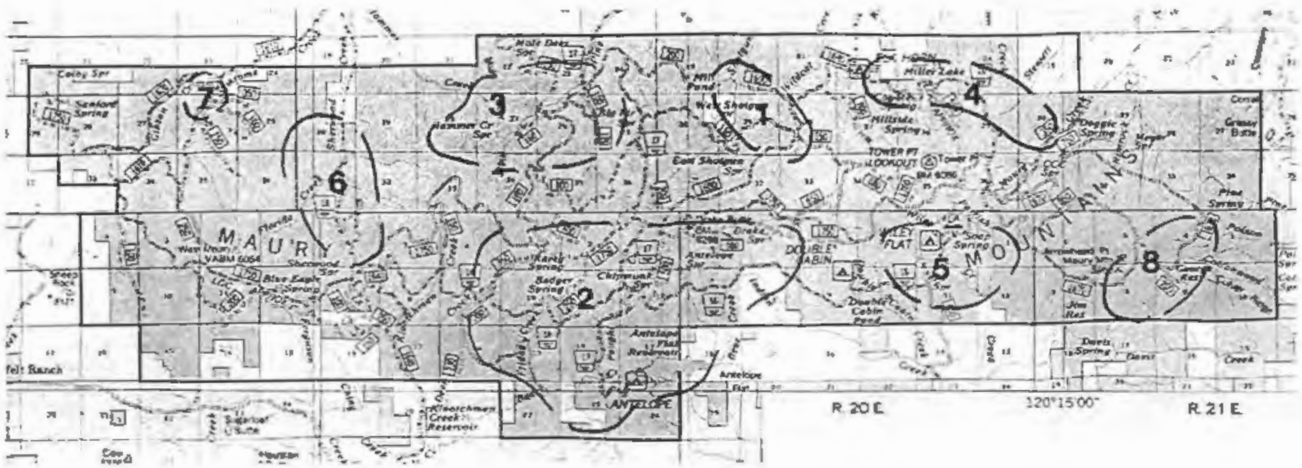


Figure 62 Map showing the distribution of archaeological site clusters on the south half of the Prineville District.

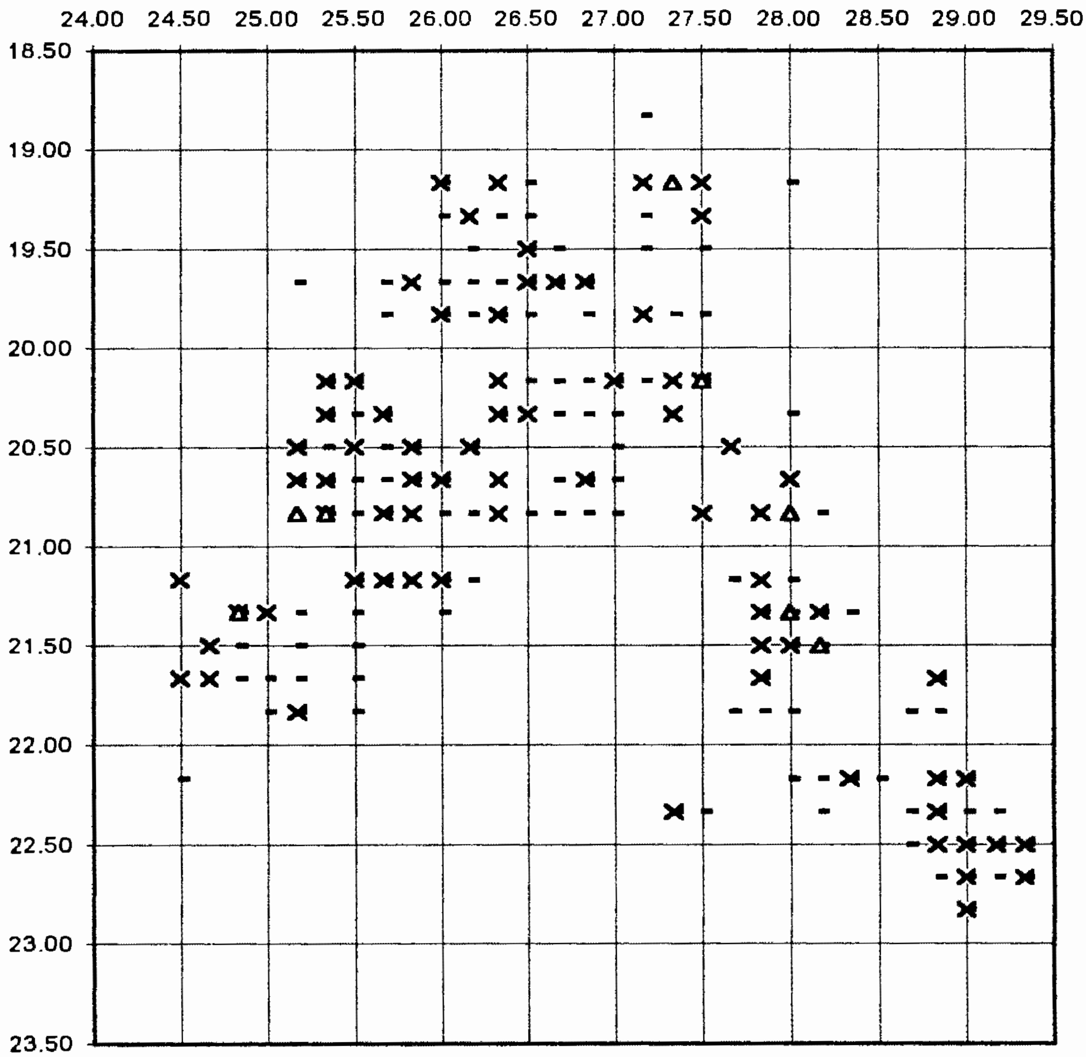


Figure 63. Spatial distribution of archaeological sites on the Snow Mountain District. A dash indicates an Isolated Activity site, an x indicates a Moderate Activity site, and a triangle indicates a High (residential) Activity site. Combined symbols signify that multiple site types exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

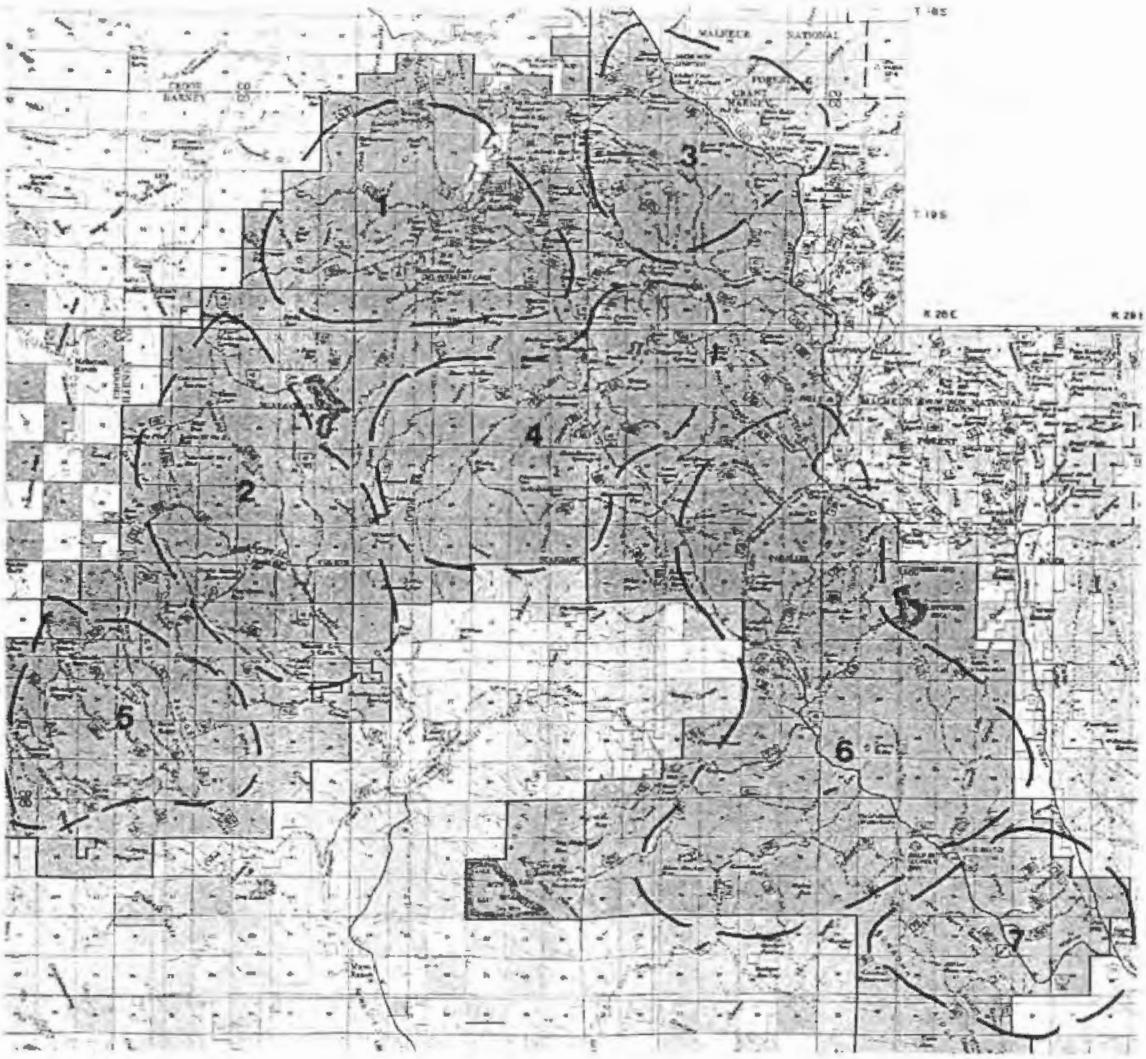


Figure 64 Map showing the distribution of archaeological site clusters on the Snow Mountain District.

located in the center of the district around Wickiup Creek, which flows south into Silver Creek. Cluster 5 was located in the southwestern portion of the district, centered around Nicoll Ridge and tributaries of Silver Creek. Clusters 6 was located in the southeastern portion of the district around Pine Spring Basin and tributaries of Cricket and Willow Creek. Cluster 7 was a large group of sites located north of Cluster 6. The sites of Cluster 7 were centered around Stinger Creek and Little Emigrant Creek, both of which flow southwest into Egypt Creek and Silver Creek.

Inspection of Figure 63 indicates the same random dispersal of Isolated Activity areas noted in the other districts, with High Activity sites centrally located. The large number of sites found on the Snow Mountain district indicates that it was heavily utilized through time. The Snow Mountain area has been ethnographically described as an important root gathering area in the spring (Couture 1978). Silver Creek and its tributaries are an important factor in the location of archaeological sites on this district, and would have been an important travel route into the district from the south. The fact that the economically important Harney and Malheur Lakes lie a short distance away in this direction is a further significant factor. Finally, five local sources of obsidian tool stone have been located on this district (see Appendix F) and were surely a factor in site placement here.

District 5 (Grasslands) contained the fewest sites recorded in any district. They were found in five dispersed clusters (Figures 65, 66). The district is divided into two sections, one on either side of the Deschutes and Crooked Rivers. The eastern section contained five of the six clusters recognized and the western section contained the other cluster. Cluster 1 was centered around Mud Springs Creek. Cluster 2 was north of the first cluster of sites around Willow Creek. Cluster 3 was located to the north of Cluster 2, around Skull Hollow and Lone Pine Creek.

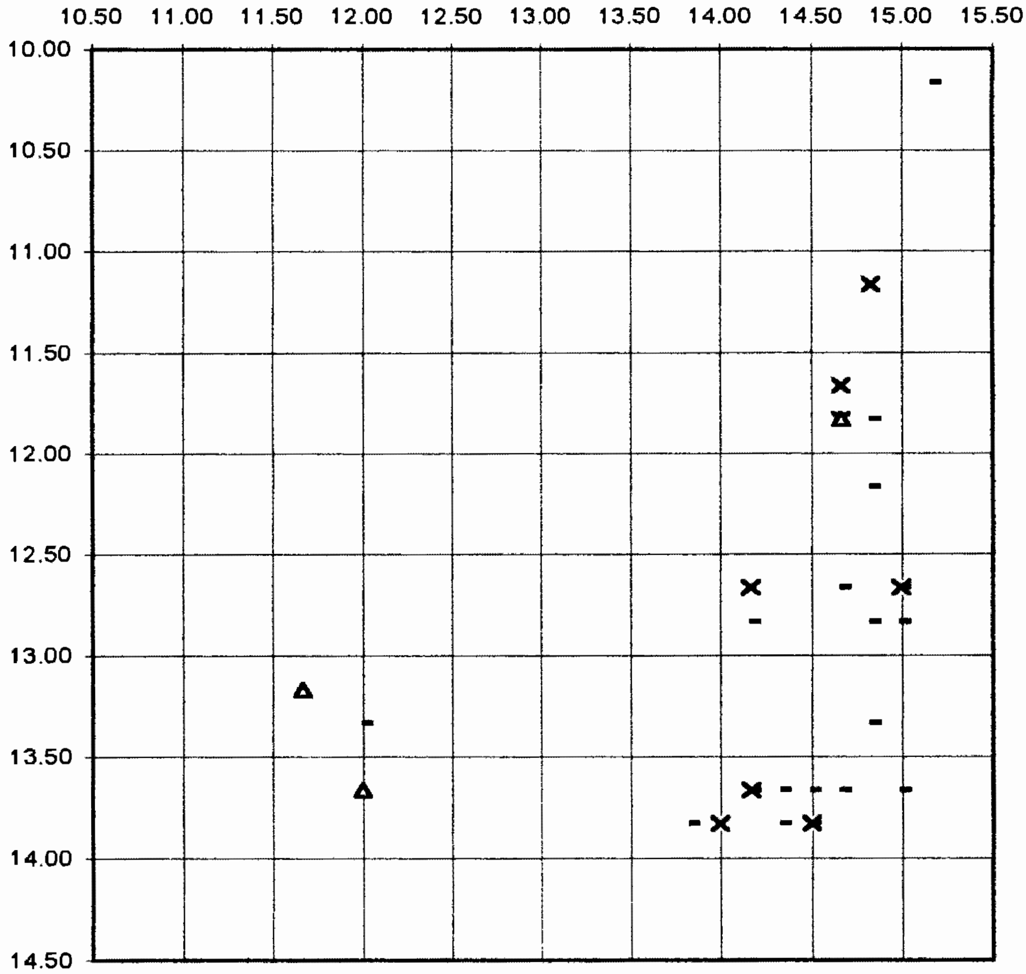


Figure 65. Spatial distribution of archaeological sites on the Grassland District. A dash indicates an Isolated Activity site, an x indicates a Moderate Activity site,and a triangle indicates a High (residential) Activity site. Combined symbols signify that multiple site types exist within the same 640 acre section, the smallest recording unit used in this analysis. Scale: 1 block = 3 square miles.

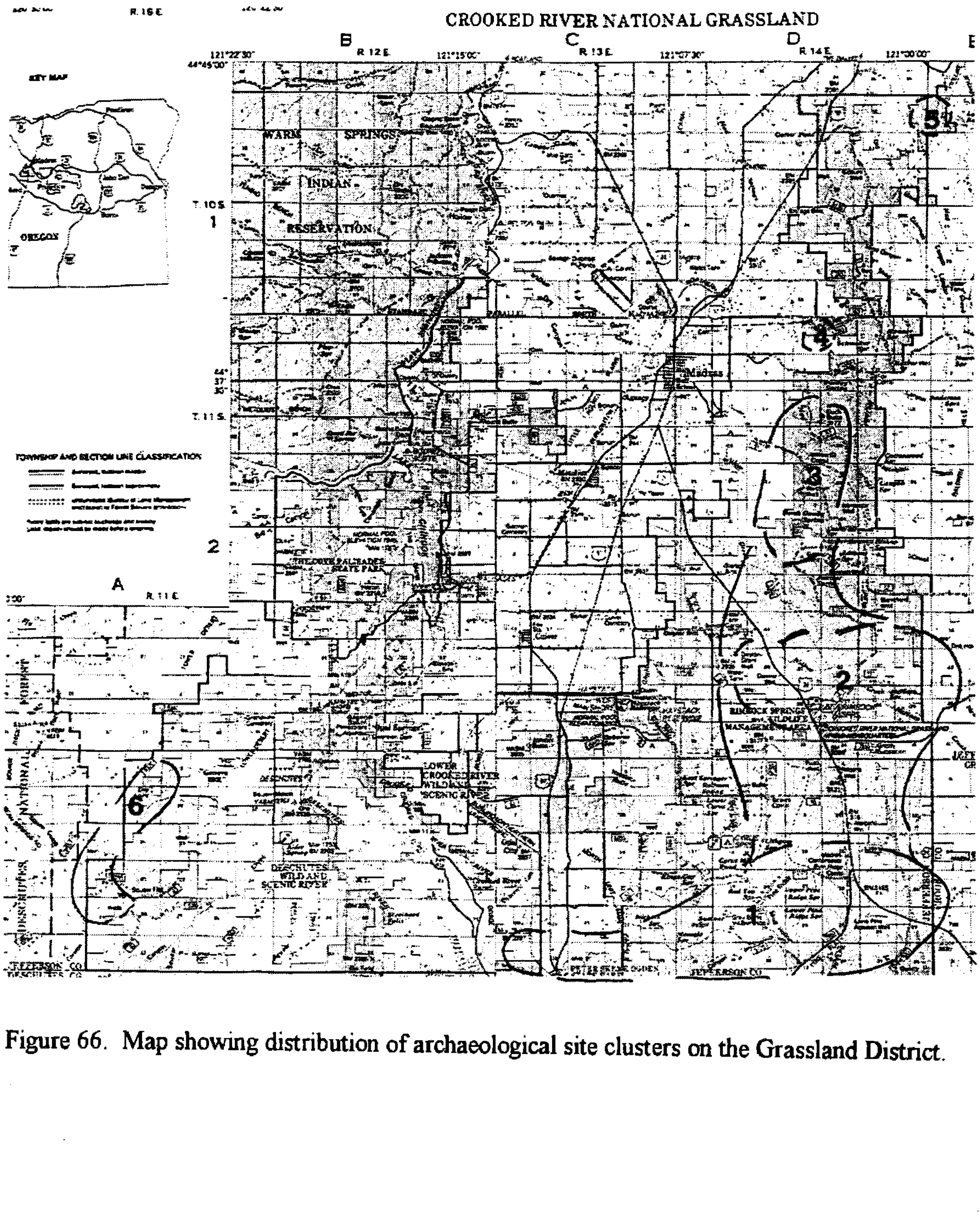


Figure 66. Map showing distribution of archaeological site clusters on the Grassland District.

Numerous springs are located in this area. Clusters 4 and 5 were small groups located in the northern most portion of the district. Finally, Cluster 6 was a small group of sites located west of the Deschutes and Crooked rivers found around Squaw Flat and Squaw Creek. The limited number of sites recorded on the Grasslands district may reflect a somewhat restricted level of biotic diversity here. It is notable nevertheless that the pattern of a few High Activity sites located centrally in relation to more dispersed Isolated and Moderate Activity sites is indicated for the Grassland District, just as it was for the others. Clearly, the Deschutes and Crooked rivers were major factors in the location of these sites that were recorded on the Grassland district.

In summary, cluster analysis of site locations throughout the Ochoco National Forest indicates that distinct patterned clusters of sites occur throughout the area. Geographical positioning and botanical data indicate that sites are associated with major water drainages and with highly productive vegetal food gathering areas. Analysis of site activity types indicates that Isolated Activity sites are widely dispersed in an essentially random pattern. As the degree of site activity increases from moderate to high, site placements tend to show more clustering, indicating that the large activity areas were places of major and consistent population aggregation, probably residential bases. There is a strong pattern of High Activity (residential) sites being centrally located with reference to subsidiary sites, suggesting an established pattern of task groups ranging out from residential bases. In some instances, as on parts of the Big Summit and Prineville Districts, there were geographic areas where high activity sites were not found at all, but in these areas relatively small samples make it unclear whether a different pattern is represented or whether relatively uncommon High Activity sites were simply not discovered.

Persistence of Site Distribution and Settlement Patterns Over Time

The question of possible change in settlement patterns over time is addressed by examining the temporal as well as spatial distributions of sites within the analytical sample. It was not possible to obtain temporal data for all the sites, but those at which temporally diagnostic projectile points were found could be assigned to a general time period. By contrasting distributions of Early, Middle, and Late Archaic sites roughly dated on the basis of their projectile point assemblages, a general picture of persistent occupation over time was apparent. for a substantial sample of central Oregon archaeological sites.

From the 1150 recorded archaeological sites, 327 classifiable projectile points were identified. When the sites were recorded in the field, each of the observed projectile points was classified into a rough type. These types have been analytically grouped to represent Early, Middle and Late Archaic Periods. In the analysis, each projectile point was counted as recording one incident of occupation during the period represented.

The Early Archaic Period extended from 9000 to 5000 BP Minor et al. (1987). Seventeen (17) Early Archaic incidents of occupation were identified. Projectile points representative of the Early Archaic Period included stemmed/ shouldered indented base points, broad stemmed/ shouldered unshouldered points, Windust points, and fluted points.

The Middle Archaic Period extended from 5000 BP to 2000 BP. One hundred ninety three (193) Middle Archaic incidents of occupation were identified. Projectile points representative of this period were classified as large corner-notched points, large basal notched points, Humboldt points, large side-notched points, and Gatecliff points.

The Late Archaic Period extended from 2000 BP to historic times. One hundred seventeen (117) Late Archaic incidents of occupation were identified. Projectile points representative of this period were classified as Cottonwood, Rose Spring, triangular, single side-notched, Gunther Barbed, Desert Side-notched, and Eastgate.

Figure 67 shows the distribution of Early, Middle, and Late Archaic occupations divided by 1000 year increments. As may be seen there are 4.25 Early Archaic occupation/ per thousand years. In the Middle Archaic there is a rapid increase to 64.2/ thousand years, and in the Late Archaic there is a slight decrease to 58.5/ thousand years.

Examination of the spatial distribution of Early, Middle, and Late Archaic incidents of occupation (see Appendix G) indicates that all three time periods are found in the same general locations. There are few Early Archaic occupations, so the problem of sample error makes it difficult to base any conclusions upon data for that period. For the Middle and Late Archaic, however, there are substantial numbers of occupation incidents represented. The fact that Middle and Late Archaic occupations are found in the same general locations lends support to the idea that the local resources attracting people to these places have not changed much over at least the last 5000 years. Early Archaic occupations are also well represented on all the same landform types as used in later periods, suggesting that earlier patterns of occupation may not have been greatly different either. The fact that the vast majority of sites yielded only single projectile point periods (Figure 68) indicates that the intensity of occupation in general was quite low, but consistently so over a long period of time.

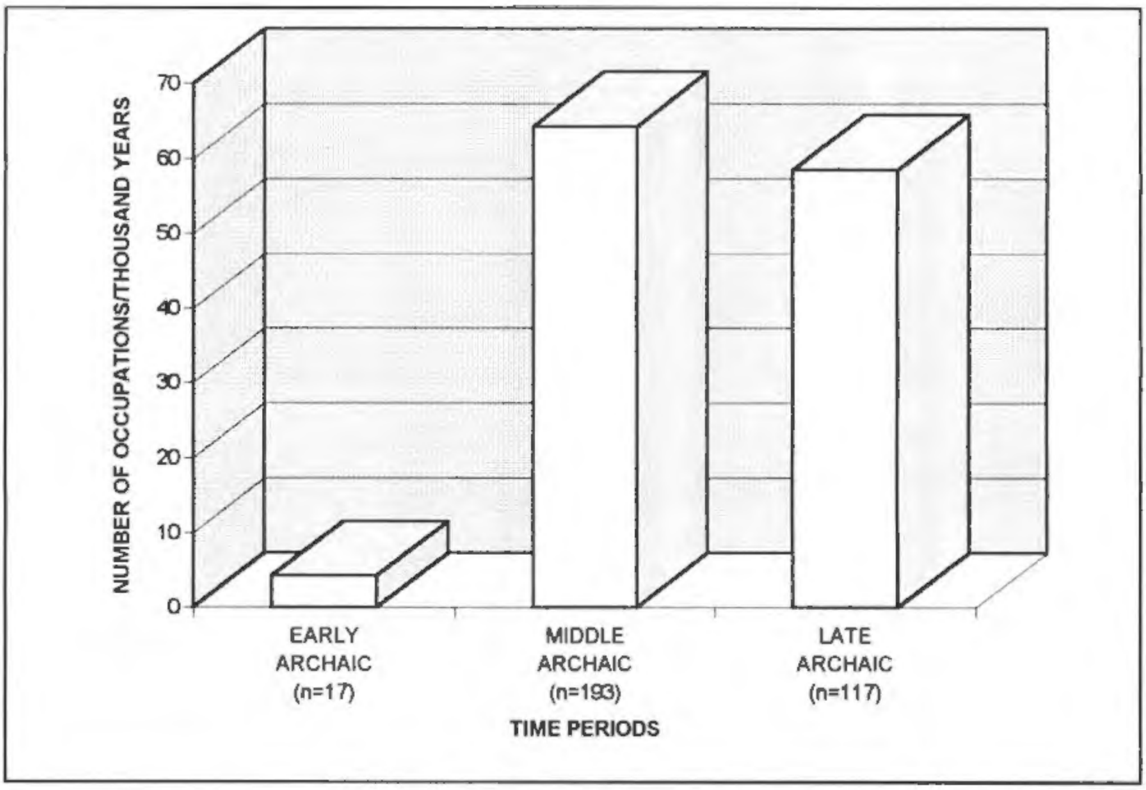


Figure 67. Distribution of Early, Middle, and Late Archaic site occupations per thousand years. The total Early Archaic occupations were divided by 4, Middle Archaic occupations by 3, and Late Archaic occupations by 2.

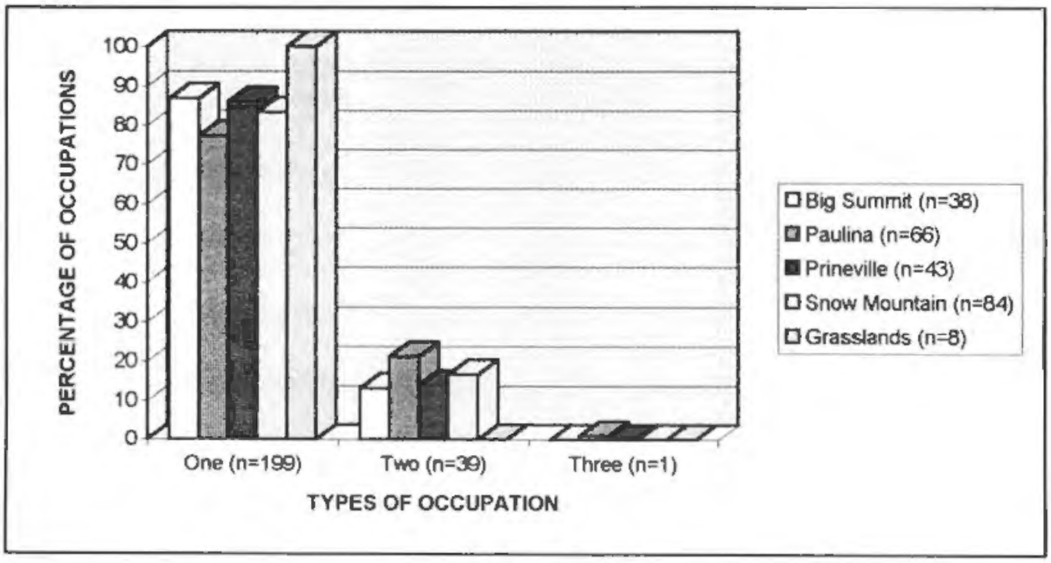


Figure 68. Distribution of periods of site occupations and forest district.

When site dated occupation of locations are compared against physiographic and environmental variables it becomes apparent that Middle and Late Archaic patterns are essentially identical (Figure 69). Analysis of site size also indicates that the Early, Middle, and Late Archaic patterns were very much the same over time (Figure 70). Again the Middle, and Late Archaic patterns are identical. The Early Archaic pattern is very similar, but there is a somewhat greater proportion of small occupations, and a somewhat lesser proportion of medium sized occupations as

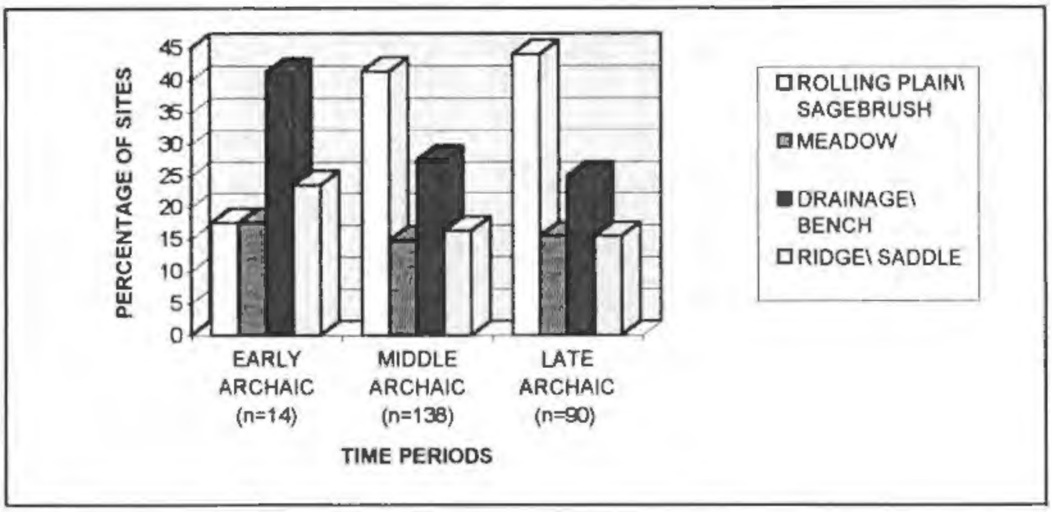


Figure 69. Early, Middle and Late Archaic occupations divided by landform.

compared with the two later periods (see Figure 70). Given the small number of occupations recorded in the Early Archaic analysis, too much should not be made of the relatively minor differences. When the degree of occupational activity attested at different site localities is examined, the same pattern of great similarity over time emerges (Figure 71).

The picture however is not one of total stability. Analysis of nearest water source to sites indicates that spring-associated sites have their highest occurrence in the Early Archaic and

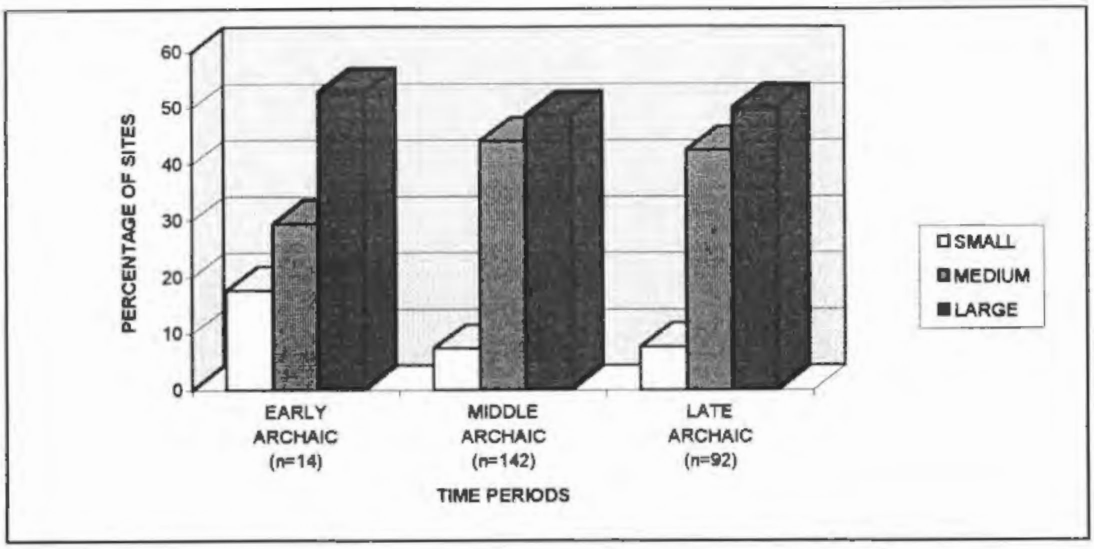


Figure 70. Early, Middle, and Late Archaic site occupations and occupation size.

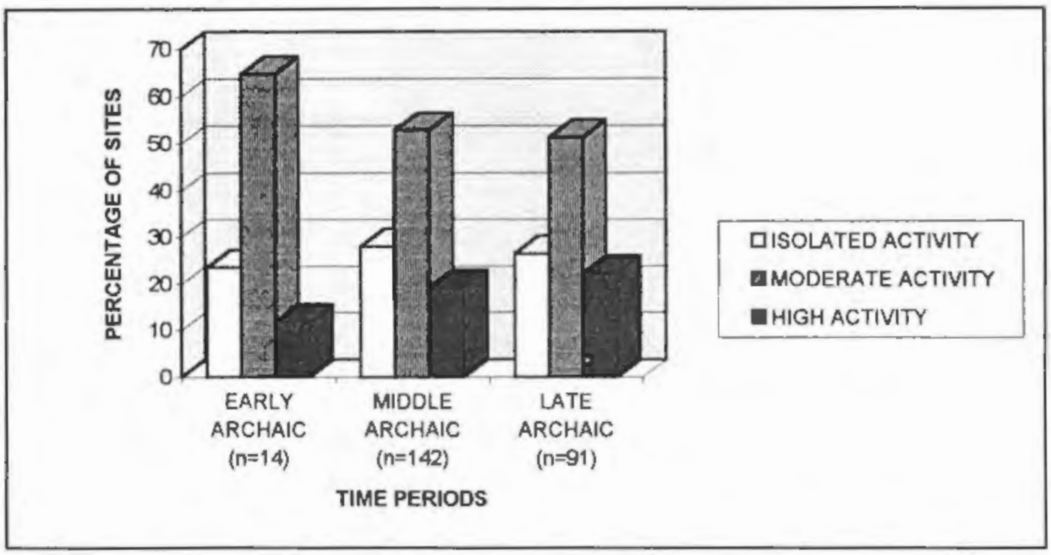


Figure 71. Early, Middle, and Late Archaic occupations and degree of activity.

decrease through time, while site occupations associated with streams and drainages increase over time (Figure 72). The overlapping and consistency of these evident trends commands attention, indicating a quite clear shift over time in relative dependence on these kinds of water sources.

Analysis of plants found associated with the occupation sites shows marked differences between periods as well. Data for the Early Archaic occupations are too slim to support much

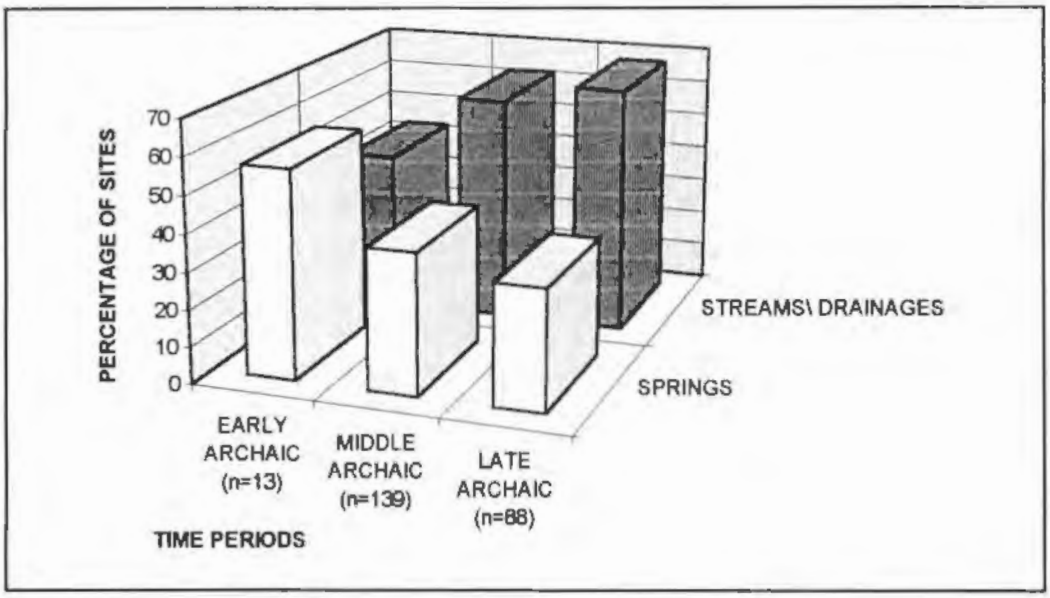


Figure 72. Early, Middle, and Late Archaic occupations and nearest source of water.

interpretation, but those for the Middle and Late Archaic occupations demonstrate quite different patterns (Figure 73). Balsamroot and onion are well represented on Middle Archaic sites, while both are found on few Late Archaic sites. Although the data is slim berries predominate and camas is present only on Late Archaic sites.

Obsidian Sources and The Movement of Tool Stone

Settlement patterns may also be addressed through the analysis of obsidian. Obtaining source data from samples of obsidian tools yields clues to human patterns of movement and

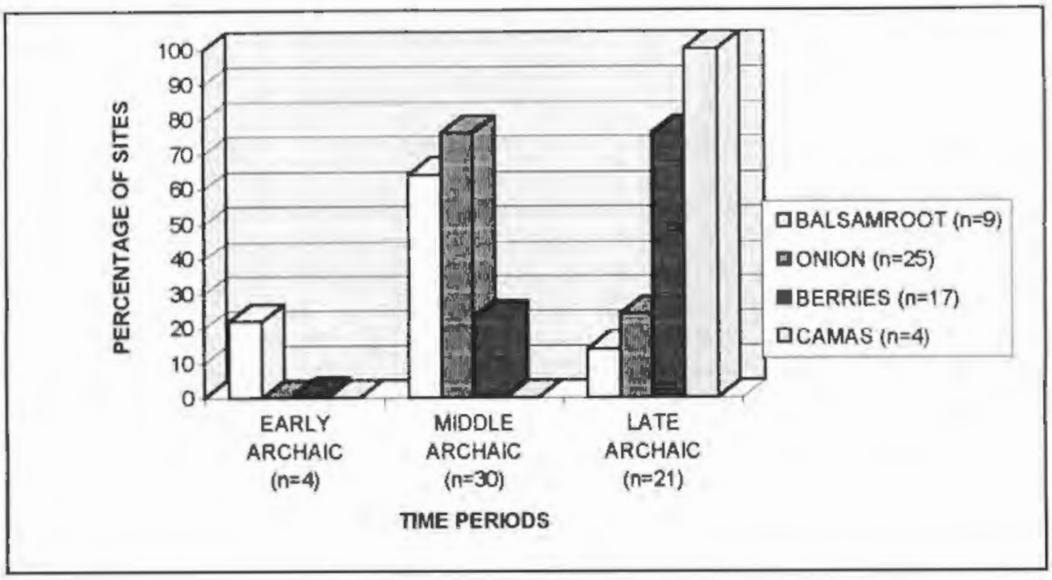


Figure 73. Early, Middle, and Late Archaic occupations in relation to and types of edible plants found on the sites.

exchange. A geochemical analysis of obsidian from central Oregon identified 18 geological sources of the popular tool stone (see Appendix C). In order to examine the distribution patterns of obsidian sources, the approximate distances from each source to the center of each of the five districts of the Ochoco National Forest were first measured, and a cluster analysis of these distances, using a squared Euclidean measure, was performed (Figure 74). The cluster analysis indicates that obsidian from the four groups of sources was widely distributed (Figure 75).

Group one comprises the sources found on or near the Snow Mountain District of the Ochoco National Forest. These sources include Glass Buttes, Yreka Buttes, Potato Hills, Delintment Creek, Sawmill Creek and Juniper Spring. The average distance from the five Ochoco National Forest districts to these obsidian sources was 47 miles, and 22.9% (n=16) of all Ochoco National Forest samples were sourced to this Group 1. Fifty percent (n=8) of the Group 1 obsidian samples were found on the Paulina District of the Ochoco National Forest (Table 23).

Figure 74. Cluster analysis of central Oregon obsidian sources, according to their individual distances from the centers of five districts of the Ochoco National Forest. Numbers refer to the obsidian sources shown on the dendrogram. Four groups of obsidian sources are indicated as determined by rescaled distances of the sources from the five districts.

Key:

1-Newberry Crater
2-McKay Butte
3-Quartz Mountain
4-Cougar Mountain
5-Obsidian Cliffs
6-Glass Buttes
7-Riley
8-Horse Mountain
9-Potato Hills
10-Beatys Butte
11-Yreka Butte
12-Double O
13-Burns Butte
14-Whitewater Ridge
15-Little Bear Creek
16-Wolf Creek
17-Delintment Creek
18-Sawmill Creek
19-Juniper Springs

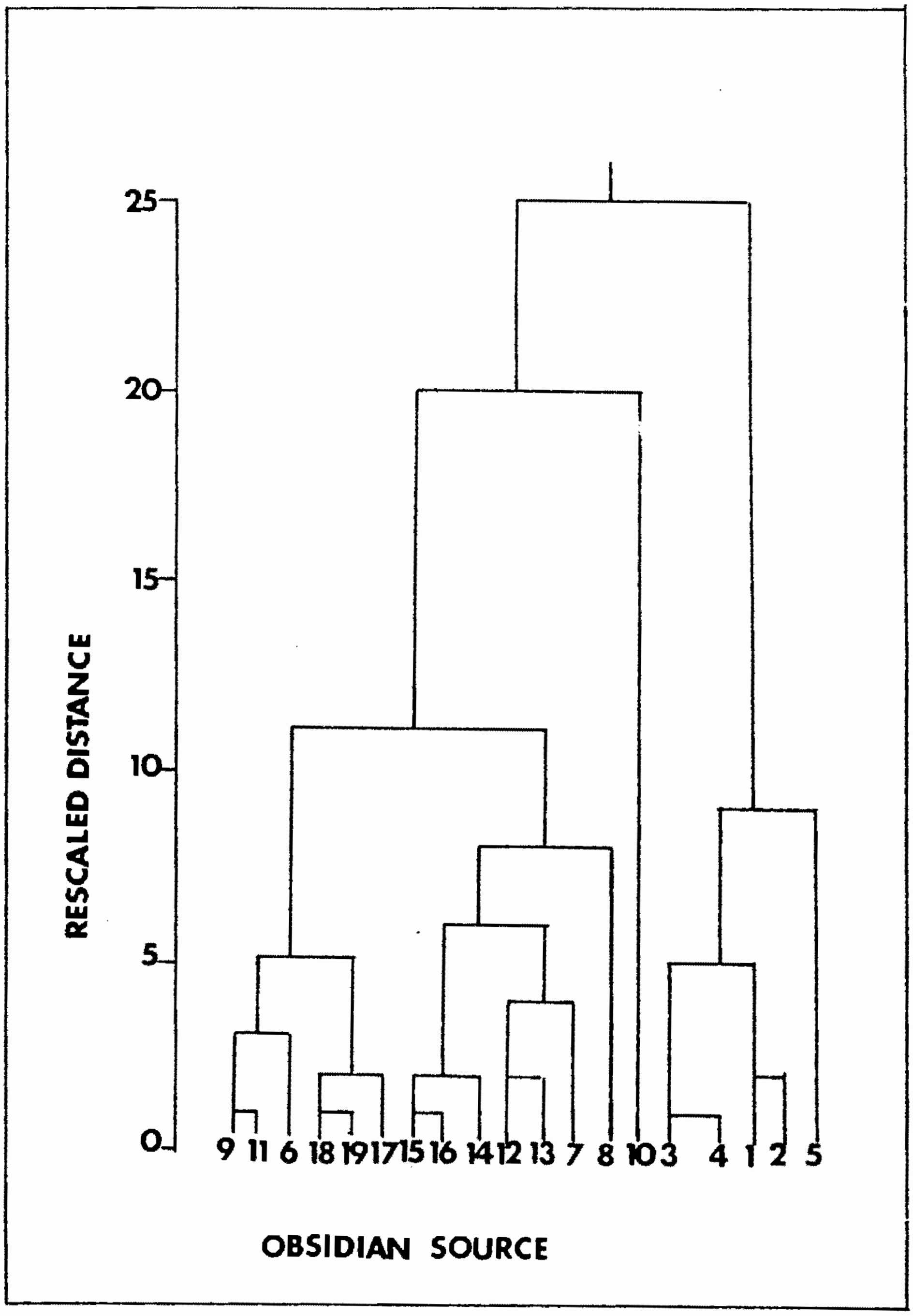

RESCALED DISTANCE
25
20
15
10
5
0
9 11 6 18 19 17 15 16 14 12 13 7 8 10 3 4 1 2 5
OBSIDIAN SOURCE

Figure 75. Central Oregon obsidian sources. Dashed lines indicate the scaled distance groupings to which the sources belong. Circled numbers indicate that sources 8 and 10 actually lie farther to the south off the map.

Key:
1-Newberry Crater
2-McKay Butte
3-Quartz Mountain
4-Cougar Mountain
5-Obsidian Cliffs
6-Glass Buttes
7-Riley
8-Horse Mountain
9-Potato Hills
10-Beatys Butte
11-Yreka Butte
12-Double O
13-Burns Butte
14-Whitewater Ridge
15-Little Bear Creek
16-Wolf Creek
17-Delintment Creek
18-Sawmill Creek
19-Juniper Springs
20-Buck Springs[a]
21-Dog Hill[a]
1-(in square block)-Obsidian Group 1
2-(in square block)-Obsidian Group 2
3-(in square block)-Obsidian Group 3
4-(in square block)-Obsidian Group 4
Star-Wind Creek Sites

[a] Identified from a previous analysis of Wind Creek obsidian and not used in the cluster analysis

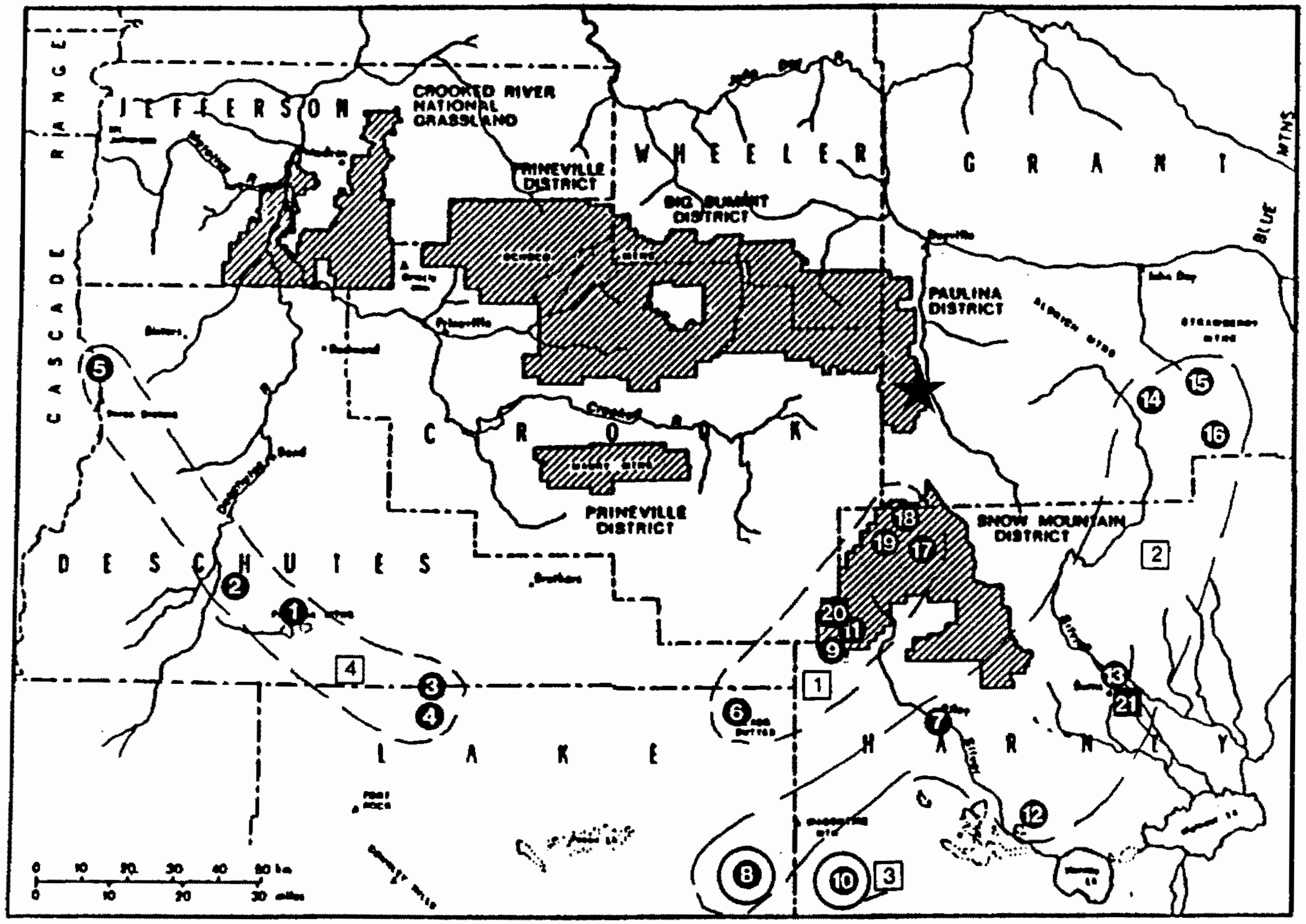

JEFFERSON
CROOKED RIVER NATIONAL GRASSLAND
PRINEVILLE DISTRICT
WHEELER
BIG SUMMIT DISTRICT
GRANT
BLUE MTNS
CASCADE RANGE
PAULINA DISTRICT
CROOK
PRINEVILLE DISTRICT
SNOW MOUNTAIN DISTRICT
DESCHUTES
LAKE
HARNEY
0 10 20 30 40 50 km
0 10 20 30 miles

Table 23. Distribution of Obsidian for Four Source Groups on Various Districts of the Ochoco National Forest

Forest Service Districts	Groups of Obsidian Sources 1	2	3	4	Total
Big Summit					
count	4	1	0	5	10
(row%)	(40.0)	(10.0)		(50.0)	(14.0)
(col%)	(25.0)	(2.8)		(26.3)	
Paulina					
count	8	29	0	3	40
(row%)	(20.0)	(72.5)		(7.5)	(55.6)
(col%)	(50.0)	(80.6)		(15.8)	
Prineville					
count	2	3	0	8	13
(row%)	(15.4)	(23.1)		(61.5)	(19.6)
(col%)	(12.5)	(8.3)		(42.1)	
Snow Mountain					
count	2	3	1	2	8
(row%)	(25.0)	(37.5)	(12.5)	(25.0)	(11.4)
(col%)	(12.5)	(8.3)	(100.0)	(10.5)	
Grasslands					
count	0	0	0	1	1
(row%)				(100.0)	(1.4)
(col%)				(5.3)	
Total	16	36	1	19	72
(col%)	(22.2)	(50.0)	(1.4)	(26.4)	

Forty percent (n=4) of the obsidian samples from the Big Summit District, 21% (n=8) of the samples from the Paulina District, and surprisingly, only 12.5% of the samples from the Snow Mountain District (n=2), were procured from Group 1 sources.

Group Two consists of sources further to the south and east, including Little Bear Creek, Wolf Creek, Whitewater Ridge, Double "O", Dog Hill, Riley, and Horse Mountain. The average distance of these sources from the district centers was 74.7 miles, and 51.4% (n=36) of the total set of obsidian samples from the Ochoco National Forest were sourced to this group. Eighty percent (n=29) of the Group 2 samples were from the Paulina District. The John Day and Silvies Rivers were probably utilized as routes to obtain this obsidian, and procurement of obsidian toolstone from this group of sources, may be identified as the Silvies River Pattern.

Group 3 consisted of only Beatys Butte, 130 miles to the south, at the far end Catlow Valley (# 10 on the Figure 74 dendrogram). This source was the most distant of those identified during these investigations. The single sample sourced to this group came from a site on the Snow Mountain District, and provides evidence for long distance procurement or a south-central Oregon non/local pattern.

The fourth group consisted of obsidian sources to the west, including Newberry Crater, Mckay Butte, Quartz Mountain, Cougar Mountain, and Obsidian Cliffs. The average distance from the center of each district to these sources was 67 miles, and 24.3% (n= 17) of the total Ochoco National Forest obsidian sample came from sources in this group. Forty seven percent (n=8) of all the Group 4 obsidian samples were from sites located on the Prineville District. This obsidian procurement pattern is called the Deschutes River Pattern because the Deschutes and Crooked Rivers were probably utilized as travel routes into this group of obsidian sources. Sixty one percent (n=8) of the samples from the Prineville district, and 100% (n=1) of the samples from the Crooked River National Grassland fell within this pattern.

The four groups of obsidian sources are all located to the east, south and west of the central Oregon upland study area, while no sources have been identified to the north. The majority of obsidian in the analysis was procured from Group 2 souces, located west and south of the study area. Within this group Whitewater Ridge obsidian is the predominant type (see Appendix C). Examination of the distribution of obsidian samples indicates that the people of the central Oregon upland study area tended to procure obsidian from the source nearest to them, but that obsidian tools from all sources were dispersed throughout the study area. A high degree of mobility and exchange is indicated.

Settlement Pattern: Conclusions

This analysis of central Oregon settlement patterns has indicated that human use of the upland area represented by five Ochoco National Forest districts has remained stable over a long period of time, and is closely tied to environmental conditions and physiographic variables. This stability is represented by the placement of archaeological sites, as well as their assemblage structure and functional tool type composition. Finally obsidian procurement patterns have been examined, the wide range of obsidian sources utilized indicating high mobility throughout the area.

Environment

It has been demonstrated that, in general, there is an even distribution of prehistoric archaeological sites within three life zones. The majority of the land in the central Oregon uplands study area is found in the Transition and Canadian zones, and thus the majority of prehistoric sites are found within these two zones. However, proportionally there are more sites located within the Transition zone, indicating a slight preference for this life zone. This may indicate that the Transition zone was the most productive area in terms of plant and animal resources. The idea is further reinforced by examination of the distribution of recorded edible plant resources and the percentage of study area land within each life zone, indicating that within the project area the Transition zone has a significantly greater amount of recorded plants observed on archaeological sites in relation to the amount of land found there.

Within the three life zones site associated landform characteristically changes. As elevation increases the percentage of sites associated with drainage/bench locations decreases, while ridge and saddle locations increase. This is a simple function of the physiography itself. Environmental variables, including nearest water source, and site distance to nearest water source, may be viewed as constants given the large percentages of sites in immediate proximity to water, or associated with streams/rivers. These are important factors when predicting site locations, and they do not change significantly through time.

Site Structure

Analysis of tool assemblages in the sites shows many of the sites contain tool types that crosscut sites, making it difficult if not impossible to examine function of sites based upon the typological makeup of tool assemblages. At the same time 30 percent of the sites (n=331) contain only flakes, and a cumulative 47.1 percent of the sites contain either flakes, flakes and projectile points, or flakes, projectile points, and bifaces.

The size of the prehistoric sites seems to be related to the degree of activity at the sites. This however is not an absolute correlation as there are some small sites giving evidence of high levels of activities and some large sites indicative of low levels of activity. The size of the sites appears to be related to the extent of time spent at the site location, while the activities undertaken are apparently related to the types of resources found near the sites. By plotting site locations on a map it has been demonstrated that site locations are not random and that clusters of sites may be identified. These clusters of sites are associated with major water drainages, as well as areas containing high densities of plant resources.

Analysis of the activity levels for sites indicates that within site clusters, isolated activities are randomly dispersed , and as level of activity increases the sites become more clustered. The high activity areas are found in the locations where water and significant plant resources are concentrated.

Examination of obsidian sources indicates that a wide range of obsidian was procured, which may be divided into four general source groups, located to the east, south, and west of the study area. Despite the fact that one group of obsidian sources was located directly on the Snow Mountain District, these are not the most prevalent sources represented by tools from that, or other districts. This indicates that distance to a source was not the only variable considered when procuring obsidian.

Stability and Change Through Time

Of the sample of sites for which time periods were able to be determined, the majority of the site occupations were classified as Middle Archaic. There were few Early Archaic occupations, followed by a large increase in Middle Archaic and Late Archaic sites. This pattern suggests there was a low use of the upland area during the Early Archaic period, associated with low population density. Through time, in general, the central Oregon uplands were most heavily utilized during the Middle Archaic (5000-2000 BP).

Sites associated with rivers and streams increase slightly through time while sites associated with springs decrease. Site location also changes from sites associated with drainages and benches to sites associated rolling plain/sagebrush. These changes, however are slight.

By plotting the locations of Early, Middle, and Late Archaic sites on maps it has been demonstrated there is little change in the locations of sites through time, except that there is an expansion of sites during the Middle Archaic and they are more broadly dispersed. The fact that site locations do not change in relation to physiographic variables lends support to the idea that the distribution of plant and animal resources has not changed in a major way over the past 5000 years. The areas where large numbers of prehistoric sites occur are probably the areas where the most predictable and stable food resources were found.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This study of central Oregon upland prehistory is based on new data from the excavation of four archaeological sites and an extensive survey program that recorded some 1150 previously unstudied sites. A chronological frame-work is developed on the basis of projectile point cross-dating, supplemented by C-14 data for the excavated sites. A settlement pattern analysis for the upland study area has been developed using quantitative data from the site survey, taking into account both assemblage and environmental variables. A succinct summary of the results developed in preceding chapters is presented below.

The Wind Creek Sites

Four prehistoric archaeological sites were excavated in 1984 along Wind Creek, which drains into the John Day River. These were the first archaeological sites excavated in the Ochoco National Forest, and their excavation has yielded important information concerning structure in the central Oregon uplands region.

The excavations produced a series of radiocarbon dates ranging from 880 +- 80 BP to 4030 +- 190 BP, placing the Wind Creek sites as representative of the Middle and Late Archaic periods. Archaeological remains recovered from the four sites indicate that they were occupied for the exploitation of local resources. Large numbers of bifaces, projectile points, and flakes at these sites indicate that tool manufacture was also an important activity there.

All four of the Wind Creek sites are located near water, and on the basis of their tool assemblages, fit into the site classification of short-term residential bases. These large sites are located in Site Cluster 1 of the Paulina District, associated with the Hardscrabble Ridge area, and within easy access of the south fork of the John Day River. Hardscrabble Ridge contains a significant amount of plant resources, making this a desirable location for the placement of archaeological sites. Obsidian samples from the Wind Creek sites are predominantly from the Whitewater Ridge source to the east, which is placed within the Silvies River obsidian procurement pattern, referred to below.

Projectile Point-Based Chronology of the Study Area

Analysis of the projectile points from the study area identified eight morphological groups of points, divided into 22 historical types (see Figure 16 and Table 2). The first group consisted of small side-notched points. The second group consisted of small corner-notched points. The third group contained medium side-notched points, while the fourth group contained medium corner-notched points, including contracting stem points. Group five consisted of large basal notched points with broken square tangs. Group six contained large corner-notched points. Group seven contained large side-notched points, and Group eight contained large shouldered to stemmed points with indented and non indented bases.

A discriminant function analysis of this set of types indicated a 91.53 % correct classification. An F statistic indicated that split stem points (Type Eleven) showed similar means to concave base points (Type Thirteen) and single notched points with slightly indented bases (Type Nine), but F statistics for the remaining projectile point types indicated their means were all significantly different.

A comparison of projectile point types from the project area with known types previously described and dated in surrounding regions identified seven time periods. Period One extended from 10,000 BP to 7000 BP. Period Two extended from 7000 to 5000 BP. Period Three extended from 5000 to 4000 BP. Period Four went from 4000 to 2000 BP. Period Five began about 2000 BP and continued to about 1500 BP. Period Six began about 1500 BP and continued to about 800 BP. Period Seven began about 800 BP and lasted to historic times. Period 1 is assigned to the Early Archaic, Periods 2, 3, and 4 to the Middle Archaic, and Periods 5 and 6 to the Late Archaic.

Settlement Patterns

The examination of central Oregon upland settlement patterns was approached through an analysis of the assemblage composition of the recorded sites, and the spatial placement of the sites in relation to each other and to physiographic and environmental variables. The typological examination of assemblage composition indicated that tool assemblages within sites consistently included a broad range of artifact types. Many tools were multi-functional, and the sites were in many cases multi-task oriented.

Quantitative cluster analysis of site assemblage data however, identified just three basic kinds of sites. The first type, Isolated Activity sites, consisted of those containing one or two artifact types; the second type, Moderate Activity sites, of those containing two to three tool types; and the third type, High Activity sites, of those containing five or more types of artifacts. This cluster analysis suggested that the function of the study area sites is best characterized in terms of degrees of activity, rather than types of activities. These degrees of activity may be expressed as low, moderate and high, with the low and moderate activity areas representing, in general, smaller sites, and the high activity areas representing probable longer- occupied base camps. Within these three groups of sites, environmental and physiographic variables were then compared.

Examination of the environmental variables indicated that the majority of the sites were located in areas where ponderosa pine comprised the overstory vegetation. The number of sites found within each of three life zones common to the study area was generally comparable, relative to the proportion of land found in each life zone. The Transition zone (3500-5000 ft), however, contained somewhat more sites than the others, possibly indicating that this life zone was the most productive in terms of plant and animal resources.

Examination of the nearest water source associated with the sites, and distance from the sites to that water source, indicated that the majority of sites were associated with streams/rivers, and were in immediate proximity to water. Roughly 61 percent of the sites were found within 16 meters of water, and a cumulative 92 percent were found within 300 meters of water. While the majority of sites were found associated with streams/rivers, a smaller but still significant proportion were also found associated with springs.

Sites, in general, tended to be medium in size (80.9 m^2 to 5384 m^2), although there was a significant proportion recorded at less than 40.4m^2 . As indicated by artifact density, small sites were generally low or moderate activity areas, and large sites were high activity areas, but this was not a direct correlation. Some sites small in areal extent were high activity areas, and some areally extensive sites were low activity areas.

Sites were found mainly on rolling plains, and on drainages or benches. Ridge/ saddles and meadows, however, did also contain significant percentages of sites, indicating that a wide range of physiographic landforms were regularly utilized in the study area. Within this physiography, analysis of recorded edible plants growing at sites indicated that there was a strong relationship between the landforms and the plants. The placement of archaeological sites appears to be strongly related to close proximity of plant and animal resources, and of water.

Examination of the spatial distribution of sites indicated that sites, in general, are not randomly dispersed, but form discrete clusters. These clusters are closely related to drainage patterns, and as Appendix H indicates, to landform. Within the clusters, Isolated Activity areas are the most randomly dispersed, and as intensity of activity increases so does the clustering of sites. This may indicate that the areas where activity appears to be the highest, and which contain the greatest density of sites, were the areas most productive in terms of plant and animal resources.

Analysis of obsidian from central Oregon uplands sites (see Appendix C) identified 22 different sources, and a cluster analysis of the distances from the sources to the center of each forest district identified three procurement patterns: a John Day / Silvies River pattern, a Deschutes River pattern, and a Snow Mountain pattern. The John Day/Silvies River pattern represented 8 obsidian sources, located to the south and east of the project area. This group contained the Whitewater Ridge source, which constituted the source of the majority of the obsidian samples in the study collection. The Deschutes River pattern consisted of 5 sources located to the west and south of the project area, while the Snow Mountain pattern contained 7 sources more centrally located to the project area. Additionally one source, identified far to the south of the project area, may be described as a distant obsidian source.

Towards an Understanding of Central Oregon Upland Prehistory

Analysis of the projectile points from sites recorded in the central Oregon uplands study area has indicated that a long time span is represented, beginning with the Early Archaic period and continuing through the Historic period. Analysis of the distribution of Early, Middle, and

Late Archaic sites indicates that through time there is little variation in settlement patterns. This is true both in terms of placement of sites in relation to environmental and physiographic variables, and with regard to the placement of sites in relation to each other. There are relatively few Early Archaic sites, representing a low population density and limited use of the central Oregon uplands during this period. There was a great expansion of occupation during the Middle Archaic, possibly associated with development of upland plant resources. There is slight decline in the intensity of occupation during the Late Archaic. Through time projectile points showing similarities with both Columbia Plateau and Great Basin types are found, thus reinforcing the idea of the central Oregon uplands as a geographically marginal area between two well defined culture areas. The Late Archaic period, however, contains large numbers of Columbia Plateau type points, indicating a strong affiliation towards the Plateau at this time.

As just noted, upland central Oregon settlement patterns appear to have remained remarkably stable through time. One possible explanation for this is suggested by a model proposed by Jochim (1991). Jochim states that in describing hunter/gatherer settlement patterns an explanation of behavioral variability is necessary, and that temporal and spatial environmental variability may be isolated. He states that temporal variability refers to yearly changes in types and amounts of resources (Jochim 1991: 311). Environments vary from low to high in terms of spatial and temporal stability, and different settlement patterns, comprised of site location, season of usage, and activities performed, result from the interaction of temporal and spatial variability.

The central Oregon upland environment through time has apparently remained relatively stable, resulting in low temporal and spatial variability in the cultural resources. The resulting pattern of archaeological sites is highly formalized, reflecting long-term adherence to an annual cycle of resource scheduling. This pattern began in the Early Archaic period and continued through historic times. The site survey has shown that there were specific areas where populations returned year after year, and that these areas today contain stable plant and animal resources By inference, their prehistoric occupation must have been attracted by the same resource base.

Thus, the uplands of central Oregon have been utilized intensively over a long period of time. The model presented by Couture (1978) indicates that in historic time the uplands were utilized during the Late Spring, Summer, and Fall months, with winter villages located in lower elevations near permanent water sources. The upland study area ,then, contains only the portion of the archaeological record related to short-termed upland seasonal occupation. The research presented in this dissertation indicates that, in general, the central Oregon uplands provided a stable resource base where a wide range of landforms and resources could be exploited throughout the Holocene.

APPENDIX A

X/Y COORDINATE PROJECTILE POINT MEASUREMENTS

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
1	1 1086	00.0	01.2	01.2	00.7	00.9	00.4	00.0	00.0	00.0	00.0	00.8	01.2	02.5	04.3
2	1 1079	00.0	00.5	00.5	00.5	01.2	00.7	00.0	00.0	00.0	00.0	00.7	00.5	01.9	00.3
3	1 1221	00.0	00.9	00.9	00.5	01.0	01.0	00.0	00.0	00.0	00.5	00.9	01.0	03.0	05.2
4	1 1921	00.0	00.3	00.3	00.3	00.8	00.4	00.0	00.0	00.2	00.2	00.4	00.3	01.0	02.0
5	1 0686	00.0	00.8	00.8	00.6	01.3	00.6	00.0	00.2	00.0	00.0	00.5	00.4	01.9	04.0
6	1 1050	00.0	00.5	00.5	00.6	00.9	00.5	00.0	00.1	00.0	00.0	00.4	00.0	02.0	04.0
7	1 0054	00.0	00.4	00.4	00.2	00.9	00.4	00.0	00.2	00.0	00.0	00.6	00.7	01.8	03.0
8	1 1044	00.0	01.0	01.0	00.5	01.1	00.6	00.0	00.0	00.0	00.5	00.9	00.9	02.9	04.1
9	1 0705	00.0	00.8	00.8	00.5	00.9	00.7	00.0	00.1	00.0	00.6	00.9	01.1	02.2	03.6
10	1 0839	00.0	00.5	00.5	00.7	00.7	00.8	00.0	00.0	00.1	00.4	00.9	01.1	02.0	03.1
11	1 1723	00.0	00.4	00.4	00.6	01.1	00.6	00.0	00.0	00.3	00.3	00.9	02.0	03.4	04.5
12	1 1724	00.0	00.5	00.7	00.5	00.6	00.6	00.0	00.2	00.0	00.2	00.6	00.8	02.4	04.3
13	1 1729	00.0	00.6	00.8	00.7	01.5	00.9	00.0	00.0	00.0	00.3	01.0	01.1	03.1	05.0
14	1 1728	00.0	00.7	00.9	00.6	00.9	00.5	00.0	00.3	00.0	00.7	01.3	01.5	01.9	03.9
15	1 1321	00.0	00.6	00.7	00.6	00.7	00.8	00.0	00.1	00.0	00.2	00.6	01.0	02.7	05.0
16	1 1115	00.0	00.9	00.9	00.7	01.1	01.0	00.0	00.0	00.0	00.0	01.0	01.4	03.0	04.9
17	1 0849	00.0	00.4	00.7	00.5	00.7	00.4	00.0	00.3	00.0	00.3	00.4	00.5	01.7	03.0
18	1 0018	00.0	00.6	00.7	00.3	00.5	00.4	00.0	00.4	00.0	00.5	00.6	00.8	01.4	02.1
19	1 0030	00.0	00.9	00.9	01.0	01.2	00.9	00.0	00.1	00.0	00.0	01.2	01.3	02.8	04.5
20	1 1605	00.0	00.7	01.1	01.0	01.3	01.1	00.0	00.2	00.0	00.6	02.0	02.3	03.6	05.9
21	1 0865	00.0	00.9	00.9	00.4	00.9	00.7	00.0	00.2	00.0	00.5	01.0	01.3	04.0	07.2
22	1 0106	00.0	00.9	00.9	00.6	01.2	00.7	00.0	00.0	00.0	00.5	00.9	01.0	02.5	04.5
23	1 1706	00.0	00.5	00.5	00.7	00.9	00.7	00.0	00.0	00.0	00.0	01.2	01.4	03.1	05.3
24	1 1708	00.0	00.6	00.6	00.3	00.5	00.7	00.0	00.2	00.0	00.0	00.6	00.7	03.2	05.3
25	1 1707	00.0	00.3	00.3	00.5	00.9	00.6	00.0	00.0	00.1	00.1	00.7	01.2	02.6	04.8
26	1 1340	00.0	01.1	01.1	01.0	01.5	01.2	00.0	00.0	00.0	00.0	01.1	00.0	04.5	08.1
27	1 0852	00.0	00.4	00.4	00.5	00.7	00.7	00.0	00.0	00.0	00.0	01.0	01.0	04.4	07.0
28	1 0178	00.0	01.0	00.8	00.6	01.4	00.6	00.0	00.0	00.0	00.3	00.8	00.5	01.9	03.1
29	1 1542	00.0	00.4	00.5	00.4	00.9	00.5	00.0	00.0	00.0	00.3	00.8	00.8	01.5	02.4
30	1 0202	00.0	01.0	01.0	00.9	00.9	01.0	00.0	00.2	00.0	01.2	01.3	01.4	04.0	08.2
31	1 9999	00.0	00.8	00.8	00.5	00.8	00.4	00.0	00.1	00.0	00.2	00.5	00.9	02.5	04.3
32	1 1076	00.0	00.8	00.9	00.6	01.1	00.7	00.0	00.0	00.0	00.4	00.9	00.8	02.8	05.5
33	1 1097	00.0	00.8	00.8	00.7	01.2	00.8	00.0	00.0	00.0	00.5	00.9	00.6	02.4	05.1
34	1 0137	00.0	01.0	01.0	01.8	01.9	01.4	00.0	00.0	00.0	00.0	05.2	05.4	09.2	14.4
35	1 1057	00.0	00.7	00.9	00.8	01.5	01.2	00.0	00.1	00.0	00.5	00.9	00.6	03.2	04.9
36	1 0141	00.0	00.8	00.8	00.7	01.5	01.0	00.0	00.1	00.0	00.0	00.5	00.0	02.2	04.3
37	1 1793	00.0	00.1	00.1	00.6	01.1	01.4	00.0	00.0	00.0	00.0	01.2	01.9	03.2	05.0
38	1 1606	00.0	01.0	01.2	01.3	01.4	01.4	00.0	01.2	00.0	00.0	00.8	01.6	04.0	07.2
39	1 1918	00.0	00.6	00.6	00.5	01.1	00.6	00.0	00.0	00.0	00.0	00.4	00.3	02.0	04.4
40	1 0267	00.0	00.6	00.7	00.5	00.8	00.4	00.0	00.0	00.1	00.3	01.0	01.1	02.0	02.9
41	1 0207	00.0	00.7	00.9	00.6	00.9	00.6	00.0	00.2	00.0	00.7	01.0	01.2	02.3	03.9
42	1 0332	00.0	00.4	00.6	00.5	00.8	00.4	00.0	00.0	00.0	00.2	00.5	00.7	01.5	02.5
43	1 1543	00.0	00.8	00.8	00.7	01.1	00.5	00.0	00.4	00.0	00.0	00.5	00.7	02.3	04.5

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
44	1 0136	00.0	00.7	00.7	00.8	01.5	00.6	00.0	00.2	00.0	00.0	00.5	00.0	02.6	04.4
45	1 1920	00.0	00.6	00.6	00.5	01.0	00.5	00.0	00.0	00.0	00.0	01.0	01.1	02.5	04.0
46	1 1039	00.0	00.7	00.7	00.7	01.1	00.7	00.0	00.0	00.0	00.0	01.0	00.9	02.5	04.3
47	1 0510	00.0	00.4	00.6	00.6	00.9	00.5	00.0	00.4	00.0	00.0	00.9	01.0	02.0	03.5
48	1 0503	00.0	00.5	00.6	00.5	00.9	00.4	00.0	00.2	00.0	00.0	00.6	00.5	01.8	02.9
49	1 0509	00.0	00.8	00.8	00.6	01.0	00.7	00.0	00.2	00.0	00.5	00.8	01.0	02.2	04.0
50	1 0506	00.0	01.3	01.4	00.7	01.5	00.7	00.0	00.3	00.0	01.0	01.3	01.4	02.8	04.7
51	1 0504	00.0	01.0	01.2	00.8	01.5	00.8	00.0	00.3	00.0	00.2	00.8	00.7	02.5	04.4
52	1 0513	00.0	00.7	00.9	00.5	01.0	00.6	00.0	00.0	00.0	00.5	00.8	00.9	02.8	04.7
53	1 0511	00.0	00.2	00.2	00.4	00.8	00.4	00.0	00.0	00.0	00.0	00.5	00.4	00.9	02.5
54	1 0505	00.0	00.8	00.8	00.6	01.3	01.0	00.0	00.0	00.0	00.0	00.5	00.2	02.5	04.7
55	1 1786	00.0	00.8	00.8	00.5	01.0	00.7	00.0	00.2	00.0	00.3	00.7	01.0	02.4	04.1
56	1 0133	00.0	00.8	00.8	00.6	01.0	00.6	00.0	00.4	00.0	00.4	00.8	01.2	02.5	04.9
57	1 0512	00.0	01.1	01.1	00.8	01.4	00.9	00.0	00.3	00.0	00.5	00.7	00.8	02.5	04.7
58	1 9000	00.0	00.8	01.2	01.1	01.3	01.2	00.0	00.0	00.0	00.9	01.4	02.0	04.4	08.2
59	1 0099	00.0	00.4	01.3	00.7	01.5	00.8	00.0	00.3	00.0	00.0	00.5	00.5	01.8	03.0
60	1 0110	00.0	00.3	00.7	00.4	00.7	00.4	00.0	00.3	00.0	00.2	00.5	00.6	01.2	01.9
61	1 0711	00.0	00.5	00.5	00.4	00.6	00.4	00.0	00.0	00.4	00.4	00.9	01.2	02.7	04.8
62	1 1001	00.0	00.2	00.4	00.5	00.8	00.4	00.0	00.1	00.0	00.1	00.9	01.1	02.6	04.4
63	1 1005	00.0	00.9	00.6	00.7	01.3	00.7	00.0	00.0	00.0	00.4	00.7	00.6	01.9	03.6
64	1 0718	00.0	00.5	00.9	00.6	00.7	00.4	00.0	00.3	00.0	00.4	00.5	00.8	01.9	03.5
65	1 0717	00.0	00.4	00.5	00.5	00.9	00.5	00.0	00.2	00.0	00.2	00.6	00.5	02.1	03.8
66	1 1090	00.0	01.0	01.0	00.6	01.1	00.7	00.0	00.0	00.0	00.3	00.7	00.9	02.5	04.3
67	1 0638	00.0	00.3	00.6	00.6	00.8	00.4	00.0	00.5	00.0	00.2	00.8	01.0	02.3	03.8
68	1 0639	00.0	00.6	00.3	00.6	01.3	00.9	00.0	00.0	00.0	00.9	00.9	00.0	03.1	06.5
69	1 1913	00.0	00.7	00.8	00.8	01.1	01.0	00.0	00.0	00.2	00.5	01.1	01.3	03.4	06.2
70	1 0695	00.0	00.9	01.0	00.6	01.0	01.1	00.0	00.0	00.0	00.3	00.9	00.7	02.8	05.3
71	1 1074	00.0	00.9	00.9	00.8	01.3	01.1	00.0	00.0	00.0	00.0	00.7	00.3	02.2	04.4
72	1 1069	00.0	00.7	00.7	01.0	01.4	01.2	00.0	00.2	00.0	00.0	00.5	01.3	02.6	04.9
73	1 0817	00.0	01.0	01.2	01.1	01.3	00.9	00.0	00.0	00.0	00.3	01.2	01.1	03.0	05.3
74	1 0204	00.0	00.8	00.8	00.7	01.0	00.7	00.0	00.0	00.0	00.0	00.9	00.8	02.2	04.5
75	1 1081	00.0	00.6	00.6	00.7	00.7	00.4	00.0	00.0	00.2	00.2	00.6	01.0	02.3	03.3
76	1 1910	00.0	00.2	00.3	00.3	00.7	00.6	00.0	00.1	00.0	00.1	00.3	00.0	01.0	02.2
77	1 0698	00.0	01.0	01.0	00.6	00.9	01.1	00.0	00.0	00.0	00.0	01.0	00.5	02.6	05.9
78	1 9001	00.0	00.8	00.9	00.6	00.9	00.6	00.0	00.3	00.0	00.5	00.8	00.9	02.4	03.7
79	1 9003	00.0	00.4	00.4	00.4	01.0	00.5	00.0	00.0	00.0	00.0	00.6	00.6	01.6	02.6
80	1 1006	00.0	00.9	01.2	01.0	01.4	01.4	00.0	00.0	00.1	00.4	01.2	01.2	04.5	07.4
81	1 0142	00.0	00.6	00.8	00.5	00.9	00.5	00.0	00.0	00.0	00.2	00.6	00.5	01.7	02.8
82	1 0941	00.0	00.7	00.7	00.6	01.1	01.3	00.0	00.4	00.0	00.0	00.6	00.5	01.9	03.6
83	1 9004	00.0	00.8	00.8	00.5	00.9	01.0	00.0	00.0	00.0	00.0	00.6	01.0	02.9	06.2
84	1 1014	00.0	01.1	01.1	00.6	01.0	00.7	00.0	00.0	00.0	00.0	00.5	00.6	02.1	04.0
85	1 0874	00.0	01.0	01.0	00.7	01.1	00.7	00.0	00.0	00.0	00.0	00.8	00.7	02.2	04.0
86	1 0720	00.0	00.6	00.6	00.4	00.8	00.6	00.0	00.0	00.0	00.0	00.7	00.8	01.8	03.6
87	1 1047	00.0	00.5	00.5	00.3	00.7	00.5	00.0	00.0	00.0	00.0	00.8	00.8	01.9	03.4

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
88	1 8420	00.0	01.2	01.2	00.7	01.9	01.0	00.0	00.0	00.0	00.0	00.8	00.9	02.7	05.0
89	1 0315	00.0	00.3	00.3	00.4	00.8	00.6	00.0	00.0	00.0	00.0	00.8	00.8	02.0	03.6
90	1 0812	00.0	00.7	00.7	00.6	01.0	00.5	00.0	00.2	00.0	00.0	00.8	00.5	02.0	03.9
91	1 0813	00.0	00.9	00.9	00.4	01.0	00.5	00.0	00.0	00.0	00.0	00.7	00.5	02.0	04.2
92	1 0643	00.0	00.7	00.9	00.7	00.9	00.5	00.0	00.3	00.0	00.1	00.6	00.7	01.9	03.2
93	1 0660	00.0	00.6	00.6	00.8	00.9	00.9	00.0	00.2	00.0	00.0	00.5	00.8	01.9	04.2
94	1 0655	00.0	01.0	01.0	00.6	01.8	00.9	00.0	00.0	00.0	00.0	00.8	00.6	02.5	04.2
95	1 0650	00.0	00.5	00.7	00.6	01.1	00.6	00.0	00.4	00.0	00.1	00.5	00.7	02.2	03.9
96	1 0816	00.0	00.3	00.8	00.6	00.8	00.4	00.0	00.4	00.2	00.5	00.6	00.8	01.5	02.6
97	1 0828	00.0	01.1	01.0	00.5	00.9	00.7	00.0	00.0	00.0	00.8	00.9	01.0	02.6	04.4
98	1 0825	00.0	00.9	01.0	00.6	01.0	00.7	00.0	00.0	00.0	00.6	00.8	00.9	02.5	04.7
99	1 1176	00.0	00.9	01.0	00.6	01.0	00.9	00.0	00.4	00.0	00.1	00.9	01.2	02.5	04.9
100	1 1177	00.0	01.4	01.4	00.9	01.4	00.7	00.0	00.0	00.0	00.0	00.6	00.7	02.9	05.0
101	1 0153	00.0	00.7	01.0	00.6	00.9	00.4	00.0	00.0	00.0	00.1	00.6	01.0	02.0	03.5
102	1 0149	00.0	00.5	00.6	00.4	00.9	00.7	00.0	00.0	00.0	00.4	00.7	00.8	02.2	04.2
103	1 0675	00.0	01.0	01.1	00.9	01.1	01.0	00.0	00.2	00.0	00.2	00.5	00.6	03.0	06.0
104	1 1226	00.0	00.8	00.8	00.7	01.4	01.0	00.0	00.0	00.0	00.0	00.6	00.7	02.1	04.2
105	1 1228	00.0	00.3	00.3	00.2	00.5	00.2	00.0	00.0	00.0	00.0	00.5	00.6	01.2	01.9
106	1 1713	00.0	01.0	01.0	00.9	01.8	01.1	00.0	00.0	00.0	00.5	01.0	00.3	03.6	06.9
107	1 1710	00.0	00.8	00.9	00.7	01.2	00.9	00.0	00.1	00.0	00.1	00.7	01.3	03.0	05.3
108	1 1711	00.0	00.7	00.8	00.7	01.1	00.9	00.0	00.0	00.0	00.5	00.7	00.6	01.7	02.8
109	1 2109	00.0	00.8	01.0	00.7	01.1	00.9	00.0	00.2	00.0	00.5	00.8	00.9	02.0	03.5
110	1 1227	00.0	01.0	01.1	00.7	01.1	01.0	00.0	00.0	00.0	00.7	00.8	01.0	02.5	04.3
111	1 1727	00.0	00.8	00.8	00.5	01.0	00.6	00.0	00.2	00.0	00.0	00.6	00.4	02.4	04.8
112	1 1299	00.0	00.5	00.8	00.7	01.0	00.5	00.0	00.2	00.0	00.1	00.5	00.4	01.6	03.2
113	1 0452	00.0	00.7	00.9	00.4	01.0	00.5	00.0	00.2	00.0	00.1	00.7	00.6	01.7	02.9
114	1 1264	00.0	01.0	01.0	00.6	01.2	00.7	00.0	00.0	00.0	00.5	01.0	01.0	02.6	05.0
115	1 9006	00.0	00.4	00.4	00.4	00.9	00.6	00.0	00.0	00.0	00.0	00.6	00.4	01.6	03.0
116	1 1021	00.0	00.3	00.3	00.6	01.0	01.3	00.0	00.0	00.0	00.0	00.7	01.3	02.7	04.5
117	1 0668	00.0	00.7	01.0	00.8	01.4	00.9	00.0	00.2	00.0	00.0	00.6	00.3	03.2	06.3
118	1 0065	00.0	00.4	00.4	00.3	00.5	00.3	00.0	00.0	00.0	00.0	00.5	00.4	01.2	02.3
119	1 1018	00.0	00.8	00.8	00.6	01.2	00.9	00.0	00.0	00.0	00.0	00.5	00.4	01.9	04.2
120	1 8001	00.0	00.6	01.1	00.7	01.0	00.7	00.0	00.3	00.0	00.0	00.4	00.5	01.8	03.6
121	1 1033	00.0	00.2	00.2	00.5	00.9	00.5	00.0	00.0	00.0	00.0	00.5	00.9	02.2	03.6
122	1 0301	00.0	00.3	00.3	00.4	00.7	00.8	00.0	00.0	00.0	00.0	00.3	00.4	01.9	03.7
123	1 0800	00.0	00.4	00.4	00.5	00.9	00.6	00.0	00.0	00.0	00.0	01.0	01.2	02.6	04.2
124	1 0810	00.0	00.2	00.2	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.5	00.3	01.3	02.6
125	1 0809	00.0	00.5	00.7	00.4	00.9	00.6	00.0	00.0	00.0	00.2	00.7	00.6	02.3	04.4
126	1 0654	00.0	00.9	00.9	00.6	01.1	00.8	00.0	00.2	00.0	00.0	00.7	00.4	02.4	04.5
127	1 0687	00.0	00.8	00.8	00.4	01.0	00.7	00.0	00.0	00.0	00.3	00.9	01.0	02.5	04.9
128	1 0824	00.0	00.6	00.9	00.6	01.0	00.0	01.0	00.0	00.0	00.0	00.3	00.5	01.9	03.7
129	1 0077	00.0	00.8	01.0	00.7	01.5	01.0	00.0	00.3	00.0	00.1	00.9	00.6	02.8	05.1
130	1 1273	00.0	00.5	00.7	00.5	01.1	00.7	00.0	00.2	00.0	00.0	00.5	00.4	02.0	03.9
131	1 1274	00.0	00.5	00.7	00.5	00.9	00.7	00.0	00.0	00.0	00.3	00.6	00.5	02.1	04.0

Projectile Point X,Y Coordinate Measurements

Item #	Cat.		P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
132	1	1272	00.0	00.6	00.6	00.5	00.9	00.4	00.0	00.1	00.0	00.0	00.5	00.4	01.8	03.0
133	1	1268	00.0	00.5	00.5	00.5	01.0	01.0	00.0	00.0	00.0	00.0	00.8	00.3	02.0	03.8
134	1	0697	00.0	00.6	00.6	00.6	01.1	00.8	00.0	00.0	00.0	00.0	00.8	00.9	02.3	03.6
135	1	0076	00.0	00.3	00.3	00.4	00.7	00.7	00.0	00.1	00.0	00.0	00.6	01.1	02.3	04.3
136	1	0739	00.0	00.8	00.9	00.5	01.0	00.4	00.0	00.3	00.0	00.5	00.9	01.1	02.1	04.8
137	1	0521	00.0	00.7	00.7	00.5	01.0	00.6	00.0	00.1	00.0	00.0	00.5	00.3	00.8	04.0
138	1	0835	00.0	00.6	00.6	00.5	01.0	00.5	00.0	00.2	00.0	00.2	00.7	00.7	02.0	03.5
139	1	0834	00.0	00.6	00.7	00.6	01.0	00.6	00.0	00.2	00.0	00.1	00.5	00.4	01.7	02.9
140	1	0672	00.0	00.8	00.9	00.5	01.3	00.5	00.0	00.2	00.0	00.2	00.8	00.5	02.0	03.5
141	1	1287	00.0	01.0	01.0	00.7	01.6	00.8	00.0	00.0	00.0	00.0	00.8	00.5	02.0	03.5
142	1	1289	00.0	00.7	00.7	00.5	01.2	00.7	00.0	00.0	00.0	00.0	00.8	00.4	02.3	04.5
143	1	1298	00.0	00.4	00.4	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.8	00.5	01.8	03.0
144	1	0328	00.0	01.4	01.5	01.5	01.7	01.8	00.0	00.2	00.0	00.4	00.8	01.0	04.2	07.9
145	1	0847	00.0	01.3	01.4	01.0	01.4	01.0	00.0	00.2	00.0	00.5	00.9	01.3	03.5	06.0
146	1	0536	00.0	00.7	01.0	00.8	01.3	01.0	00.0	00.2	00.0	00.3	00.9	00.6	02.3	04.9
147	1	0864	00.0	00.7	01.1	00.6	01.2	00.9	00.0	00.2	00.0	00.0	00.7	00.6	02.4	04.2
148	1	0374	00.0	01.0	01.0	00.7	01.5	00.9	00.0	00.0	00.0	00.0	01.0	00.5	02.4	03.5
149	1	9006	00.0	00.4	00.4	00.6	01.1	00.8	00.0	00.0	00.4	00.4	01.1	01.1	03.4	06.0
150	1	9007	00.0	00.9	00.9	00.5	01.0	00.6	00.0	00.0	00.0	00.5	01.0	01.3	02.3	03.5
151	1	1604	00.0	00.6	00.9	01.0	01.0	00.8	00.0	00.5	00.0	00.0	00.5	01.0	03.6	06.5
152	1	0253	00.0	00.9	01.0	00.7	00.9	00.5	00.0	00.0	00.0	00.6	00.8	01.0	02.0	02.8
153	1	0252	00.0	00.9	01.0	00.7	01.1	00.5	00.0	00.0	00.0	00.4	00.8	00.8	01.9	03.0
154	1	1189	00.0	00.7	00.7	00.5	00.9	00.5	00.0	00.0	00.0	00.0	00.4	00.3	02.0	03.5
155	1	1338	00.0	00.2	00.2	00.4	00.5	00.5	00.0	00.1	00.0	00.0	00.6	01.0	02.6	04.2
156	1	0011	00.0	00.4	00.8	00.4	01.0	00.5	00.0	00.2	00.0	00.0	00.6	00.5	02.2	03.9
157	1	0859	00.0	01.0	01.1	00.7	01.6	00.8	00.0	00.0	00.0	00.2	00.8	00.7	02.2	03.6
158	1	0866	00.0	00.5	00.8	00.5	01.0	00.5	00.0	00.2	00.0	00.2	00.6	00.6	02.1	03.8
159	1	1050	00.0	00.5	00.5	00.6	00.7	00.6	00.0	00.1	00.0	00.0	00.5	01.0	03.4	06.5
160	1	1147	00.0	00.4	00.4	00.4	00.6	00.4	00.0	00.0	00.0	00.0	00.5	00.5	01.5	02.5
161	1	1183	00.0	00.4	00.6	00.5	00.8	00.6	00.0	00.3	00.0	00.0	01.0	01.2	02.1	03.6
162	1	0516	00.0	01.0	01.0	00.5	01.0	01.0	00.0	00.0	00.0	00.7	00.9	01.0	03.0	06.0
163	1	9008	00.0	00.2	00.2	00.2	00.6	00.4	00.0	00.0	00.0	00.0	00.3	00.0	00.6	01.3
164	1	1288	00.0	00.5	00.7	00.6	01.0	00.7	00.0	00.2	00.0	00.0	00.8	00.5	02.5	04.0
165	1	0051	00.0	00.7	01.1	00.8	01.5	00.9	00.0	00.2	00.0	00.3	00.9	00.5	02.5	04.5
166	1	1518	00.0	00.4	00.5	00.5	00.8	00.7	00.0	00.4	00.0	00.0	00.8	00.8	02.2	03.5
167	1	0027	00.0	01.0	01.0	00.8	01.5	01.0	00.0	00.0	00.0	00.0	00.7	00.0	02.1	04.6
168	1	1519	00.0	00.6	00.6	00.5	01.0	00.5	00.0	00.0	00.0	00.2	00.5	00.0	01.5	02.0
169	1	1115	00.0	00.4	00.3	00.0	01.0	00.6	00.0	00.0	00.0	00.0	00.5	00.0	00.9	01.6
170	1	1732	00.0	00.4	00.4	00.3	00.6	00.3	00.0	00.2	00.0	00.0	00.5	00.4	01.7	03.0
171	1	1792	00.0	00.3	00.5	00.5	01.0	00.6	00.0	00.0	00.0	00.5	00.7	00.3	02.1	04.0
172	1	0012	00.0	00.7	01.1	00.7	01.1	00.6	00.0	00.2	00.0	00.5	01.0	01.3	02.5	03.4
173	1	1731	00.0	00.4	00.7	00.4	01.0	00.6	00.0	00.1	00.0	00.0	00.7	00.3	02.0	04.0
174	1	1730	00.0	00.9	00.9	00.4	00.9	00.6	00.0	00.0	00.0	00.0	00.5	00.6	01.8	02.8
175	1	0282	00.0	00.8	00.8	00.5	01.2	00.7	00.0	00.1	00.0	00.0	00.5	00.2	02.8	05.5

Projectile Point X,Y Coordinate Measurements

Item # Cat. P1X P1Y P2X P2Y P3X P3Y P4X P4Y P5X P5Y P6X P6Y P7X P7Y

176	1	1123	00.0	00.7	01.0	01.1	01.2	01.4	00.0	00.7	00.0	00.0	00.5	01.0	03.6	06.6
177	1	1111	00.0	01.0	01.0	00.6	01.5	00.9	00.0	00.0	00.0	00.0	01.0	00.5	02.6	05.1
178	1	0301	00.0	00.8	00.8	00.5	01.0	01.0	00.0	00.2	00.0	00.0	00.8	00.5	02.0	04.2
179	1	1231	00.0	00.8	00.8	00.5	01.0	00.5	00.0	00.2	00.0	00.0	00.6	00.5	02.2	04.3
180	1	0823	00.0	00.8	00.8	00.5	01.9	00.7	00.0	00.0	00.0	00.0	00.6	00.4	02.9	05.9
181	1	1145	00.0	01.3	01.2	00.9	01.0	00.5	00.0	00.2	00.0	00.4	00.7	01.0	02.0	02.8
182	1	0021	00.0	00.5	00.5	00.5	00.9	00.4	00.0	00.1	00.0	00.0	00.4	00.7	01.9	03.6
183	1	9009	00.0	00.7	00.8	00.4	00.6	00.6	00.0	00.2	00.0	00.4	00.7	00.6	01.8	03.0
184	1	1531	00.0	01.0	01.0	00.5	01.1	01.0	00.0	00.0	00.0	00.6	00.9	01.1	03.2	06.5
185	1	0371	00.0	00.5	00.5	01.0	01.1	00.5	00.0	00.0	00.0	00.8	01.0	01.5	02.6	03.6
186	1	1715	00.0	00.3	00.3	00.2	01.1	00.6	00.0	00.0	00.0	00.0	00.5	00.0	01.0	01.8
187	1	1276	00.0	00.3	00.5	00.5	01.1	00.6	00.0	00.4	00.0	00.0	00.6	01.2	03.3	05.3
188	1	1265	00.0	00.4	00.4	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.7	00.4	02.2	04.4
189	1	1270	00.0	00.6	00.7	00.5	00.8	00.5	00.0	00.0	00.0	00.5	00.7	00.8	02.0	03.7
190	1	0495	00.0	00.5	00.5	01.9	00.9	04.6	00.0	00.0	00.0	00.0	00.5	00.0	01.8	04.6
191	1	0131	00.0	00.9	00.9	00.7	01.1	00.6	00.0	00.0	00.0	00.0	00.8	01.0	02.0	03.2
192	1	0499	00.0	00.4	00.4	00.4	01.3	00.6	00.0	00.0	00.0	00.0	00.7	00.3	01.7	03.5
193	1	0953	00.0	00.3	00.3	00.2	00.8	00.5	00.0	00.0	00.0	00.0	00.3	00.1	01.2	02.6
194	1	1296	00.0	00.2	00.2	00.2	00.9	00.4	00.0	00.0	00.0	00.0	00.4	00.4	01.5	02.5
195	1	0134	00.0	00.4	01.0	00.9	01.0	00.8	00.0	00.6	00.0	00.0	00.5	00.9	02.7	05.0
196	1	1529	00.0	00.5	00.5	00.4	00.7	00.5	00.0	00.0	00.0	00.0	00.5	00.5	01.3	02.6
197	1	0321	00.0	00.3	00.3	00.3	00.5	00.4	00.0	00.0	00.0	00.0	00.5	00.4	01.5	02.6
198	1	1115	00.0	01.0	01.0	01.0	01.8	01.2	00.0	00.0	00.0	00.0	01.9	01.9	04.5	07.7
199	1	1526	00.0	00.4	00.4	00.3	00.8	00.5	00.0	00.0	00.0	00.0	00.4	00.2	01.0	01.8
200	1	1719	00.0	00.6	00.6	00.5	00.9	01.0	00.0	00.0	00.0	00.3	00.5	00.8	02.5	05.4
201	1	9010	00.0	00.4	00.4	00.3	00.9	00.7	00.0	00.0	00.0	00.0	00.4	00.0	01.2	03.3
202	1	1121	00.0	00.6	00.5	00.4	00.7	00.5	00.0	00.0	00.0	00.3	00.5	00.8	01.6	02.6
203	1	1108	00.0	00.9	00.9	00.5	00.9	00.5	00.0	00.0	00.0	00.0	01.0	01.4	03.0	05.2
204	1	8486	00.0	00.9	00.0	00.4	01.5	01.0	00.0	00.0	00.0	00.0	00.8	00.3	03.2	06.0
205	1	1516	00.0	00.7	00.7	00.5	00.8	00.8	00.0	00.1	00.0	00.0	00.7	00.6	02.5	05.8
206	1	1790	00.0	00.6	00.7	00.5	01.0	00.6	00.0	00.1	00.0	00.1	00.6	00.3	02.0	04.0
207	1	0247	00.0	00.4	00.5	00.3	00.7	00.4	00.0	00.1	00.0	00.1	00.7	00.6	01.5	02.4
208	1	1239	00.0	00.7	00.7	00.6	01.2	00.7	00.0	00.2	00.0	00.0	00.5	00.4	02.3	04.5
209	1	1229	00.0	00.7	00.7	00.6	01.0	00.9	00.0	00.1	00.0	00.0	00.2	00.5	02.0	04.0
210	1	1285	00.0	00.8	00.9	00.7	02.2	01.4	00.0	00.0	00.0	00.3	00.6	00.5	03.2	07.0
211	1	0514	00.0	00.4	00.4	00.3	00.6	00.4	00.0	00.0	00.0	00.0	00.4	00.5	01.3	02.5
212	1	1515	00.0	00.4	00.4	00.5	00.9	00.5	00.0	00.0	00.0	00.0	00.5	00.5	01.8	03.0
213	1	0444	00.0	00.3	00.3	00.2	00.8	00.5	00.0	00.0	00.0	00.0	00.4	00.2	01.5	03.0
214	1	1279	00.0	00.8	00.9	00.8	01.5	01.0	00.0	00.0	00.0	00.3	00.7	00.3	02.4	05.0
215	1	1148	00.0	00.6	00.7	00.6	01.2	00.8	00.0	00.0	00.0	00.2	00.7	00.8	01.9	02.7
216	1	1248	00.0	00.4	00.4	00.3	00.9	00.7	00.0	00.0	00.0	00.0	00.4	00.3	01.1	02.2
217	1	1113	00.0	00.1	00.1	00.5	00.9	00.6	00.0	00.0	00.0	00.0	00.7	00.8	02.0	03.5
218	1	1114	00.0	00.7	00.8	00.6	00.8	00.5	00.0	00.0	00.0	00.3	00.4	00.6	01.4	02.5
219	1	0868	00.0	00.3	00.5	00.5	00.8	00.5	00.0	00.4	00.0	00.0	00.6	00.8	01.9	03.5

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
220	1 1233	00.0	00.5	00.8	00.5	01.0	00.8	00.0	00.1	00.0	00.1	00.7	00.4	01.9	04.5
221	1 1103	00.0	00.4	00.5	00.5	00.9	00.6	00.0	00.1	00.0	00.0	00.5	00.4	01.6	03.0
222	1 0109	00.0	00.8	00.7	00.4	00.8	00.5	00.0	00.0	00.0	00.4	00.5	00.6	01.3	02.1
223	1 1118	00.0	00.3	00.5	00.4	00.6	00.3	00.0	00.1	00.0	00.0	00.3	00.5	01.1	01.6
224	1 0152	00.0	00.4	00.9	00.9	01.0	00.9	00.0	00.0	00.0	01.0	01.3	01.7	02.9	04.5
225	1 0123	00.0	00.4	00.4	00.3	01.0	00.5	00.0	00.0	00.0	00.0	00.7	00.3	01.7	03.5
226	1 1403	00.0	00.4	00.4	00.3	00.5	00.3	00.0	00.0	00.0	00.0	00.4	00.4	01.0	01.4
227	1 1402	00.0	00.1	00.7	00.4	00.7	00.4	00.0	00.5	00.3	00.7	00.8	00.9	01.6	02.5
228	1 0222	00.0	01.0	01.0	00.8	01.2	00.7	00.0	00.1	00.0	00.2	00.6	00.4	02.2	03.7
229	1 0032	00.0	00.3	00.3	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.4	00.0	00.8	01.9
230	1 0031	00.0	00.7	00.7	00.5	01.0	01.1	00.0	00.0	00.0	00.0	00.8	00.5	01.9	03.5
231	1 0095	00.0	00.8	00.8	00.6	01.0	00.7	00.0	00.2	00.0	00.0	00.6	00.5	01.5	02.5
232	1 1281	00.0	00.4	00.4	00.6	00.9	00.7	00.0	00.0	00.0	00.0	00.8	01.4	03.0	05.0
233	1 2111	00.0	00.7	00.7	00.6	00.9	00.5	00.0	00.3	00.0	00.0	00.4	00.3	01.4	02.9
234	1 2110	00.0	00.4	00.4	00.5	01.3	00.6	00.0	00.0	00.0	00.0	00.7	00.3	01.9	04.1
235	1 2108	00.0	00.4	00.4	00.5	01.2	00.5	00.0	00.0	00.0	00.0	00.6	00.5	02.1	03.9
236	1 1187	00.0	00.2	00.2	00.4	01.2	00.7	00.0	00.0	00.0	00.0	00.4	00.0	00.8	01.7
237	1 1191	00.0	00.5	00.5	00.4	00.7	00.3	00.0	00.0	00.0	00.0	00.5	00.5	02.0	03.7
238	1 1323	00.0	01.0	01.0	00.8	01.8	01.3	00.0	00.0	00.0	00.0	00.9	00.0	03.6	08.0
239	1 1200	00.0	00.2	00.2	00.2	00.5	00.4	00.0	00.0	00.0	00.0	00.6	00.9	01.9	03.5
240	1 0066	00.0	00.2	00.2	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.3	00.1	01.0	02.2
241	1 0869	00.0	00.5	00.9	00.6	01.9	00.5	00.0	00.2	00.0	00.0	00.7	00.6	02.8	04.7
242	1 0707	00.0	00.3	00.3	00.3	00.7	00.5	00.0	00.0	00.0	00.0	00.5	00.3	01.4	02.6
243	1 1102	00.0	00.7	00.7	00.5	01.0	00.5	00.0	00.0	00.0	00.0	00.7	00.6	01.8	03.0
244	1 1407	00.0	00.3	00.3	00.5	01.0	00.5	00.0	00.0	00.0	00.0	00.5	00.4	01.7	02.9
245	1 1022	00.0	01.0	01.2	00.7	01.2	01.0	00.0	00.2	00.0	00.5	01.0	01.2	02.6	04.4
246	1 0551	00.0	00.4	00.4	00.4	01.1	00.6	00.0	00.0	00.0	00.0	00.6	00.5	01.8	03.3
247	1 0556	00.0	00.5	00.6	00.5	01.0	00.5	00.0	00.2	00.0	00.1	00.6	00.4	02.0	03.8
248	1 9162	00.0	00.2	00.2	00.3	00.7	00.4	00.0	00.0	00.0	00.0	00.4	00.2	01.1	02.1
249	1 0209	00.0	00.3	00.3	00.2	01.1	00.5	00.0	00.0	00.0	00.0	00.4	00.0	01.2	02.6
250	1 0293	00.0	00.9	00.9	00.5	01.3	00.7	00.0	00.0	00.0	00.0	00.7	00.7	02.0	03.4
251	1 1224	00.0	00.2	00.3	00.5	01.1	00.5	00.0	00.1	00.0	00.0	00.4	00.3	01.5	03.0
252	1 1206	00.0	00.3	00.3	00.3	00.4	00.4	00.0	00.0	00.1	00.1	00.8	01.8	02.9	04.1
253	1 1205	00.0	00.3	00.5	00.4	00.9	00.9	00.0	00.4	00.0	00.1	00.8	01.0	02.8	05.3
254	1 0316	00.0	00.5	00.6	00.5	01.0	00.5	00.0	00.2	00.0	00.4	00.7	00.7	01.6	03.0
255	1 0318	00.0	01.1	01.2	00.8	01.8	01.0	00.0	00.1	00.0	00.5	00.8	01.0	02.5	04.3
256	1 0538	00.0	00.5	00.7	00.4	01.0	00.5	00.0	02.0	00.0	00.1	00.6	00.6	01.5	03.0
257	1 0372	00.0	00.1	00.1	00.2	00.3	00.3	00.0	00.0	00.0	00.0	00.1	00.1	00.8	01.3
258	1 0459	00.0	00.3	00.3	00.4	00.6	00.4	00.0	00.0	00.2	00.2	00.5	00.4	01.7	03.1
259	1 1112	00.0	00.5	00.7	00.5	00.8	00.6	00.0	00.0	00.0	00.2	01.5	01.6	03.4	06.6
260	1 0071	00.0	00.7	01.0	00.6	00.9	00.5	00.0	00.2	00.0	00.4	00.8	00.8	02.1	03.8
261	1 1392	00.0	00.5	00.9	00.8	01.8	01.2	00.0	00.0	00.0	00.3	00.8	00.4	02.0	03.5
262	1 1146	00.0	00.3	00.3	00.6	01.1	00.7	00.0	00.0	00.0	00.0	00.8	00.7	02.5	04.3
263	1 5870	00.0	00.7	00.7	00.6	00.9	00.6	00.0	00.0	00.0	00.2	00.7	00.9	02.1	03.6

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
264	1 0593	00.0	00.3	00.5	00.6	01.2	00.8	00.0	00.0	00.1	00.5	01.0	01.0	02.4	04.7
265	1 0056	00.0	00.1	00.1	00.5	00.4	00.5	00.0	00.0	00.1	00.1	00.5	00.8	02.0	03.6
266	1 1045	00.0	00.8	00.8	00.7	01.7	01.0	00.0	00.0	00.0	00.0	00.8	00.0	02.4	04.6
267	1 0242	00.0	00.7	00.7	00.6	01.2	01.0	00.0	00.0	00.4	00.4	01.2	01.2	02.8	04.9
268	1 1235	00.0	00.7	00.8	00.7	01.2	00.9	00.0	00.0	00.0	00.3	00.6	00.7	01.6	03.2
269	1 1225	00.0	00.4	00.4	00.3	00.9	00.7	00.0	00.0	00.0	00.0	00.4	00.3	01.6	03.3
270	1 0250	00.0	00.2	00.2	00.2	00.4	00.4	00.0	00.0	00.0	00.0	00.5	00.5	01.5	02.8
271	1 1193	00.0	00.4	00.4	00.3	00.9	00.5	00.0	00.0	00.0	00.0	00.4	00.2	01.1	02.5
272	1 0156	00.0	01.0	01.1	00.7	01.2	01.3	00.0	00.0	00.0	00.5	00.9	01.1	03.3	07.0
273	1 0272	00.0	01.0	01.0	00.7	01.4	00.9	00.0	00.0	00.0	00.0	00.6	00.1	01.9	04.0
274	1 0273	00.0	01.0	01.0	00.8	01.8	01.3	00.0	00.0	00.1	00.4	00.9	00.3	02.5	05.5
275	1 1203	00.0	01.0	00.9	00.6	01.0	00.7	00.0	00.0	00.0	00.5	00.7	00.9	02.5	04.5
276	1 1223	00.0	00.4	00.4	00.4	00.8	00.4	00.0	00.0	00.0	00.0	00.5	00.3	01.7	03.7
277	1 1720	00.0	00.8	00.8	00.5	01.0	00.6	00.0	00.0	00.0	00.3	00.9	01.2	02.9	04.2
278	1 1149	00.0	00.5	00.7	00.5	01.1	00.6	00.0	00.2	00.0	00.1	00.6	00.5	02.7	05.3
279	1 0112	00.0	00.5	00.8	00.6	01.2	00.5	00.0	00.2	00.0	00.0	00.6	00.3	01.8	03.5
280	1 1292	00.0	00.9	01.2	00.8	01.5	00.8	00.0	00.3	00.0	00.3	00.9	00.9	03.0	05.5
281	1 0304	00.0	00.6	00.6	00.4	00.8	00.6	00.0	00.0	00.0	00.1	00.6	00.8	01.9	03.8
282	1 1237	00.0	00.2	00.2	00.2	00.7	00.5	00.0	00.0	00.0	00.0	00.5	00.4	01.8	03.5
283	1 0082	00.0	01.0	01.0	00.6	01.0	00.8	00.0	00.0	00.0	00.0	00.7	00.9	01.7	03.2
284	1 1247	00.0	00.3	00.3	00.2	00.5	00.4	00.0	00.0	00.0	00.0	00.5	00.5	02.0	04.0
285	2 9011	00.0	00.2	00.2	00.1	00.3	00.2	00.0	00.0	00.0	00.0	00.4	00.6	01.2	01.8
286	2 8000	00.0	00.6	00.6	00.5	00.8	00.5	00.0	00.0	00.0	00.0	00.5	00.7	01.9	03.3
287	2 8001	00.0	00.5	00.5	00.4	00.8	00.6	00.0	00.2	00.0	00.0	00.5	00.4	02.0	03.7
288	2 2277	00.0	00.3	00.3	00.3	00.6	00.5	00.0	00.0	00.0	00.0	00.5	00.4	01.7	03.0
289	2 8002	00.0	00.2	00.2	00.2	00.4	00.3	00.0	00.0	00.0	00.0	00.4	00.4	01.2	02.2
290	2 8003	00.0	00.8	01.0	00.5	01.0	00.6	00.0	00.2	00.0	00.5	01.0	01.5	03.0	04.7
291	2 2577	00.0	00.8	00.8	00.5	00.9	00.5	00.0	00.3	00.0	00.2	01.0	01.3	02.7	05.0
292	2 8004	00.0	00.6	00.7	00.4	00.7	00.4	00.0	00.2	00.0	00.2	00.7	00.8	01.9	03.3
293	2 8005	00.0	00.8	00.9	00.5	00.9	00.5	00.0	00.2	00.0	00.2	00.7	00.9	01.6	02.5
294	2 8006	00.0	00.6	00.6	00.5	00.8	00.5	00.0	00.0	00.0	00.2	00.4	00.4	01.9	03.7
295	2 8007	00.0	00.5	00.5	00.4	00.6	00.5	00.0	00.0	00.0	00.4	00.5	00.6	01.5	02.5
296	2 8008	00.0	00.6	00.6	00.7	00.6	00.5	00.0	00.2	00.0	00.0	00.4	00.7	01.4	02.3
297	2 8009	00.0	00.7	00.7	00.6	01.1	00.6	00.0	00.1	00.0	00.0	00.5	00.4	01.8	03.7
298	2 8010	00.0	00.5	00.8	00.5	00.9	00.5	00.0	00.2	00.0	00.1	00.7	00.6	02.6	04.5
299	2 8011	00.0	00.6	00.7	00.5	01.0	00.7	00.0	00.2	00.0	00.1	00.7	00.8	01.9	03.0
300	2 8012	00.0	00.5	00.5	00.4	00.6	00.5	00.0	00.0	00.0	00.0	00.6	00.5	01.5	03.0
301	2 8013	00.0	00.6	00.7	00.5	00.6	00.5	00.0	00.0	00.0	00.3	00.8	01.0	02.1	03.7
302	2 8014	00.0	00.9	01.0	00.7	01.1	01.0	00.0	00.0	00.0	00.4	00.8	01.1	02.5	04.0
303	2 8015	00.0	00.8	01.0	00.7	00.8	00.5	00.0	00.2	00.0	00.3	00.9	01.0	02.0	03.2
304	2 8016	00.0	00.8	00.8	00.6	00.9	00.5	00.0	00.0	00.0	00.3	00.7	01.1	02.3	03.7
305	2 8017	00.0	00.7	00.7	00.4	00.5	00.3	00.0	00.0	00.0	00.2	00.5	00.8	01.5	02.4
306	2 8018	00.0	00.8	01.0	00.7	01.0	00.5	00.0	00.3	00.0	00.2	00.8	01.3	03.1	04.7
307	2 8019	00.0	01.0	01.0	00.7	01.4	00.8	00.0	00.0	00.0	00.0	00.7	00.6	02.2	04.0

Projectile Point X,Y Coordinate Measurements

Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
308	2 8020	00.0	00.6	00.8	00.5	00.7	00.5	00.0	00.0	00.0	00.4	00.7	01.1	01.9	02.8
309	2 2555	00.0	00.6	00.7	00.5	00.7	00.5	00.0	00.1	00.0	00.1	00.8	01.0	02.2	03.6
310	2 2580	00.0	00.4	00.6	00.4	00.5	00.5	00.0	00.2	00.0	00.0	00.6	01.4	02.1	03.1
311	2 8021	00.0	00.6	00.6	00.5	01.0	00.7	00.0	00.1	00.0	00.0	00.5	00.3	01.5	03.0
312	2 8022	00.0	00.5	00.6	00.4	00.8	00.7	00.0	00.0	00.0	00.2	00.5	00.3	01.9	03.6
313	2 8023	00.0	00.5	00.9	00.4	00.6	00.5	00.0	00.2	00.0	00.0	00.8	01.0	02.0	03.0
314	2 2280	00.0	01.0	01.0	00.7	01.1	01.0	00.0	00.0	00.0	00.0	00.5	00.5	01.7	03.0
315	2 8024	00.0	00.5	00.7	00.6	00.9	00.5	00.0	00.1	00.0	00.1	00.6	00.7	01.5	02.2
316	2 2576	00.0	00.5	00.5	00.4	00.7	00.6	00.0	00.0	00.0	00.5	00.7	00.9	02.1	03.5
317	2 8025	00.0	00.5	00.5	00.4	01.0	00.5	00.0	00.0	00.0	00.0	00.7	00.5	01.7	03.0
318	2 8026	00.0	00.3	00.3	00.4	00.6	00.5	00.0	00.1	00.0	00.0	00.7	00.7	02.0	03.5
319	2 2567	00.0	00.3	00.3	00.5	01.0	00.5	00.0	00.0	00.0	00.0	00.9	00.9	01.9	03.4
320	2 8027	00.0	00.5	00.5	00.3	00.9	00.4	00.0	00.0	00.0	00.0	00.5	00.3	01.5	03.0
321	2 2564	00.0	00.6	00.6	00.5	00.7	00.5	00.0	00.0	00.0	00.0	00.8	01.0	02.6	04.3
322	2 8028	00.0	00.4	00.5	00.3	00.5	00.5	00.0	00.2	00.0	00.1	00.6	00.7	01.8	03.0
323	2 8029	00.0	00.3	00.3	00.2	00.6	00.5	00.0	00.0	00.0	00.0	00.5	00.3	01.1	02.0
324	2 2336	00.0	00.5	00.6	00.4	00.8	00.5	00.0	00.4	00.0	00.1	00.8	00.8	02.1	03.6
325	2 8030	00.0	00.3	00.6	00.5	00.7	00.9	00.0	00.0	00.0	00.6	00.9	01.2	02.9	06.0
326	2 8031	00.0	00.9	00.9	00.6	00.9	00.4	00.0	00.0	00.0	00.0	00.7	01.1	02.1	03.1
327	2 0034	00.0	00.9	00.9	00.7	01.5	01.0	00.0	00.0	00.0	00.0	00.6	00.0	01.5	03.0
328	2 2559	00.0	00.6	00.8	00.6	00.7	00.5	00.0	00.4	00.0	00.0	00.8	01.1	02.2	04.3
329	2 2077	00.0	00.9	00.9	00.7	01.0	00.6	00.0	00.1	00.0	00.0	00.4	00.4	02.4	04.3
330	2 8032	00.0	00.5	00.5	00.4	00.6	00.5	00.0	00.0	00.0	00.3	00.4	00.5	01.3	02.3
331	2 2337	00.0	00.4	00.4	00.4	01.0	01.3	00.0	00.0	00.0	00.0	00.5	00.3	01.3	02.1
332	2 2275	00.0	00.2	00.2	00.2	00.8	00.5	00.0	00.0	00.0	00.0	00.3	00.0	00.9	02.0
333	2 2278	00.0	00.8	00.8	00.5	00.8	00.5	00.0	00.0	00.0	00.2	00.6	00.6	01.7	03.6
334	2 0383	00.0	00.3	00.3	00.3	01.0	00.3	00.0	00.0	00.0	00.0	00.7	00.7	02.2	04.2
335	2 0411	00.0	00.5	00.9	00.5	01.0	00.5	00.0	00.1	00.0	00.0	00.5	00.5	01.5	02.6
336	2 0470	00.0	00.3	00.3	00.2	00.8	00.4	00.0	00.0	00.0	00.0	00.3	00.1	01.0	01.9
337	2 8033	00.0	00.5	00.6	00.5	00.8	00.6	00.0	00.0	00.0	00.2	00.4	00.8	02.1	04.1
338	2 2560	00.0	00.6	00.6	00.5	01.0	00.5	00.0	00.0	00.0	00.0	00.4	00.4	01.4	02.8
339	2 8034	00.0	00.6	00.6	00.5	00.6	00.6	00.0	00.0	00.0	00.0	00.4	00.8	02.0	03.5
340	2 8035	00.0	00.7	00.7	00.7	01.0	00.6	00.0	00.0	00.0	00.0	00.9	01.3	03.0	05.0
341	2 8036	00.0	00.5	00.7	00.5	00.8	00.7	00.0	00.3	00.0	00.0	00.4	00.7	01.6	02.7
342	2 8037	00.0	00.8	00.8	00.8	01.5	00.8	00.0	00.0	00.0	00.0	00.7	00.8	01.8	02.9
343	2 8038	00.0	00.2	00.2	00.5	00.9	00.9	00.0	00.0	00.1	00.1	00.8	00.8	03.1	06.4
344	2 8039	00.0	00.3	00.3	00.3	00.8	00.5	00.0	00.0	00.0	00.0	00.4	00.3	01.0	02.1
345	2 8040	00.0	00.2	00.4	00.4	00.5	00.5	00.0	00.1	00.0	00.0	00.4	00.6	02.0	03.5
346	2 8041	00.0	00.1	00.1	00.5	01.0	00.5	00.0	00.0	00.0	00.0	00.6	00.7	02.0	03.0
347	2 8042	00.0	00.4	00.6	00.5	01.0	00.5	00.0	00.1	00.0	00.2	00.7	00.8	01.7	02.5
348	2 8043	00.0	00.5	00.6	00.4	00.6	00.5	00.0	00.2	00.0	00.2	00.5	00.5	01.2	02.2
349	2 8044	00.0	00.5	00.5	00.4	00.8	00.5	00.0	00.0	00.0	00.0	00.4	00.1	01.2	02.0
350	2 8045	00.0	01.0	01.0	00.8	01.4	01.1	00.0	00.0	00.0	00.0	00.9	01.0	02.9	05.5
351	2 8046	00.0	00.8	00.8	00.5	00.9	00.3	00.0	00.1	00.0	00.0	00.5	00.4	02.2	04.0

Projectile Point X,Y Coordinate Measurements

	Item #	Cat.	P1X	P1Y	P2X	P2Y	P3X	P3Y	P4X	P4Y	P5X	P5Y	P6X	P6Y	P7X	P7Y
352	2	8047	00.0	00.5	00.5	00.4	00.5	00.4	00.0	00.2	00.0	00.3	00.5	00.6	01.4	02.2
353	2	2556	00.0	00.7	00.7	00.5	01.0	00.5	00.0	00.1	00.0	00.2	00.6	00.5	01.9	03.5
354	2	2071	00.0	00.3	00.4	00.5	01.0	00.5	00.0	00.2	00.0	00.0	00.3	00.2	01.7	03.5
355	2	8048	00.0	00.8	01.0	00.8	01.0	00.5	00.0	00.0	00.0	00.5	00.8	01.4	02.5	03.9
356	2	8049	00.0	00.7	00.7	00.5	00.9	00.6	00.0	00.2	00.0	00.0	00.7	00.5	01.9	04.0

APPENDIX B

FAUNAL ANALYSIS FROM THE WIND CREEK PROJECT

BY GRADY CAULK

FAUNAL ANALYSIS

Due to the acidic nature of the forest soils the only faunal remains preserved in the sites are either very fresh bones, or bones which have been burnt by some means. This is because acid soils tend to disolve mineral portions of bones (Chaplin 1971: 16). Burnt portions of bones have a change in the hydroxyapatite and collagen components (Shipman, Foster, and Schoeninger 1984). These changes, along with the burning off of the organic component, possibly contribute to the preservation of the burnt bone fragments. Burning of the bone causes internal strresses and an increased brittleness which contributes to the highly fragmentary conditions of the remains. Only two of the fragments recovered from the Wind Creek Project were larger than 20 mm in their longest dimension.

There were 247 bone fragments recovered from the Wind Creek Project (Table 24). Of these only three could be identified: one as a mandible from a recent pocket gopher (Thomomys), and two deer (Dama) antler tines. The remainder of the bones could be divided into the general size categories of large mammal (which includes pronghorn, deer, bear, man, and larger mammals), medium mammals (which range in size from large rabbits to domestic sheep), and small mammals. Most of the bone fragments from the sites came from the large and medium mammal category, with the majority of bones from the large mammal group. This is most likely due to a greater preservation potential for the larger bone fragments, rather than a selection bias of the native populations. None of the bone fragments appear to have come from the very large category consisting of elk or bison, but this is not to say they are not represented.

Site 35GR-147 unit 1 contained seven fragments from large mammals, two medium mammals fragments, and one fragment from either a large or medium mammal. These were found

Table 24. Summary of Bone From the Wind Creek Sites[a]

SITE #	LEV.	PER.	EXCAV.	TEST.	TOTAL	DESCRIPTION							
						LM	LMM	MM	MS	SM	DA	BTF	OTHER
148	1	1	3		3	2							1[b]
	2	1	19	4	23	17	1	1					
	3	1	24	4	28	17	6	1	1				
	4	1	9	8	17	8	1				1		
	5	1	1	12	13	1							
	6	1	5	6	11		3	2					
	7	1	1		1	1							
	8	1	3		3		2			1[c]			
	9	1	1		1		1						
	10	1	1		1		1						
	11	1	1		1		1						
Total			68	34	102	46	16	4	1	1	1		1
159	1	1	1		1		1						
	2	1											
	3	2		2	2		2						
	4	2		1	1		1						
Total			1	3	4		4						
162	1	1	6		6		5						
	2	1	47	1	48		35	4	8				
	3	2	54	9	63		54	7	1			1[d]	

Table 24. (Continued)

SITE #	LEV.	PER.	EXCAV.	TEST.	TOTAL	DESCRIPTION LM	LMM	MM	MS	SM	DA	BTF	OTHER
162	4	3	48	3	51	48	1	2					
	5	3	31	4	35	32	1	2					
	6	3	7	2	9	5	4						
	7	3	2	1	3	1	2						
Total			95	16	211	180	19	13			1		1
147	1	1	4		4								
	2	1	4	1	5	2							
	3	1	1		1		1						
	4	1	1	5	6		5						1[e]
	5	1	1	3	4	4							
	6	1		2	2	2							
	7	1											
	8	1											
	9	1											
	10	1											
	11	1											
	12	1											
	13	1		1	1	1							
Total			11	12	23	9	6						1

LM-large mammal, LEV-Level, a-includes the testing phase, LMM- Large to medium mammal, PER-Period, b-pocket gopher mandible MM-Medium mammal, EXCAV-excavation, c-probably intrusive, MS-Medium to small mammal, TEST-Testing , d-sheep or pronghorn ,SM-Small mammal, e-from a large mammal, DA-Deer antler, BTF-Burnt tooth fragment.

in the top four levels. Four came from level one, three from level two and one each from levels three and four. Unit 2 contained two fragments from a large mammal. One from levels two and five. No faunal remains were recoverd from unit 3. The test units for this site contained 17 bone fragments. Test unit A had five large/medium mammal bones recovered fron 4 and one large mammal bone fragment recovered from s two and six. Test unit B had one large mammal bone fragment recovered from levels two and six, one large/medium mammal bone from level 3, and three large/medium mammal bones recovered fron unit four. Test unit 19 contained a burnt tooth fragment from a large/medium mammal in unit 4, two large mammal bone fragments in level five, and one large mammal bone from level 13.

Site 35GR-148 unit 2 contained 25 large mammal bones fragments, two medium mammal bone fragments, and one small mammal bone fragment, probably an intrusive rodent. Unit 3 had 24 large mammal bones, including one probable deer antler, six large to medium mammal bones, two medium mammal bones, one medium to small mammal bone, and one pocket gopher mandible. The test units of this site contained 30 bone fragments. Test unit A contained two bone fragments from large/medium mammals in two. Test unit B contained eight bone fragments from large/medium mammals; two each in levels four and six, and four in level five. Unit five contained two bone fragents from large/medium mammals in level three, and three large mammals, and onelarge/medium mammal bone fragments from level four. Unit seven, level 3 contained a first phalynx fragment, probably from a deer (dama sp.). Level four contained one fragment from a large mammal, and one from a large/medium mammal, and one fragment from a large/medium mammal in level five. Unit 15 level two, and unit 16 level five contained six large/medium mammal bone fragments. Unit 23 five contained six large/medium mammal bone fragments.

Level 2 of unit 28 contained a metatarsal shaft from a deer or pronghorn. Test pit C level level three contained an unburnt proximal tibia fragment from a deer, sheep, or pronghorn.

Site 35GR-159 unit two contained only one bone fragment. This was from level one, and came from a large mammal. The test units from this site contained three large mammal bone fragments, one from each unit; unit B level three, unit C level 4, and unit 2 level three.

Site 35GR-162 unit 1 had the largest quantity of bone fragments recovered. These consisted of 137 large mammal bone fragments including one probable deer antler fragment, 13 large to medium mammal bone fragments, and 13 medium mammal bone fragments. These fragments were concentrated, as should be expected, in the levels with the highest concentration of cultural material (levels two to five). Unit two contained one bone fragment from a mediunm mammal. The testing of this site recovered 14 bone fragments. Unit B had six large mammal, two large/medium mammal, and one burnt tooth fragment from a deer, sheep, or pronghorn antelope in level three. Level 4 contained two large mammal, and one medium mammal bone fragment. Unit B level 6 contained 2 bone fragments, and level 7 contained one bone fragment from large/medium mammals. Unit C levels 2 and 3 contained one large mammal bone fragment each.

Site 35GR-150 was not excavated, but the testing phase resulted in the identification of one large mammal bone fragment each from Unit A level one, and unit 46 level five. There was a trace of fragments from Unit A level 2.

The highly fragmentary conditions of the faunal remains from the sites precludes the formation of any type of species list. The distribution of the bones within the the sites should give supporting indicatiuons of cultural horizons, especially noticable in the distributions from sites 35GR-162, unit 1, 35GR-148, unit 3, and probably from 35GR-148, unit 2.

APPENDIX C

OBSIDIAN SOURCE AND HYDRATION ANALYSIS

BY CHARLES LAWRENCE ARMITAGE

Introduction

Lithic material from the Wind Creek sites and a sample of projectile points from central Oregon were subjected to obsidian source and hydration analyses. Material from the Wind Creek sites was analyzed by Richard Hughes (1987), and Tom Origer (1987) of Sonoma State University, under a research grant to the author from the University of Oregon Archaeological Reesearch Trust Fund. Obsidian source analysis of the projectile points from central Oregon was done by Richard Hughes (1993), and the hydration analysis was performed by Scott Byram (1993) of the Museum of Anthropology at the University of Oregon. Analysis of the central Oregon collection was funded by a grant from the University of Oregon Archaeological Research Trust Fund, and money from the Ochoco National Forest.

Historical Background

Methods

Analytic studies on volcanic glasses have progressed rapidly within the last 15 years. Within the field of archaeology these studies have taken the form of obsidian sourcing of cultural material and hydration studies of volcanic glasses to obtain dates. Despite the advances that have been made in volcanic glass studies many problems with the techniques remain to be resolved, and have hindered the full recognition of the potential of these methods of analysis in archaeological studies.

The first description of the obsidian hydration process was presented by Ross and Smith (1958) who stated that naturally formed surfaces of obsidian undergo hydration. It was not until 1960 that Friedman and Smith fully described the hydration process, and the laboratory procedures involved in the application of obsidian hydration as a dating technique (Friedman and Smith 1960). Simply stated a freshly exposed surface (cut) of volcanic glass will absorb water from the surrounding atmosphere forming a hydrated surface layer. When a thin section of obsidian is cut, and mounted on a slide, the hydrated surface or rim may be examined, and its thickness quantitatively measured in microns (u). Once known rates of obsidian hydration are developed, a hydration rate and date for the obsidian sample may be formed.

Of critical importance in the dating process is the rate of water absorbtion by a given sample. Subsequent research indicated that the diffusion process is continious (Michels 1967), but that obsidian hydrates more rapidly at higher temperatures. It is currently believed that a change in 1 degree c. effective temperature equals a 10% change in the hydration rate (Ambrose 1976). Obsidian hydration rates have been developed both experimentally and by direct correlation with known radiocarbon dates. Experiments in obsidian hydration rates indicate that the hydration rate is proportional to the square root of time, or the rim thickness squared as in the equation (Ambrose 1976)

$$X=Kt^{1/2}$$

Where: X=rim thickness in microns
K=constant for hydration rate at a fixed temperature
t=time elapsed

The value as a dating tool thus becomes appearent, however problems are inherent in the process. The problems include insufficient knowledge of the effects of temperature, burning, erosion, reuse of the artifact, chemical composition of the obsidian, and insufficient knowledge of the hydration process to develop diffusion equations.(Michels and Tsong 1980). In view of these problems obsidian hydration must be approached cautiously and applied spariingly with ample support from the archaeological record. The largest value of the obsidian hydration process is that it is a quick and relatively inexpensive dating technique, and unlike radiocarbon dating, the artifact is dated and not its context. As of 1968 it was possible to prepare, mount, and examine 6 obsidian samples per hour (Friedman 1968).

Obsidian source analysis has been known for some time, but recieved attention in the late 1960's,as neutron activation techniques were developed, yielding an inexpensive and non destructive method of sourcing samples. Obsidian sourcing involves analysis of the chemical composition of obsidian to determain the parent or original source of the sample. Originally samples had to be crushed to determine the chemical composition, but with the advent of neutron activation techniques ("chemical fingerprinting" or "trace element analysis"), non destructive methods of analysis were developed. These methods involve the irradiation of a sample with thermal neutrons, and the measurement of the resulting energy tranferal (gamma rays). Different chemicals contain different different wave lengths, and thus the chemical compositions of obsidian may be measured (Gordus et al. 1968). The graphic representation of the data may be presented either as a triangular grid (ternary diagram), or in the form of a multi-variate analysis. The ternarry diagram will not be statistical, while the multi-variate method describes, and predicts unknown groups (Hughes 1986b).

Obsidian source analysis depends upon the identification of geologic sources; thus if a greater number of sources are known, the success rate of the sourcing project will also be greater. Four factors are involved in obsidian sourcing; the degree to which sources may be characterized, the number of sources in a region, the extent that other sources may exert, and the area over which the identification of material is attempted (Friedman 1968).

Problems exist in the application of sourcing, and generally involve the accuracy of the measurements, identification of a full range of sources, and the uncritical acceptence of the results by archaeologists. The benifits are that it is a non destructive method, that is inexpensive, and may be accomplished in a short period of time, with results of high precission (Hughes 1986b).

Geology

An understanding of the local geology is of critical importance in the formation of models of analysis of obsidian studies in the central Oregon region. Much of central Oregon is covered by massive sheets of Columbia River basalt. Volcanic activity was also present in the region, especially in southern Oregon, thus deposits of obsidian are found predominantly in southern Oregon. These deposits take two forms, that of massive flows, such as Glass Butte, and smaller flows that are buried beneath basalt. The latter form are found eroding from basalt formations, and comprise the majority of local obsidian sources. These local sources are much smaller than the massive deposits of obsidian, but may have been an important source of obsidian for the Northern Paiute Indians. In the surrounding area of the Wind Creek sites no obsidian deposits are found, the nearest source being about 60 miles away at Dayville, or south about 60 miles to Burns. Thus, any obsidian that was found at the Wind Creek sites had necessarily to be transported from outside central Oregon. The lithic sources of material present in central Oregon consist of basalt in the southern, north, and eastern portion, and sedimentary deposits such as the Madras formation in the western portion. Obsidian sources are found in a band across southern Oregon and the Cascades. A few sources have been identified in the Blue Mountains, and to the north near Dayville, but these are small outcrops. A map of obsidian sources in Oregon has been compiled by Skinner (1983).

Previous Work

Early work concerning obsidian studies within the Great Basin was limited and fragmented, but recently with research by Hughes (1986b) a synthesis of the known data is begining to come together. The first work done in Oregon was by Johnson (1969) in the Klamath Basin region. Other research was done by Layton (1972a) with Cougar Mountain material, obsidian from the Dirty Shame Rock Shelter was examined by Sappington (Aikens et.al 1977), and Sappington's research continued with analyses from the Aurora Joint Venture project in southern Oregon (Sappington 1980), the Bonneville Powerline Survey through Central and Southern Oregon (Sappington and Toepel 1981), and the Gravelly Flat site in east central Oregon (Sappington 1982). Recent work by Hughes includes the Beaver Dam Creek site in east central Oregon, four projects in the Deschutes National Forest, along the Deschutes River, at Nightfire Island (Sampson 1985), and analysis of obsidian work on the Rough Site, located on the Big Summit District of the Ochoco National Forest (Flenniken et al 1992). To the north at Mitchell Cave (Connolly et al. 1993) 50 samples were sourced, and a gas pipeline project (Lebow et al. 1991; Speulda et al. 1993) resulted in the analysis of a large amount of obsidian from the Deschutes River area. In the Cascades and western Oregon several projects have been conducted (Toepel and Sappington 1982; Fagan 1975; Toepel 1985). Recently, Hughes (1984, 1986a, 1986b) has conducted reseach in Northern California, and one or two locations in southern Oregon.

The main emphasis to date has been upon the characterization of the major obsidian sources, located in southern Oregon. These studies have been primarily undertaken by geologists. Only recently have archaeologists tried to characterize some of the smaller, more local sources, necessary if any firm results may be obtained from source analysis. Obsidian hydration analyses have been limited, with few conclusive results. Research on the Cougar Mountain material by Layton (1972b) resulted in a provisional hydration rate, and a classification of projectile points. A hydration rate for the Klamath Basin region was obtained by Johnson (1969), and some projectile points were analyzed. Aikens and Minor (1978) applied this rate to the dating of a midden site in Klamath County. The most ambitious work has been presented by Hughes (1986b), but is mainly relevant for the Northern California region and the Klamath Basin. Research to date has largely been site specific, with few attempts to cross correlate obsidian results or to build theories.

Discussion

Obsidian Hydration Analysis

The obsidian hydration analysis of the Wind Creek lithic material was done by Sonoma State University (Origer 1987). Twelve samples of obsidian from the Wind Creek sites were subjected to analysis (Table 25). This analysis involved the preparation of a thin section slide, and the measurement of the hydration band in microns (u). Each specimen was first examined so that two or more surfaces could be found that would yield edges that would be perpendicular to the slide during the preparation of the thin section. For each specimen two parallel cuts were made using a 4 inch diameter circular saw blade mounted on a lapidary trimsaw. The resulting thin sections were approximately 1 millimeter thick. The samples were mounted using Lakeside Cement onto petrographic microslides (Origer 1987).

The thickness of each specimen was then reduced by manual grinding using a slury of #500 silicon carbide abrasive on a glass plate. The grinding process involved first reducing the specimen by approximately one half, eliminatiing any micro chips created by the cutting of the

Table 25. Summary of Central Oregon Obsidian Hydration Measurements and Dates[a]

Site Lab #	Cat #	Description	Provenience	Remarks	Readings	M	Date
Samples from the Wind Creek Sites							
147							
01	103	Point	10cm	None	1.1 1.1 1.1 1.1 1.2 1.2	1.1	406
02	147	Flake	60cm	W	3.0 3.1 3.1 3.2 3.3 3.3	3.2	3437
03	186	Point	40cm	None	2.9 2.9 3.0 3.0 3.1 3.2	3.0	3020
148							
04	244	Flake	20cm	None	.09 1.0 1.0 1.0 1.1 1.1	1.0	336
06	318	B. Tip	40cm	None	2.0 2.0 2.0 2.0 2.0 2.1	2.0	1342
07	15	Point	10cm	None	3.1 3.1 3.2 3.3 3.3 3.3	3.2	3437
09	470	Point	Sur	None	1.2 1.3 1.2 1.2 1.3 1.3	1.2	453
159							
05	310	Flake	70cm	None	(no visible hydration)		
08	40	Flake	30cm	None	2.3 2.3 2.3 2.3 2.4 2.4	2.3	1664
162							
10	523	Flake	10cm	None	3.3 3.4 3.4 3.4 3.5 3.6	3.4	3665
11	611	Flake	70cm	None	2.5 2.5 2.5 2.6 2.6 2.7	2.6	2126
12	690	Point	60cm	None	9.9 9.9 10 10 10.1 10.1	10	nm
Samples from the Central Oregon Upland Surface Survey							
2		Point 6	Sur	None	2.09 1.86 2.16 2.24 1.94	2.06	1334
18		Point 2	Sur	None	1.04 1.19 1.27 1.04 1.12	1.13	402
20		Point 17	Sur	None	3.87 4.32 4.10 4.10 4.17	4.11	5312
23		Point 20	Sur	None	4.92 5.22 5.07 5.07 5.37	5.13	8276
26		Point 16	Sur	None	(no visible hydration)		nm
30		Point 19	Sur	None	2.83 2.83 2.68 2.68 2.53	2.71	2309

Table 25. (Continued)

Site Lab #	Cat #	Description	Provenience	Remarks	Readings	M	Date
36		Point 18	Sur	None	2.24 2.53 2.24 2.38	2.37	1766
49		Point 4	Sur	None	(diffuse)		
51		Point 18	Sur	None	3.73 4.17 3.73 3.87 4.02	3.90	4783
53		Point 6	Sur	None	1.94 1.94 1.94 1.79 1.49	1.82	1042
60		Point 2	Sur	None	(< .5 microns)	<.5	100
67		Point 11	Sur	None	2.34 1.86 1.94 2.09 2.09	2.06	1432
73		Point 18	Sur	None	1.49 1.49 1.49 1.79 1.64	1.58	785
79		Point 6	Sur	None	2.68 2.83 2.68 2.53 2.83	2.71	2309
96		Point 2	Sur	None	(no visible hydration)	nm	
98		Point 19	Sur	None	4.77 5.37 5.37 5.37 5.07	5.19	8470
109		Point 4	Sur	None	3.87 4.17 4.32 4.17 4.17	4.14	5390
110		Point 19	Sur	None	3.13 3.29 2.98 3.29 3.13	3.16	3140
160		Point 3	Sur	None	2.08 1.94 1.94 1.94 1.78	1.94	1184
174		Point 8	Sur	None	2.53 2.68 2.53 2.83 2.83	2.68	2259
175		Point 18	Sur	None	1.79 1.79 1.79 2.09 2.09	1.91	1147
176		Point 21	Sur	None	(approximately 4.5,but diffuse)		6368
184		Point 19	Sur	None	1.19 1.19 1.34 1.27	1.25	524
208		Point 18	Sur	None	1.34 1.34 1.34 1.49 1.56	1.41	625
217		Point 15	Sur	None	1.64 1.79 1.94 1.79 1.79 2.08	1.84	1065
222		Point 1	Sur	None	1.64 1.79 1.34 1.49 1.34	1.52	775
224		Biface	Sur	None	2.68 2.83 2.68 2.83 2.75	2.75	2378
225		Point 6	Sur	None	2.98 2.98 3.13 2.98 2.53	2.92	2681
237		Point 12	Sur	None	1.71 1.79 1.94 1.94 2.01	1.88	1111
238		Point 16	Sur	None	2.09 2.24 2.39 2.07 2.39	2.24	1578
239		Point 12	Sur	None	1.94 1.79 1.79 1.94 1.79	1.85	1076
243		Point 14	Sur	None	2.38 2.68 3.38 2.68 2.68	2.76	2395
247		Point 14	Sur	None	3.29 3.43 3.13 3.13 3.27	3.25	3322
253		Point 22	Sur	None	1.56 1.72 1.79 1.79 1.79	1.73	941
254		Point 14	Sur	None	(no visible hydration)		
257		Point 5	Sur	None	1.94 1.79 1.86 1.86 1.94	1.88	1076
263		Point 8	Sur	None	1.71 1.34 1.42 1.56 1.34	1.47	680
274		Point 16	Sur	None	1.79 2.09 1.94 1.79 1.94	1.91	1147
275		Point 19	Sur	None	1.94 2.09 2.24 1.94 2.09	2.06	1334
280		Point 18	Sur	None	4.03 4.03 3.73 3.87 4.02	3.94	4882
282		Point 6	Sur	None	(no visible hydration)		
291		Point 19	Sur	None	2.53 2.53 2.35 2.38 2.54	2.47	1919
307		Point 18	Sur	None	3.58 3.73 3.87 3.42 3.73	3.67	4520
308		Point 4	Sur	None	2.98 2.53 2.98 2.83 2.83	2.83	2688

Table 25. (Continued)

Site Lab #	Cat #	Description	Provenience	Remarks	Readings	M	Date
324		Point 11	Sur	None	1.64 1.49 1.49 1.42 1.57	1.52	775
331A		Point 6	Sur	Edge A	4.47 4.92 4.47	4.62	6712
331A				Edge B	4.02 4.02 3.43 3.43	3.73	4376
330		Point 1	Sur	None	3.73 4.02 3.87 3.95 3.87	3.85	4661
335		Point 14	Sur	None	2.98 2.76 3.13 3.20 2.76	2.97	2774
351		Point 14	Sur	None	3.43 3.87 3.87 4.02 3.87	3.81	4565
Rough Site							
01	1-6a	Flake	60cm	None	2.9 2.9 3.0 3.1 3.1 3.1	3.0	2830
02	1-6b	Flake	60cm	None	1.6 1.7 1.7 1.7 1.8 1.8	1.7	535
03	1-8	Point	80cm	None	2.4 2.4 2.5 2.5 2.6 2.6	2.5	1965
04	2-3a	Flake	30cm	None	1.8 1.8 1.8 1.8 1.8 1.8	1.8	1019
05	2-3b	Flake	30cm	None	2.9 3.0 3.0 3.0 3.0 3.2	3.0	2830
06	2-3c	Flake	30cm	None	2.1 2.1 2.1 2.1 2.3 2.3	2.2	1522
07	2-3d	Flake	30cm	None	1.6 1.7 1.7 1.8 1.8 1.8	1.7	909
08	2-6	Point	60cm	None	1.7 1.7 1.8 1.8 1.8 1.8	1.8	1019
09	2-11a	Flake	110cm	None	3.5 3.6 3.6 3.6 3.6 3.7	3.6	4075
10	2-11b	Flake	110cm	None	3.7 3.7 3.8 3.8 3.8 3.9	3.8	4541
11	2-12a	Flake	120cm	None	3.6 3.8 3.8 3.9 3.9 3.9	3.8	4541
12	2-12b	Flake	120cm	None	3.6 3.6 3.7 3.8 3.8 3.8	3.7	4305
13	3-3a	Flake	30cm	None	2.1 2.1 2.3 2.3 2.3 2.3	2.2	1522
14	3-3b	Flake	30cm	None	2.4 2.4 2.5 2.6 2.6 2.6	2.5	1965
15	3-10	Biface	100cm	None	1.9 2.0 2.0 2.0 2.0 2.0	2.0	1258

a-The readings are measured in microns and the date is based upon an estimated hydration rate of 2.98 microns^2 /thousand years for the Whitewater Ridge source and 3.18 microns^2/ thousand years for the Wind Creek sites. For the Wind Creek sites 2.98 was the constant used when determaining the estimated date, and 3.18 was used for all other samples.
w-Weathering present.
M-Mean hydration reading.
Date-Estimated date in years BP.

specimen. Each slide sample was then reheated liquifing the cement, and then the samples were inverted, the grinding continuing until the correct thickness was achived. Correct thickness was determained by touch and by a transparency test. Touching involved rubbing a finger across the slide in order to determain thickness differrences, while The transparency test involved applying a strong light source to the slide and the translucency of the specimen examined. Thin sections were determined to be complete when they readily allowed the passage of light. Protective coverslips were placed over each specimen and the micro slides currated at the Sonoma State University hydration laboratory under File No. 87-H584 (Origer 1987).

Hydration bands were then measures using a 45X objective attached to a petrographic microscope containing a Bausch and Lomb 10X filar micrometer eyepiece. Six measuremnets were taken at several locations along the edges of each specimen, and the mean of the six measurements was calculated with a standard error of ± 0.2u.

Of the twelve hydration readings from the Wind Creek specimens, five were from projectile points, six were on flakes, and one was from a biface tip. Samples 103 and 470 were from points similar to Rosegate or Columbia Basin pin stem points, The samples had a hydration thickness of 1.1 and 1.2. Samples 310 and 690 were from projectile points similar to the Elko series Split Stem and Side-notched. One sample had a hydration thickness of 10, and the second could not be determained. Sample 186 from a point was similar to the Elko Corner-notched series. This sample had an hydration thickness of 3.0. The biface (sample 318), had a hydration band thickness of 2.0. The flakes ranged from a thickness of 1 micron to 3.4.microns

The obsidian hydration analysis of projectile points collected by the central Oregon upland surrvey was performed by Scott Byram of the State Museum of Anthropology, University of Oregon. All specimens were prepared and analyzed using the following techniques:

> The artifacts were examined to determine the appropriate location for the removal of a wedge for thin sectiopning. Two parrallel cuts spaced 1mm apart were then made in each artifact using a circular lapidary saw equipped with a .04 mm brass blade. The resulting wedge was removed and ground by hand to approximately one half its original thickness using a 600 carborundum slurry and a glass plate. The specimen is then mounted onto a petrographic microslide using heated Lakeside cement. The specimens are ground to a thickness less than 100 microns. The appropriate thickness for each thin section is determined by its translucency; darker obsidian is ground thinner than more translucent obsidian.
>
> Each specimen was analyzed using a Zeiss petrographic microscope equipped with an Olympus 60x objective and an OSM 10x ocular filar micrometer, for a total magnification of 600x. The ocular scale is calibrated with a stage micrometer. After primary examination of the hydration rind, five readings were taken from the hydrated surfaces of each specimen (Byram 1993).

Of 49 samples examined, 4 contained no visible hydration rims, one had only a diffuse hydration band, and hydration bands on the remaining 44 samples ranged from < .5 to 5.19 average microns (Table 25).

Obsidian Source Analysis

Thirty two obsidian artifacts from the Wind Creek sites were chosen for obsidian sourcing. The analysis was performed by Richard Hughes at Sonoma State University pursuant to Sonoma State University Academic Foundation, Inc. Account 6081, Job X87-36. Analysis of the artifacts was

> performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray flourescence spectrometer with a Rh x-ray tube, a 50 kv x-ray generator, 1251 pulse processor (amplifier), 1236 bias/protection module, a 100 mHz analog to digital conveter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 30.0 kV, .30 mA, using a .127 mm Rh primary beam filter in an air path at 200 seconds livetime to generate quantitative data for elements Zn-Nb. Data processing for all analytical subroutines is executed by a Hewlett Packard 20 megabyte fixed drive. Trace element concentrations were computed from a least square calibration line established from each element from analysis of up to 25 international rock

> standards certified by the U.S. Geological Survey,the U.S. National Bureau of Standards, the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France) (Hughes 1987: 1).

All of the trace elements were expressed in quantitative units (parts per million [ppm] by weight), and were compared to known sources of obsidian. Descriptions of thsese sources appear in Hughes (1985, 1986a, 1986b), Hughes and Mikkelsen (1986), Jack (1976), Jack and Charmichael (1969), and Skinner (1983), as well as other unpublished data in the possession of Richard Hughes.

The initial sourcing of the Wind Creek artifacts in 1987 was limited, since few sources had been identified from eastern Oregon. Of the 34 samples submitted, 2 were sourced to Buck Springs Creek and the remaining 32 samples were unable to be sourced. Analysis of the geochemical compositions indicated however, that 10 discrete groups of obsidian were present in the collection. Hughes stated that:

> So little trace element geochemistry has been published on obsidians from this part of Oregon that it has been possible to assign only a few of these artifacts to obsidian source. In the general vicinity of the Wind Creek sites, obsidian is known to occur in at least two places in the John Day Formation north of Mitchell, as well as in the Dansforth formation, near Clarno, and numerous places to the south (Skinner 1983) and east (McDonald 1986) (Hughes 1987: 2).

In 1993 Hughes analyzed 50 projectile points from the Ochoco National Forest pursuant to Ochoco National Forest Procurement Request No. 17-91-PC (Table 26). Methods similar to those employed in the previous analysis were used, with the addition of the chemical analysis of Ba, Ti, and Mn where needed. Artifacts were compared to other oregon obsidian types at the 2 sigma level and the matching of artifacts to geochemical types were considered reliable if the measurements fell within 2 standard deviations of mean values for source values (Hughes 1993: 1).

Table 26. Cemtral Oregon Upland Obsidian Source Specimen Analysis Showing Geochemical Sources, Site Location of Specimens, and Specimen Projectile Point Types [a].

Specimen #	Trace Element Concentrations Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
2	87	21	85	71	64	367	19	nm	1633	656	Yreka Butte	6	671 NA-173
±	6	3	4	3	2	5	3		30	20			
18	123	22	108	2	100	242	36	36	723	628	Sawmill Creek	2	isolate
±	7	4	4	3	2	5	3	13	23	20			
20	36	14	125	157	15	154	9	942	nm	nm	Beatys Butte	17	674 NA-065
±	6	3	4	3	2	5	3	14					
23	116	21	92	0	96	274	31	134	879	698	Sawmill Creek	20	673 NA-128
±	6	3	4	3	2	5	3	13	23	20			
26	50	15	102	36	41	147	14	nm	880	471	Cougar Mountain ?	16	674 NA-040
±	6	3	4	3	2	5	3		26	20			
30	45	12	68	48	42	114	10	1240	nm	nm	Unknown	19	674 NA-219
±	5	3	4	3	2	5	3	14					
36	31	15	82	22	50	90	9	nm	nm	nm	Glass Buttes	18	isolate
±	6	3	4	3	2	5	3						
42	44	14	112	66	24	114	7	nm	861	267	Whitewater Ridge	3	isolate
±	6	4	4	3	2	5	3		29	20			
49	98	20	115	9	62	462	22	1113	nm	nm	Riley	4	isolate
±	6	3	4	3	2	5	3	14					
51	94	22	129	1	102	161	37	nm	nm	nm	Delintment Creek	18	isolate
±	6	3	4	7	2	5	3						
53	41	15	99	20	48	88	8	nm	nm	nm	Glass Buttes	6	isolate
±	6	3	4	3	2	5	3						
60	69	15	108	139	31	94	15	928	383	614	Unknown	1	673 NA-030
±	7	4	5	4	2	5	3	16	26	20			
67	38	14	86	95	25	126	7	nm	1158	366	Whitewater Ridge	11	672 NA-123
±	6	3	4	3	2	5	3		29	20			
73	33	16	98	65	24	103	7	nm	577	367	Little Bear Creek	18	672 NA-182
±	5	3	4	3	2	5	3		24	20			

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
79	41	19	78	107	19	93	8	nm	nm	nm	Obdisian Cliffs	6	isolate
±	6	3	4	3	2	5	3						
96	48	16	115	87	25	130	6	nm	nm	nm	Whitewater Ridge	2	672 NA-152
±	7	4	4	3	2	5	3						
98	115	19	97	2	99	272	31	137	828	724	Sawmill Creek	19	isolate
±	6	3	4	3	2	5	3	13	23	20			
109	70	18	132	58	43	176	6	nm	650	363	Quartz Mountain	4	isolate
±	6	3	4	3	2	5	3		24	20			
110	28	18	96	66	27	103	6	nm	640	390	Juniper Spring, Variety 1	19	672 NA-079
±	6	3	4	3	2	5	3		25	20			
151	37	18	114	71	22	113	7	nm	1111	254	Whitewater Ridge	21	674 NA-065
±	6	3	4	3	2	5	3		26	20			
60	33	17	113	54	23	102	10	nm	709	269	Little Bear Creek	3	isolate
±	6	3	4	3	2	5	3		28	20			
174	64	16	133	54	40	173	9	nm	1048	381	McKay Butte	8	673 NA-135
±	6	3	4	3	2	5	3		28	20			
175	49	13	115	4	67	81	13	nm	391	442	Potato Hills	18	isolate
±	6	3	4	3	2	5	3		20	20			
176	98	20	121	3	94	171	34	nm	nm	nm	Delintment Creek	21	isolate
±	6	3	4	3	2	5	3						
184	30	15	113	79	24	126	6	nm	nm	nm	Whitewater Ridge	19	isolate
±	6	3	4	3	2	5	3						
208	67	22	132	60	43	183	7	nm	740	359	Quartz Mountain	18	673 NA-105
±	6	3	4	3	2	5	3		24	20			
217	181	19	126	0	103	607	34	nm	1212	681	Horse Mountain	15	isolate
±	7	3	4	3	2	6	3		26	20			
222	47	14	136	92	29	135	5	nm	1174	284	Whitewater Ridge	1	673 NA-029
±	7	4	5	3	2	5	3		30	20			

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
224	34	16	115	86	23	132	8	nm	nm	nm	Whitewater Ridge	(Biface?)	672 NA-077
±	6	3	4	3	2	5	3						
225	45	19	128	60	42	268	15	nm	nm	nm	Newberry Volcano	6	isolate
±	6	3	4	3	2	5	3						
237	41	20	76	98	16	89	10	nm	nm	nm	Obsidian Cliffs	12	isolate
±	6	3	4	3	2	5	3						
238	127	21	106	3	82	514	44	0	1390	508	Dog Hill	16	isolate
±	6	3	4	3	2	5	3	25	25	20			
239	115	22	136	1	113	170	41	nm	nm	nm	Delintment Creek	12	672 NA-324
±	7	3	4	6	2	5	3						
243	52	19	119	5	71	82	13	nm	566	463	Potato Hills	14	isolate
±	6	3	4	3	2	5	3		22	20			
247	44	16	77	104	18	92	6	nm	nm	nm	Obsidian Cliffs	14	675 NA-071
±	6	3	4	3	2	5	3						
253	35	165	96	66	27	99	5	nm	1460	412	Unknown	22	673 NA-095
±	6	3	4	3	2	5	3		27	20			
254	76	24	138	62	45	184	11	nm	1237	357	McKay Butte	14	isolate
±	6	3	4	3	2	5	3		27	20			
257	101	18	119	10	66	476	24	1108	1378	706	Riley	5	isolate
±	9	5	5	3	3	7	4	18	40	21			
263	74	18	90	33	52	125	11	nm	387	367	Cougar Mountain	8	isolate
±	6	3	4	3	2	5	3		26	20			
274	42	16	100	111	28	193	9	1392	nm	nm	Unknown	16	674 NA-272
±	6	3	4	3	2	5	3						
275	56	18	125	58	44	172	5	nm	550	325	Quartz Mountain	19	isolate
±	6	3	4	3	2	5	3		23	20			
280	37	19	155	47	40	274	14	nm	1786	362	Double "O"	18	673 NA-036
±	6	3	4	3	2	5	3		27	20			

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
282	77	23	142	63	46	191	11	nm	568	327	Quartz Mountain	6	isolate
±	6	3	4	3	2	5	3		24	20			
290	37	13	113	87	24	126	8	nm	nm	nm	Whitewater Ridge	19	Wind Creek
±	6	3	4	3	2	5	3						
307	37	13	112	88	26	129	7	nm	nm	nm	Whitewater Ridge	18	Wind Creek
±	6	3	4	3	2	5	3						
308	38	15	112	86	23	132	10	nm	nm	nm	Whitewater Ridge	4	Wind Creek
±	6	3	4	3	2	5	3						
324	53	16	127	91	28	136	7	nm	nm	nm	Whitewater Ridge	11	Wind Creek
±	7	4	5	3	2	5	3						
330	121	27	115	1	105	247	31	67	1088	679	Sawmill Creek	1	Wind Creek
±	7	3	4	7	2	5	3	13	24	20			
335	36	16	124	40	27	92	7	nm	nm	nm	Wolf Creek	14	Wind Creek
±	6	3	4	3	2	5	3						
351	33	12	96	65	27	102	8	nm	741	368	Juniper Spring,	14	Wind Creek
	6	3	4	3	2	5	3		25	20	Variety 1		
Site 147													
6	42	14	110	86	26	124	11	nm	nm	nm	Whitewater Ridge	Biface	Wind Creek
±	11	6	5	3	2	4	4				(Group 1)		
92	50	12	125	46	28	90	13	nm	nm	nm	Wolf Creek ?	Biface	Wind Creek
±	11	10	6	3	3	5	4				(Group 2)		(30 cm)
103	43	17	114	91	24	128	9	nm	nm	nm	Whitewater Ridge	5	Wind Creek
±	12	6	5	3	3	5	4				(Group 1)		(10 cm)
121	40	16	112	87	25	125	8	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	10	5	5	3	2	4	4				(Group 1)		(30 cm)
147	48	21	113	91	25	129	8	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	8	4	5	3	2	4	4				(Group 1)		(60 cm)
152	74	20	145	18	32	57	19	nm	nm	nm	Unknown Group 3	Flake	Wind Creek
±	8	4	5	3	2	4	4						(40 cm)

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
175	59	19	105	94	24	133	9	nm	nm	nm	Whitewater Ridge	Biface	Wind Creek
±	8	4	5	3	2	5	4				(Group 1)		(50 cm)
186	29	12	109	85	21	123	8	nm	nm	nm	Whitewater Ridge	1	Wind Creek
±	20	7	5	3	3	5	4				(Group 1)		(50 cm)
Site 148													
244	42	16	126	92	26	131	6	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	9	5	5	3	2	4	4				(Group 1)		
310	56	18	89	107	29	142	8	nm	nm	nm	Unknown Group 6	2	Wind Creek
±	8	4	5	3	2	5	4				(Group 4)		
315	42	14	126	66	25	102	9	nm	nm	nm	Whitewater Ridge/	Flake	Wind Creek
±	8	5	5	3	2	4	4				Little Bear Creek		
318	46	14	124	100	24	134	10	nm	nm	nm	Whitewater Ridge	Biface	Wind Creek
±	9	6	5	3	3	5	4				(Group 1)		(40 cm)
39	57	14	123	47	23	88	14	nm	nm	nm	Wolf Creek ?	Flake	Wind Creek
±	8	5	5	3	3	4	4				(Group 2)		(20 cm)
411	42	13	130	41	26	95	10	nm	nm	nm	Wolf Creek ?	14	Wind Creek
±	9	6	5	3	2	4	4						(30 cm)
403	114	27	126	6	88	199	37	nm	nm	nm	Buck Spring	Flake	Wind Creek
±	7	4	5	4	3	5	4						(40 cm)
44	113	18	125	6	87	198	37	nm	nm	nm	Buck Spring	Flake	Wind Creek
±	7	4	5	3	3	5	4						(40 cm)
383	47	14	121	64	24	108	7	nm	nm	nm	Whitewater Ridge	12	Wind Creek
±	7	5	5	3	2	4	4						(30 cm)
58	61	17	115	95	22	131	10	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	9	5	5	4	3	5	4				(Group 1)		(50 cm)
Site 159													
11	37	17	110	83	22	120	8	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	10	4	5	3	2	4	4				(Group 1)		

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
15	72	24	110	27	47	301	19	nm	nm	nm	Unknown Group 10	Flake	Wind Creek
±	8	4	5	3	2	5	4				(Group 8)		(70 cm)
24	48	15	101	69	23	100	13	nm	nm	nm	Whiteweater Ridge/	Flake	Wind Creek
±	8	5	5	3	2	4	4				Juniper Spring 1		(20 cm)
35	42	19	111	86	24	123	11	nm	nm	nm	Whitewater Ridge	Biface	Wind Creek
±	8	4	5	3	2	4	4				(Group 1)		(30 cm)
40	108	24	91	146	46	378	22	nm	nm	nm	Unknown Group 11	Flake	Wind Creek
±	9	4	5	4	3	7	4						(30 cm)
470	148	22	125	7	76	674	48	nm	nm	nm	Unknown Group 1	5	Wind Creek
±	8	4	5	3	3	9	4						(50 cm)
Site 162													
90	13	17	105	4	74	648	47	nm	nm	nm	Unknown Group 1	Flake	Wind Creek
±	7	4	5	8	2	7	4						(20 cm)
477	136	19	111	7	73	649	54	nm	nm	nm	Unknown Group 1	Flake	Wind Creek
±	8	4	5	3	3	8	4						
523	44	18	115	80	22	126	12	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	8	4	5	3	3	4	4						(10 cm)
611	41	17	118	86	25	127	12	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	9	4	5	3	2	4	4						(70 cm)
618	38	15	120	90	25	125	10	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	9	4	5	3	2	4	4						(70 cm)
634	47	17	72	46	29	103	11	nm	nm	nm	Unknown Group 2	Flake	Wind Creek
±	7	4	5	3	2	4	3						(30 cm)
690	108	18	102	10	73	283	29	nm	nm	nm	Unknown Group 9	2	Wind Creek
±	7	4	5	3	2	5	4						(60 cm)
726	46	17	111	85	24	126	10	nm	nm	nm	Whitewater Ridge	Flake	Wind Creek
±	7	4	5	3	2	4	4						(50cm)

Table 26 (continued)

Specimen #	Trace Element Concentrations									Obsidian Source	Projectile	
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Chemical Group	Point Type	Location
Rough Site													
1:6a	90	31	153	68	49	196	5	nm	nm	53	Quartz Mountain	Flake	Rough Site
±	7	4	5	3	2	5	3						
1:6b	54	21	94	113	30	150	4	nm	nm	nm	Unknown A	Point tip	Rough Site
±	8	4	5	4	2	5	3						
1:8	30	16	96	58	25	94	10	nm	nm	nm	Glass Butte	P. Point	Rough Site
±	6	3	4	3	2	5	3						
1:3a	100	19	118	10	62	466	26	nm	nm	nm	Unknown B	Flake	Rough Site
±	6	3	4	3	2	5	3						
2:3b	65	29	157	73	52	199	5	nm	nm	58	Quartz Mountain	Flake	Rough Site
±	9	5	5	4	3	5	4						
2:3c	88	22	164	70	45	196	8	nm	nm	57	Quartz Mountain	Flake	Rough Site
±	8	4	5	3	3	5	3						
2:3d	67	21	154	72	51	306	17	nm	nm	nm	Unknown C	Flake	Rough Site
±	7	4	5	3	2	5	3						
2:6	39	13	103	67	24	101	7	nm	nm	28	Unknown D	P. Point	Rough Site
±	6	4	4	3	2	5	3						
2:11a	52	22	130	100	25	136	9	nm	nm	47	Unknown E	Flake	Rough Site
±	6	3	4	3	2	5	3						
2:11b	89	26	153	69	47	188	8	nm	nm	56	Quartz Mountain	Flake	Rough Site
±	8	4	5	4	3	5	4						
2:12a	100	15	167	68	47	202	7	nm	nm	56	Quartz Mountain	Flake	Rough Site
±	9	6	5	4	3	5	4						
2:12b	53	17	129	97	27	146	8	nm	nm	52	Unknown E	Flake	Rough Site
±	6	3	4	3	2	5	3						
3:3a	63	23	126	56	39	175	7	nm	nm	56	Quartz Mountain	Flake	Rough Site
±	6	3	4	3	2	5	3						
3:3b	33	15	95	64	29	99	4	nm	nm	nm	Glass Butte	Flake	Rough Site
±	6	3	4	3	2	5	3						

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
	Trace Element Concentrations												
3:10	68	17	94	33	53	127	10	nm	nm	nm	Cougar Mountain	Biface	Rough Site
±	6	3	4	3	2	5	3						
Beaverdam Creek Site													
1	nm	nm	129	3	104	187	31	nm	nm	nm	Delintment Creek Unknown	Flake	35 CR-29
2	nm	nm	90	20	50	101	16	nm	nm	nm	Glass Buttes Unknown	Flake	35 CR-29
3	nm	nm	108	3	76	448	35	nm	nm	nm	Dog Hill	Flake	35 CR-29
4	nm	nm	126	57	28	118	14	nm	nm	nm	Whitwwater Ridge Unknown	Flake	35 CR-29
5	nm	nm	105	79	18	119	14	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
6	nm	nm	118	64	23	112	13	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
7	nm	nm	110	74	23	125	16	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
8	nm	nm	112	78	24	132	13	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
9	nm	nm	113	90	23	126	12	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
10	nm	nm	118	90	25	146	16	nm	nm	nm	Whitewater Ridge ? Unknown	Flake	35 CR-29
11	nm	nm	117	89	22	128	15	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
12	nm	nm	124	60	27	123	15	nm	nm	nm	Whitewater Ridge ? Unknown	Flake	35 CR-29
13	nm	nm	131	91	30	139	14	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
14	nm	nm	125	93	25	136	16	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29

Table 26 (continued)

Specimen #	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Ti*	MN*	Obsidian Source Chemical Group	Projectile Point Type	Location
15	nm	nm	128	25	45	252	26	nm	nm	nm	Burns Butte	Flake	35 CR-29
16	nm	nm	121	0	88	155	31	nm	nm	nm	Unknown 7 Unknown	Flake	35 CR-29
18	nm	nm	117	85	25	138	15	nm	nm	nm	Whitewater Ridge Unknown	Flake	35 CR-29
19	nm	nm	99	62	25	109	0	nm	nm	nm	Whitewater Ridge ? Unknown	Flake	35 CR-29
20	nm	nm	101	42	30	102	18	nm	nm	nm	Litle Bear Creek ? Unknown	Flake	35 CR-29
21	nm	nm	112	0	93	567	40	nm	nm	nm	Dog Hill	Flake	35 CR-29

* X-ray counting uncertainty and regression fitting error at 300 seconds livetime.[a] -Source categories are presented under the column heading "Obsidian Source Chemical Group". Richard Hughes' original source information is presented in parentheses, while Craig Skinner's reinterpertation of the Wind Creek and the Beaverdamn material contain no parentheses. If there are no categories are in parentheses, then this is Richard Hughes' original data; all trace elements in parts per million (ppm); $\pm$ = pooled estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 seconds livetime; mm = not measured.

[a] This material was compiled from previous analyses of obsidian from the Rough site (Flenniken et al. 1992), Beaverdam Creek site (Skinner 1993), and the current central Oregon projectile point study, and Wind Creek sites analyses

The results of Hughes' analysis indicated that of the 50 specimens examined, 4 remained unsourced and the remaining 46 were traced to 19 different obsidian sources. The sourcing of these artifacts was sucessful because Hughes had available extensive new comparitive data that he had recently collected from eastern Oregon. Many of the samples submitted were traced to obsidian sources east of Seneca, Oregon. Craig Skinner (1993) then reclassified the previously indeterminate samples from the Wind Creek sites as well as the samples taken from the Beaverdam Creek site and found that the geochemical composition of many of the previously unidentified samples were similar to the newly characterized sources east of Seneca, Oregon. (Figures 76, 77).

The results of the central Oregon upland source analysis identified 19 different sources. When combined with two previously defined sources for the central Oregon uplands a total of 21 sources is achieved. These sources are described in more detail in chapter V, and included Beatys Butte, Buck Spring, Burns Butte, Cougar Mountain, Delintment Creek, Dog Hill, Double "O", Glass Buttes, Horse Mountain, Juniper Spring, Little Bear Creek, McKay Butte, Newberry Volcano, Obsidian Cliffs, Potato Hills, Quartz Mountain, Riley, Sawmill Creek, Whitewater Ridge, Wolf Creek, and Yreka Butte.

Obsidian Hydration Rate

Obsidian hydration and source results from Beaverdam Creek, Wind Creek, and the Rough Site were utilized in an attempt to determine obsidian hydration rates for the sources of central Oregon obsidian. These results were then applied to the source and hydration results from the central Oregon upland surface survey projectile point collection.

The hydration data from the Wind Creek sites were compared with the depth below surface from which samples came (see Table 26), the source of the obsidian and the average radiocarbon

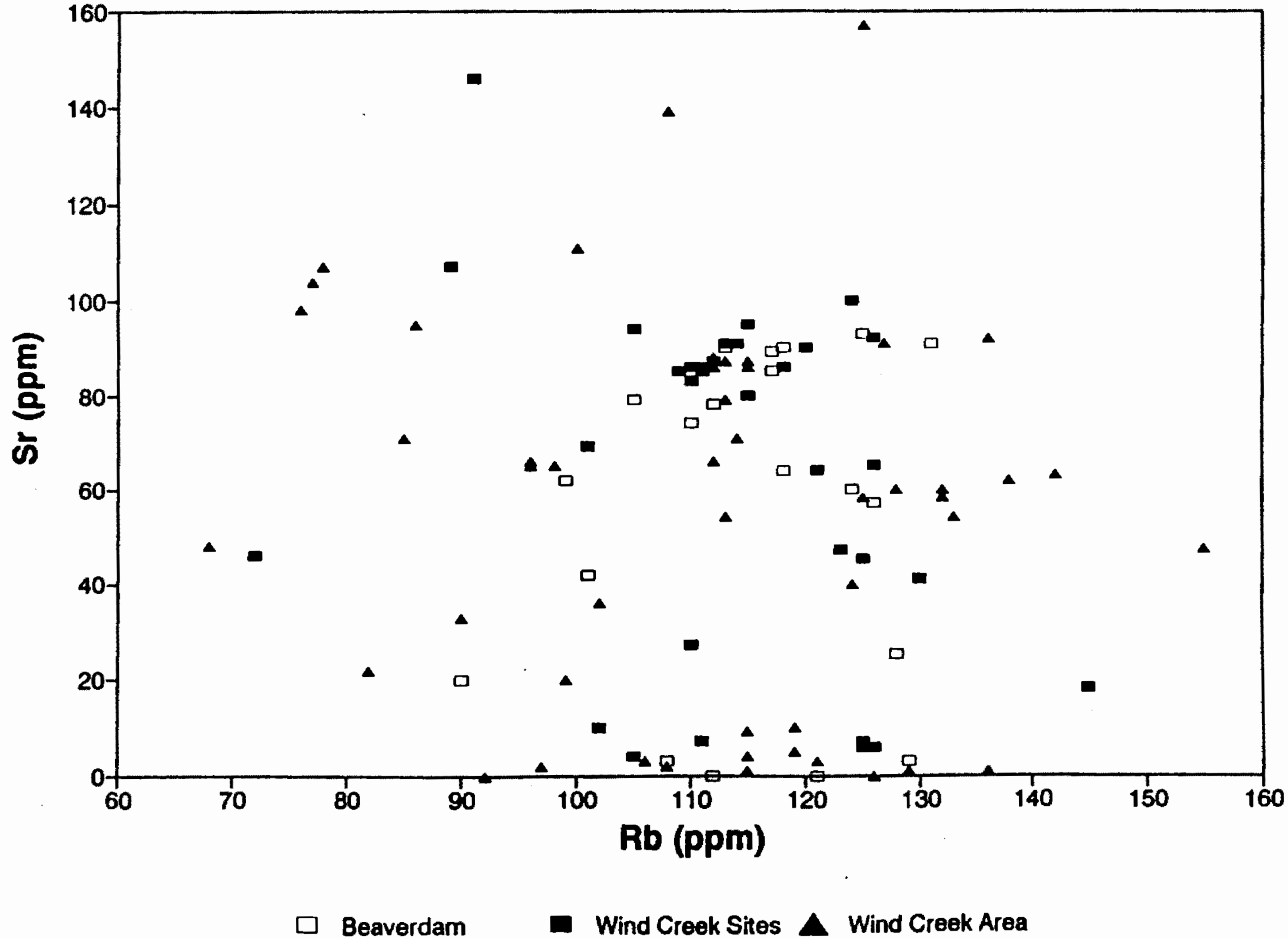


Figure 76. Sr and Rb amounts in obsidian samples from Beaverdam Creek, Wind Creek sites, and the central Oregon upland area (from Skinner 1993).

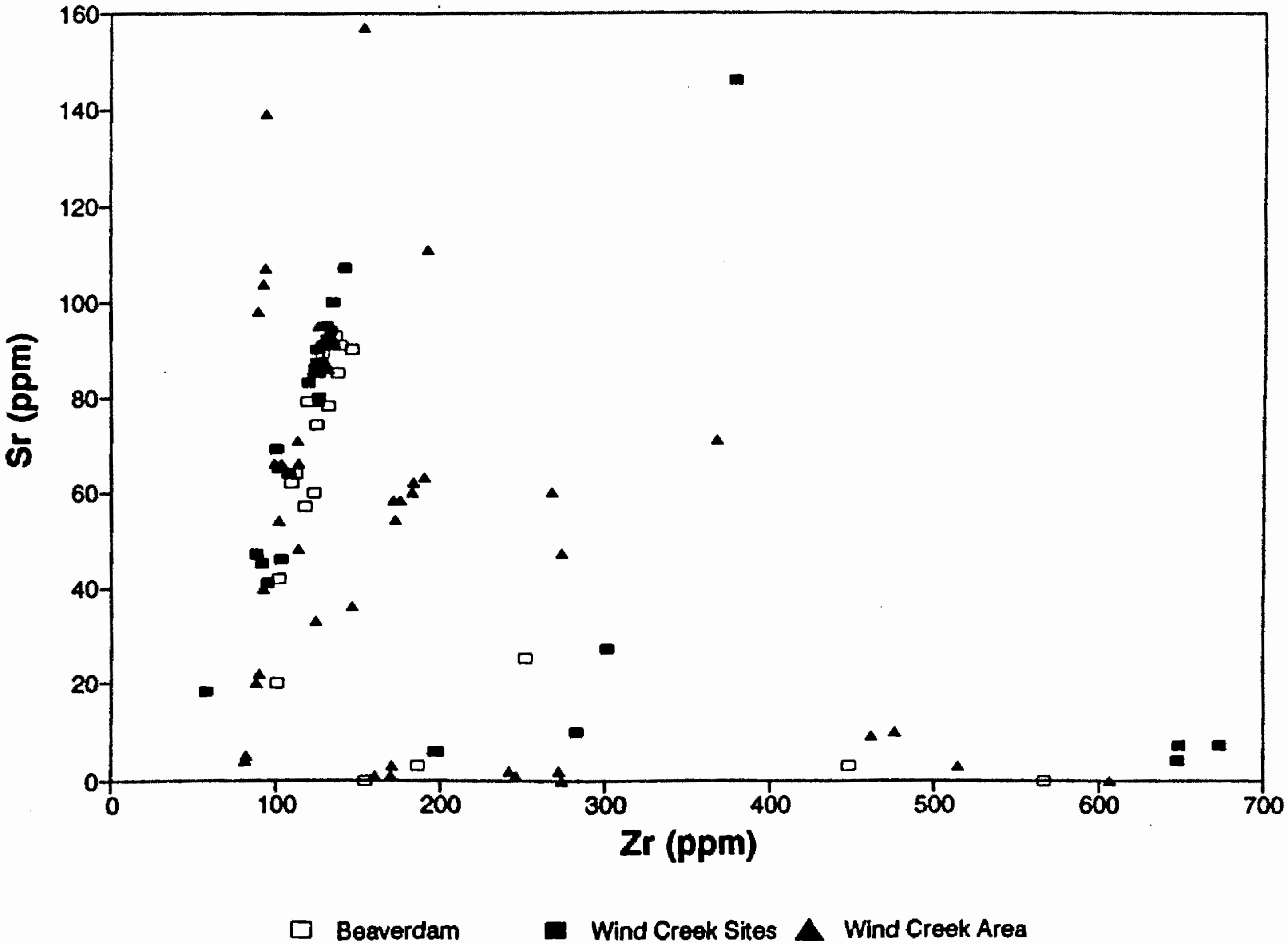


Figure 77. Sr and Zr amounts in obsidian samples from Beaverdam Creek, Wind Creek sites, and the central Oregon upland area (from Skinner 1993).

dates for the site components (see Figure 16). Of the 12 samples from the Wind Creek sites, 7 were from the White-water Ridge source, 4 were from unknown sources and 1 contained no measurable rim thickness. The average hydration constant for the Whitewater Ridge source was determined, in addition to the average for the Wind Creek sites. The constant was determined by squaring the sample rim thickness, dividing the result by the average radiocarbon date for the period in which the sample was found, and multiplying the result by 1000. The average hydration constant for the Whitewater Ridge source, using average radiocarbon dates from the Wind Creek Sites, was thus determined to be 2.98 microns^2/1000 years. The rim thickness of the samples ranged from 1.1 to 3.4, and the hydration constants from .605 to 5.78. A composite hydration constant, derived by using all sources at the Wind Creek sites, except Whitewater Ridge, was determined to be 3.18 microns^2/1000 years.

Conclusions

Obsidian sourcing and hydration studies in the central Oregon region are important to understanding the prehistory of the area. The close proximity of the studied central Oregon sites to obsidian sources, and the dominance of obsidian debitage and tools in central Oregon archaeological sites emphasizes this importance. Previous sourcing studies in central Oregon have been hampered by a large amount of unresearched obsidian sources, in addition to a lack of well stratified and radiocarbon dated archaeological sites from which obsidian hydration rate constants could be extrapolated.

Analysis of the obsidian from the Ochoco National Forest sites has identified 21 sources, with a large amount of the obsidian found in the upland sites coming from an area east of Seneca, Oregon. The hydration rates from the Wind Creek sites were analyzed and a hydration rate constant of 2.98 microns^2/1000 years was extrapolated for the Whitewater Ridge source and a composite rate of 3.18 microns^2/1000 years was extrapolated for the remaining Wind Creek sites sources.

APPENDIX D

ETHNOBOTANICAL AND CONSTANT VOLUME ANALYSIS

BY MANDY COLE

Ethnobotanical Analysis

Analysis of the ethnobotanical remains involved the floatation of constant volume samples. Inorganic and organic remains were seperated into the groups of charcoal, seeds, gravel, bone, lithics (flakes), and other organic debris (consisting of sticks and duff material). The constant volume samples were 10 cm. by 10 cm by 10 cm. each representing a 1% sample of each excavation unit. Analysis of the samples (Table 27) resulted in the identification of bone in site 35GR-162, and seeds from all four sites.

Site 35GR-147 contained seed samples in level 1 (Period 1). These included one uncharred Poa bulbosa L.(bluegrass), numerous Poa pratensis L.(kentucky bluegrass), five uncharred Montia linearis (Dougl.) Greene (narrow leafed Montia; Indian Lettace), two Polygonum sp.(Buck wheat; knot weed), and one each of charred Pinus sp. and Pinus Ponderosa Dougl.

Site 35GR-148 contained seed samples in level 4 (Period 1), and consisted of one charred seed fragment of Purshia tridentata (Pursh) DC.(antelope brush; bitter brush).

Site 35GR-159 contained seed samples in levels 2 and 3 (Periodds 1 and ll). In level 2 the samples consisted of 2 charred Pinus sp., and one uncharred Polgonaceae (buck wheat; knot weed). Level 3 contained one uncharred Pinus sp.

Site 35GR-162 contained seed samples in levels 1 and 3 (Periods 1 and ll). Period 1 contained thirty six seeds consisting of 2 uncharred Pinus ponderosa Dougl., one uncharred seed belonging to the Cruciferae family (mustard family), one uncharred seed belonging to the species Collinsia (figwort), and thirty two dried uncharred seeds belonging to the species Polygonum.

Table 27. Constant Volume Summary[a]

Site #	BO	CH	GV	LI	Ot[b]	Seeds
162						
1	(8).-23gms		81.20gms	(4)-.24gms	72.32gms	2-Pinus ponderosa Dougl. uncharred seed frg. 1 cruciferae family uncharred seed frg. 1 Collinsia sp.uncharred 32 Polygonum sp. dried uncharred
2	(1).-04gms	traces	168.40gms	(7)-.42gms	19.90gms	
3	(5)-.12gms	.23gms	221.10gms	(5)-.23gms	14.95gms	1-Bromus sterilis L. dried uncharred 1 Polygonum sp. uncharred
4			63.98gms	(5)-.13gms	10.18gms	
5	(4)-.19gms	.35gms	289.50gms	(21)-4.03gms	16.38gms	
6	(5)-.09gms	.01gms	316.40gms	(17)-1.57gms	13.32gms	
7	(1)-.01gms	.17gms	305.20gms	(10)-11.17gms		
148						
2		1.02gms	11.50gms	(3)-.12gms	3.01gms	
3		traces	12.50gms	(2)-.32gms	4.39gms	
4		traces	7.90gms	(1)-.01gms	7.01gms	1-cf Purshia tridentata (Pursh)DC. charred seed frg.
5		.42gms	11.65gms	(4)- .19gms	9.80gms	
6		traces	8.20gms	(11)-.01gms		
159						
1		.39gms	261.3gms	(10)-.43gms		
2		traces	228.60gms	(17)-.63gms	21.60gms	3-cf Pinus sp. charred seed frg. 1-Polgonaceae Family uncharred
3		traces	133.30gms	(11)-.45gms	6.80gms	1 Pinus sp.charred seed frg.
4			324.90gms	(1)- .30gms	.53gms	

Table 27. (Continued)

Site #	BO	CH	GV	LI	Ot[b]	Seeds
147						
1		12gms	137.90gms	(4)-.96gms	20.50gms	1-*Poa bulbosa* L. uncharred numerous-*Poa pratensis* L. uncharred 5-Montia linearis (Dougl.) Greene appear uncharred 2 *Polygonum* sp. 1 *Pinus* sp. charred 1 *Pinus ponderosa* Dougl. charred seed
2			167.30gms	(4)-71gms	9.01gms	
3		traces	218.20 gms	(7)-.05gms	14.70gms	
		.22gms	300.40gms	(8)-1.57gms	.55gms	
			594.20gms	traces		

a-10 cm cubes used as sample sizes. b-this included sticks and duff material
BO-bone, GV-gravel, Li-flakes, Ot-other

Period ll contained two seeds, one dried uncharred of Bromus sterilis (brome grass), and one uncharred dried of the species Polygonum.

Period l may be summarized as containing Poa bulbosa (grass), numerous Poa pratensis (grass), Montia Linearis (herb), Polygonum (buck wheat), Pinus sp.(pine tree), Pinus ponderosa dougl.(pine tree), Purshia tridentata (bitter brush), Cruciferae (herb), and Collinsia (herb). Period ll contained Pinus sp.(pine tree), Bromus sterilis (grass), and Polygonum. Nine plants types are represented in Period l and three in Period ll.

While it is highly likely that the majority of the seed samples are intrusive, many of the seeds represented in the sample are edible and ethnographic data referrs to Native American usage. Of the seeds found in the constant volume samples all the grasses are intrusive (introduced from Europe). Pinus ponderosa Dougl. (bull pine) is an edible plant. The cambium layer of this pine which was eaten raw formed an important food. Sap scrappers were made from deer ribs, and the nuts were gathererd in the fall but not stored for winter (Ray 1932:103-105). The seeds of the pine were eaten raw or crushed and made into bread (Dickson 79: 1940). The Thompson Indians (British Columbia) used the gum of the pine, mixed with grease as an eye salve for inflamed eyes (Moerman 158: 1982). Also the pinyon needles were used as basketry material, and the pine pitch served as an adhessive (Bean and Saubel 104-105: 1972).

Some limited ethnographic references are made to Purshia tridentata. Balls (1972:40) states that the local Ephedra was used with antelope brush and Weeden (1975:175) states that the seeds are bitter. Other mentions of the uses of bitter brush are limited to ceremnoial usages. Murphey (1959:90) states it was burned with juniper "in times of epidemic to drive away the devil", and that cooked ripe seeds males a violet dye. Montia linearis is a herb refered to as Indian Lettace. The leaves were eaten raw, or steamed for greens. Cruciferae (Mahar 74:1954) belongs to the mustard family and the seeds are edible. This again is a herb. Collinsia belongs to the figwort family and is an edible herb (Mahar 109:1954). Finally Polygonum is an important edible plant. At maturity the seeds are enclosed in a dry "hull". The seeds are gathered and rubbed by hand, with the seeds parched and ground. The meal is either eaten dry or mixed boiled with water which turns the product to red (Colville 1985; Dicksen 1946). It is possible that the red staining on some of the ground stone may have been a result of the use of grinding the boiled meal. While the sample of seeds is small, the majority of seeds are edible and could have been utilized by the inhabitants of the Wind Creek sites. There are no archaeological studies to which this data may be compared, and this represents a first attempt to understand the ethnobotany from the central Oregon region.

APPENDIX E

GRAIN SIZE AND SOIL ANALYSIS FROM THE WIND CREEK PROJECT

BY GRADY CAULK

GRAIN SIZE ANALYSIS

Procedures

The soil samples were mechanically shaken for ten minutes through a series of progressively smaller screens ranging in size from -3 to 4 phi. The separated size components were then weighed using an analytical balance. Moist samples were first dried in a low temperature oven then screened. Consolidated samples were screened, lightly crushed within each size class and rescreened prior to weighing. In samples containing significant amount of silts and clays (20 to 30% and over 15g.), a hydrometer silt-clay size analysis was conducted. Cumulative weights and percentages were calculated and plotted on a graph against the size in phi units (similar to the combined size-cumulative weight percentage graphs from each unit). From these graphs Folk and Ward (1956) statistical parameters were taken for the phi size at 5, 16, 25, 50, 75, 84, and 95 percent. The parameters were used to determine the mean grain size, degree of sorting, symmetry or skewness, and kurtosis or peakedness of the distribution.

Colors were determined, by comparison, to a Munsell Soil Color charts. The samples were moistened for the wet color readings and for the pH test using distilled water. The pH readings were made using a very wide pH test paper. This with the length of time out of ground and the drying and rewetting may have lead to the consistent low acidic measurement.

Graphs of the diameter-cumulative weight percent for each unit show very close inter-unit grain size consistency, especially in units 35GR-148 1,2,3, 35GR-159 1,2, and 35GR- 162 1. The deviation of level 11 in unit 35GR-148, may be due to the sample being taken from decomposing bedrock.

Description

Site 35 GR-147

Unit 1

level 1

Color: dry, 10YR5/3 brown; wet, 10YR/2 very dark brown; pH 5. Very poorly sorted silty sand, having a symetrical, normal distribution. Consisting of 8.4% gravel, 70% sand, and 21.6% silt and clay, with a mean grain size of 2.2 phi.

level 2

Color: dry, 10YR6/3 pale brown;wet, 10YR3/3 dark brown; pH 5. Very poorly sorted silty sand, having a normal symmetrical distribution. Consisting of 9.6% gravel, 69.3% sand, and 21.1% silt and clay, with a mean grain size of 2.1 phi.

level 3

Color: dry, 10R6/3 pale brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted silty sand, having a very coarsely skewed, platykurtic distribution. Consisting of 12.1% gravel, 67.1% sand, and 20.8% silt and clay, with a mean grain size of 2.6 phi.

level 4

Color: dry, 10YR6/3 pale brown; wet, 10YR4/3 brown to dark brown; ph 5. Extremely poorly sorted silty sand, having a coarsely skewed, leptorkurtic distribution . Consisting of 9.3% gravel, 69.7% sand, and 21% silt and clay , with a mean grain size of .83 phi.

level 5

Color: dry, 10YR5/4 yellow brown; wet, 10R3/4 dark yellowish brown; pH 5. Very poorly sorted gravely sand, having a very coarsely skewed, normal distribution. Consisting of 23% gravel, 67.8% sand, and 9.2% silt and clay, with a mean grain size of .63 phi.

level 6

Color: dry, 10YR5/4 yellowish brown; wet, 10YR3/4 dark yellowish brown; pH 5. Very poorly sorted gravely sand, having a symmetrical leptokurtic distribution. Consisting of 22.6% gravel, 68.2% sand, and 9.2% silt and clay, with a mean grain size of .65 phi.

level 7

Color: dry, 10YR5/4 yellowish brown ; wet, 10YR3/4 yellowish brown; pH 5. Extremely poorly sorted sandy gravel, having a very coarsely skewed, platykurtic distribution. Consisting of 55.7% gravel, 40.9% sand, and 3.6% silt and clay, with a mean grain size of -1.5 phi.

Site 35 GR-147

Unit 2

level 1

Color: dry, 10YR4/3 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted silty sand, having a symetrical platykurtic distribution. Consisting of 5.7% gravel, 78.6% sand, and 21.4% silt and clay, with a mean grain size of 2.3 phi.

level 2

Color: dry, 10YR5/3 brown;wet,10YR3/3 dark brown; pH 5. Poorly sorted silty sand, having a finely skewed, normal distribution. Consisting of 1.7% gravel, 75.6% sand, and 22.7% silt and clay, with a mean grain size of 2.4 phi.

level 3

Color: dry, 10YR6/3 pale brown; wet, 10YR3/4 dark yellowish brown; pH 5. Very poorly sorted sand, having a finely skewed, normal distribution. Consisting of 9.4% gravel, 71.1% sand, and 19.5% silt and clay, with a mean grain size of 1.9 phi.

level 4

Color: dry, 10YR6/3 pale brown; wet, 10YR3/3 dark brown; pH 5. Poorly sorted silty sand, having a coarsely skewed, normal distribution. Consisting of 7.4% gravel, 71.5% sand, and 21.1% silt and clay, with a mean grain size of 2.6 phi.

level 5

Color: dry, 10YR6/3 pale brown; wet, 10YR3/4 dark yellowish brown; pH 5. Poorly sorted sandy gravel, having a finely skewed, platykurtic distribution. Consisting of 45.8% gravel, 43% sand, and 11.2% silt and clay, with a mean grain size of .15 phi.

level 6

Color: dry, 10YR6/4 light yellowish brown; wet, 10YR3/4 dark yellowish brown; pH 5. Poorly sorted gravely sand, having a finely skewed, normal distribution. Consistinng of 35.2% gravel, 60.4% sand, and 4.4% silt and clay, with a mean grain size of .03 phi.

Site 35GR-147

Unit 3

level 1

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; pH 5. Extremely poorly sorted gravely sand, having a coarsely skewed, extremely leptokurtic distribution. Consisting of 25.9% gravel, 70.8% sand, and 3.3% silt and clay with a mean grain size of -4 phi.

level 2

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; Ph 5. Poorly sorted sand, having a very finely skewed, normal distribution. Consisting of 4.9% gravel, 88.7% sand, and 6.4 silt and clay, with a mean grain size of .9 phi.

level 3

Color: dry, 7.5YR5/4 brown: wet, 7.5YR3/4 dark brown; Ph 5. Poorly sorted sand, having a symmetrical platykurtic distribution. Consisting of 4.4% gravel, 89.7% sand, and 5.9% silt and clay with a mean grain size of 1.5 phi.

Site 35GR-148

Unit 1

level 1

Color: dry, 10YR3/4 dark yellowish brown: wet, 10YR2/2 very dark brown; pH 5. Poorly sorted sand, having a coarsely skewed, normal distribution. Consisting of 8.1% gravel, 81.4% sand, and 10.5% silt and clay, with a mean grain size of 1.8 phi.

level 2

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Poorly sorted sand, having a coarsely skewed, normal distribution. Consisting of 10.1% gravel, 77.3% sand, and 12.6% silt and clay, with a mean grain size of 1.8 phi.

level 3

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted sand, having a coarsely skewed platykurtic distribution. Consisting of 10.4% gravel, 74.9% sand, and 14.7% silt and clay, with a mean grain size of 1.8 phi.

level 4

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR3/4 dark yellowish brown; pH 5. Very poorly sorted sand, having a coarsely skewed, normal distribution. Consisting of 9.9% gravel, 74.5% sand, and 15.6% silt and clay, with a mean grain size of 1.9 phi.

Level 5

Color: dry, 7.5YR3/4 dark brown, 10YR3/4 dark yellowish brown; pH 5. Poorly sorted gravely sand, having a coarsely skewed, normal distribution. Consisting of 13.7% gravel, 78.8% sand, and 7.5% silt and clay, with a mean grain size of 1.4 phi.

Site 35GR-148

Unit 2

level 1

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical, normal distribution. Consisting of .3% gravel, 93.7% sand, and 6.0% silt and clay, with a mean grain size of 2.7 phi.

level 2

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical, very leptokurtic distribution. Consisting of 96.3% sand, and 3.7% silt and clay, with a mean grain size of 2.5 phi.

level 3

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical, normal distribution. Consisting of 93.4% sand, and 6.6% silt and clay, with a mean grain size of 2.8 phi.

level 4

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a finely skewed leptokurtic distribution. Consisting of 92.1% sand, and 7.9% siltand clay, with a mean grain size of 2.8 phi.

level 5

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 darl grayish brown; pH 5. Moderately well sorted sand, having a finely skewed, very leptokurtic distribution. Consisting of 93.9% sand, and 6.1% silt and clay, with a mean grain size of 2.7 phi.

level 6

Color; dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sasnd, having a finely skewed, leptokurtic distribution. Consisting of 95.1% sand, and 4.9% silt and clay, with a mean grain size of 2.7 phi.

level 7

Color: dry, 10YR 6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical leptokurtic distribution. Consisting of 96.5% sand, and 3.5% silt and clay, with a mean grain size of 2.5 phi.

level 8

Color: dry, 10YR6/2 light brownish gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a finely skewed, leptokurtic distribution. Consisting of 96.8% sand, and 3.2% silt and clay, with a mean grain size of 2.6 phi.

level 9

Color: dry, 10YR6/2 light brownish gray; wet, 10YR3/2 very dark grayish brown; pH 5. Moderately well sorted sand, having a finely skewed normal distribution. Consisting of 97.5% sand, and 2.5% silt and clay, with a mean grain size of 2.3 phi.

level 10

Color: dry, 10YR8/1 white; wet, 10YR4/2 dark grayish brown: pH 5. Moderately well sorted sand, having a finely skewed, normal distribution. Consisting of 97.7% sand, and 2.3% silt and clay, with a mean grain size of 2.6 phi.

level 11

Color: dry, 10YR8/1 white; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical, very leptokurtic distribution. Consisting of 99.2% sand, and .8% silt and clay, with a mean grain size of 3.3 phi.

level 12

Color: dry, 10YR8/2 white; wet, 10YR6/3 pale brown; pH 5. Moderately well sorted sand , having a symmetrical, leptokurtic distribution. Consisting of 97.4% sand, and 2.5% silt and clay, with a mean grain size of 2.5 phi.

Site 35GR-148

Unit 3

level 1

Color: dry, 10YR5/2 grayish brown; wet, 10YR2/2 very dark brown; pH 5. Moderately sorted sand, having a finely skewed, normal distribution. Consisting of .8% gravel, 83.2% sand, and 16% silt and clay, with a mean grain size of 3 phi.

level 2

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; pH 5. Moderately sorted sand, having a finely skewed, leptokurtic distribution. Consisting of 1.4% gravel, 89.4% sand, and 9.2% silt and clay, with a mean grain size of 2.7 phi.

level 3

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; pH 5. Moderately well sorted sand, having a finely skeweed, very platykurtic distribution. Consisting of 91.5% sand, and 8.5% silt and clay, with a mean grain size of 2.6 phi.

level 4

Color: dry, 10YR5/3 brown : wet, 10YR2/2 very dark brown; pH 5. moderately sorted sand, having a symmetrical, leptokurtic distribution. Consisting of .7% gravel, 91.9% sand, and 7.4% silt and clay, with a mean grain size of 2.6 phi.

level 5

Color: dry, 10YR5/2 grayish brown: wet, 10YR3/2 very dark grayish brown; pH 5. Moderately sorted sand, having a symmetrical, leptokurtic distribution. Consisting of .7% gravel, 92.4% sand, and 6.9% silt and clay, with a mean grain size of 2.6 phi.

level 6

Color: dry, 10YR6/2 light grayish brown; wet, 10YR3/2 very dark grayish brown; pH 5. Moderately sorted sand, having a finely skewed, leptokurtic distribution. Consisting of 1.6% gravel, 92.2% sand, and 6.2% silt and clay, with a mean grain size of 2.5 phi.

level 7

Color: dry, 10YR6/2 light grayish brown; wet, 10YR3/2 very dark grayish brown; pH.5. Moderately sorted sand, having a symmetrical, normal distribution. Consisting of 92.1% sand, and 7.9% silt and clay, with a mean grain size of 2.9 phi.

level 8

Color: dry, 10YR6/2 light grayish brown; wet, 10YR3/2 very dark grayish brown; pH 5. Moderately well sorted sand, having a finely skewed leptokurtic distribution. Consisting of .3% gravel, 94.8% sand, and 4.9% silt and clay, with a mean grain size of 2.5 phi.

level 9

Color: dry, 10YR 7/2 light gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately well sorted sand, having a symmetrical, leptokurtic distribution. Consisting of .4% gravel, 94.4% sand, and 5.2% silt and clay, with a mean grain size of 2.5 phi.

level 10

Color: dry, 10YR7/2 light gray; wet, 10YR4/2 dark grayish brown; pH 5. Moderately sorted sand, having a symmetrical, leptokurtic distribution. Consisting of .4% gravel, 92.8% sand, and 6.8% silt and clay, with a mean grain size of 2.5 phi.

level 11

Color: dry, 10YR6/4 light yellowish brown; wet, 10YR3/4 dark yellowish brown; pH 5. Very poorly sorted silty sand, having a coarsely skewed, platykurtic distribution. Consisting of 10.4% gravel, 68.3% sand, and 21.3% silt and clay, with a mean grain size of 2.3 phi.

Site 35GR-159

Unit 1

level 1

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown, pH 5. Extremely poorly sorted silty sand, having a finely skewed, very leptokurtic distribution. Consisting of 9.4% gravel, 65.5% sand, 15.8% silt, and 7.3% clay, with a mean grain size of 2.8 phi.

level 2

Color: dry, 7.5YR 4/4 brown to dark brown; wet 10YR2/2 very dark brown, pH 5. Extremely poorly sorted silty sand, having a finely skewed, very leptokurtic distribution. Consisting of 6.8% gravel, 74.8% sand, and 18.4% silt and clay, with a mean grain size of 2.8 phi.

level 3

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown, pH 5. Extremely poorly sorted silty sand, having a finely skewed, very leptokurtic distribution. Consisting of 11.4% gravel, 64.7% sand, 14.9% silt, and 9% clay, with a mean grain size of 3.1 phi.

level 4.

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown, pH 5. Extremely poorly sorted silty sand, having a finely skeewed, very leptokurtic distribution. Consisting of 6.8% gravel, 69.9% sand, 15.3% silt, and 8% clay with a mean grain size of 2.9 phi.

level 5

Color: dry, 7.5YR4/4 brown to dark brown; wet 10YR2/2 very dark brown, pH 5. Very poorly sorted sand, having a coarsely skewed, leptokurtic distribution. Consistinng of 6.2% gravel, 82.4% sand, and 11.4% silt and clay, with a mean grain size of 1.9 phi.

Site 35GR-159

<u>Unit 2</u>

level 1

Color: dry, 7.5YR4/4 brown to dark brown; wet, 10YR2/2 very dark brown, pH 5. Very poorly sorted silty sand, having a finely skewed, normal distribution. Consisting of 1.6% gravel, 63.3% sand, 30.4% silt, and 6.3% clay, with a mean grain size of 3.4 phi.

level 2

Color: dry, 7.5YR5/4 brown; wet, 7.5YR3/4 dark brown, pH 5. Very poorly sorted sand, having a finely skewed, normal distribution. Consisting of 8.1% gravel, 67.9% sand, and 16.8% silt and clay, with a mean grain size of 1.8 phi.

level 3

Color: dry, 7.5YR5/4 brown; wet, 7.5YR3/4 dark brown, pH 5. Extremely poorly sorted silty sand, having a finely skewed, normal distribution,. Consisting of 5.5 gravel, 58.1% sand, 30.3% silt, and 6% clay, with a mean grain size of 3.2 phi.

level 4

Color: dry, 7.5YR5/4 brown; wet, 7.5YR3/4 dark brown, pH 5. Very poorly sorted silty sand, having a coarsely skewed, normal distribution. Consisting of 6.6% gravel, 70.8% sand, and 23.3% silt and clay, with a mean grain size of 2.4 phi.

level 5

Color: dry, 7.5YR5/4 brown; wet, 7.5YR3/4 dark brown, pH 5. Very poorly sorted silty sand, having a very finely skewed, normal distribution. Consisting of 3.0% gravel, 75.7% sand, and 21.3% silt and clay, with a mean grain size of 2.3 phi.

level 6

Color: dry, 7.5YR5/4 brown; wet, 7.5YR3/4 dark brown, pH 5. Very poorly sorted silty sand, having a coarsely skewed, leptokurtic distribution. Consisting of 8.2% gravel, 69.9% sand, and 21.9% silt and clay, with a mean grain size of 2.5 phi.

Site 35GR-162

Unit 1

level 1

Color: dry, 10YR4/3 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted silty sand, having a symmetrical, normal distribution. Consisting of 3.9% gravel, 64.4% sand, 29.4% silt, and 2.3% clay, with a mean grain size of 2.9 phi.

level 2

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted silty sand, having a symmetrical, normal distribution. Consisting of 4.2% gravel, 61.8% sand, 30.5% silt, and 3.5% clay, with a mean grain size of 3.0 phi.

level 3

Color: dry, 10YR5/3 brown; wet, 10YR2/2 very dark brown; pH 5. Poorly sorted silty sand, having a symmetrical leptokurtic distrribution. Consisting of .1% gravel, 71.3% sand, and 28.6% silt and clay, with a mmean grain size of 3.0 phi.

level 4

Color: dry, 10YR4/3 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Poorly sorted sand, having a finely skewed, very platykurtic distribution. Consisting of 5.5% gravel, 74.5% sand, and 19.8% silt and clay, with a mean grain size of 2.4 phi.

level 5

Color: dry, 10YR4/3 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Poorly sorted sand, having a symmetrical, leptokurtic distribution. Consisting of 4.6% gravel, 76.9% sand, and 18.5% silt and clay, with a mean grain size of 2.4 phi.

level 6

Color: dry, 10YR 4/3 brown to dark brown; wet, 10YR2/2 very dark brown; pH 5. Very poorly sorted silty sand, having a symmetrical leptokurtic distribution. Consisting of 5.7% gravel, 72.3% sand, and 22.0% silt and clay, with a mean grain size of 2.5 phi.

level 7

Color: dry, 10YR5/4 yellowish brown; wet, 10YR3/4 dark yellowish brown; pH 5. Very poorly sorted sand, having a symmetrical distribution. Consisting of 3.9% gravel, 76.6% sand, and 19.5% silt and clay, with a mean grain size of 2.1 phi.

Site 35GR-162

Unit 2

level 1

Color: dry, 7.5 YR4/4 brown to dark brown; wet, 7.5 YR3/4 dark brown; pH 5. Very poorly sorted silty sand, having a symmetrical, normal distribution. Consisting of 3.1% gravel, 62.8% sand, and 34.1% silt and clay, with a mean grain size of 3.2 phi.

level 2

Color: dry, 7.5YR4/4 brown to dark brown; wet, 7.5YR3/4 dark brown; pH 5. Poorly sorted silty sand, having a symmetrical, normal distribution. Consisting of 7.5% gravel, 70.9% sand, and 21.6% silt and clay, with a mean grain size of 2.5 phi.

level 3

Color: dry, 7.5YR4/4 brown to dark brown; wet, 7.5YR3/4 dark brown; pH 5. Poorly sorted silty sand, having a symmetrical normal distribution. Consisting of 3.0% gravel, 76.5% sand, and 20.5% silt and clay, with a mean grain size of 2.4 phi.

Conclusions

The analysis of the soils from the four Wind Creek sites indicate that three types of soil were found. The first category consists of the soils found at 35GR-148. The soils here consisted of gravelly to non gravelly sandy and silt loams on the surface increasing in clay and clay loams as depth below ground surface increased.

The second category of soils consisted of soils found at 35GR-147. Surface soils were silt and clay loams, increasing in clay as depth below ground surface increased.

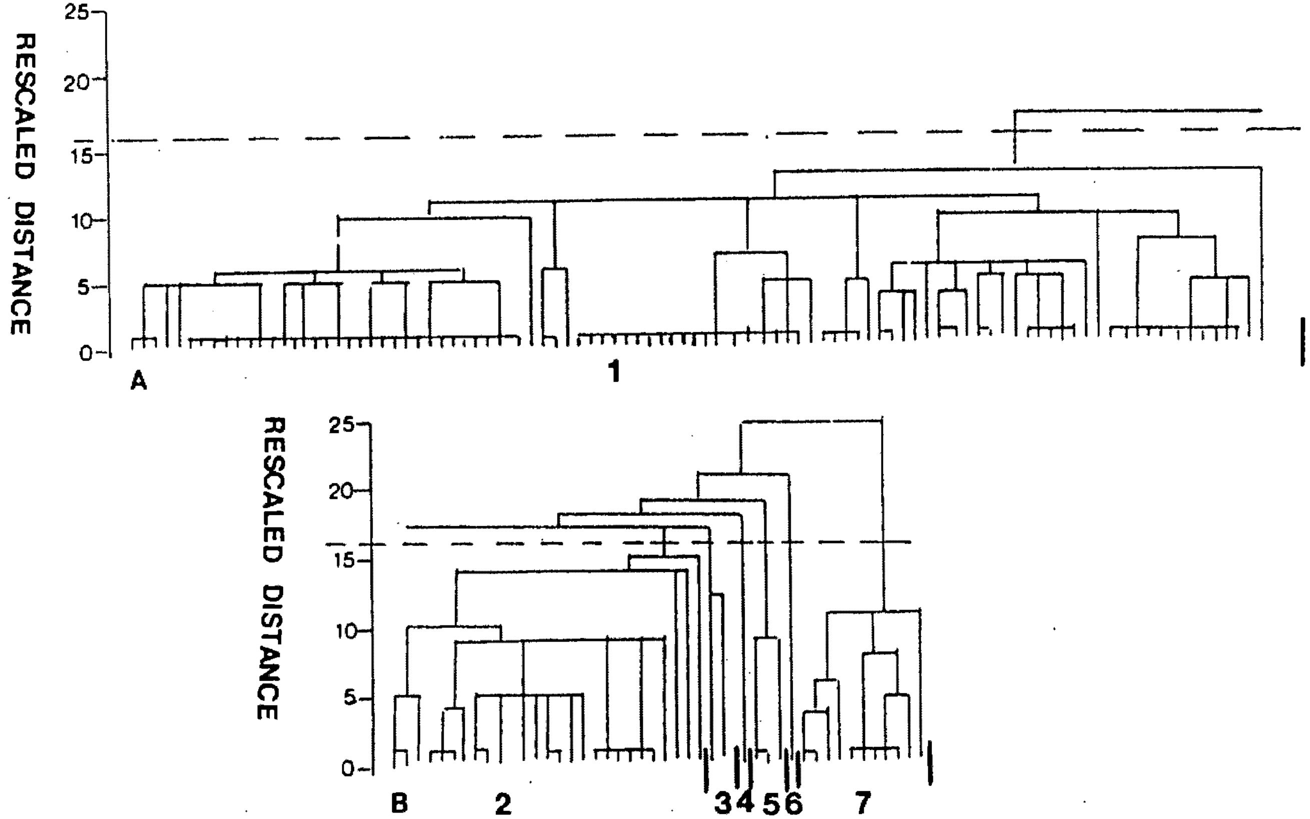
The third category of soils was found at 35GR-159, and 162. Surface soils here consisted of non gravely to gravelly clay loams and clays increasing with clay as the depth below the ground surface increased. The soils at the Wind Creek sites show close inter-unit grain size consistency. They generally may be divided into three vertical layers consisting of a duff layer, a broad middle layer with increasing clay and gravel, and a moderately thick lower level that contains high amounts of clay or gravel.

APPENDIX F

CLUSTER ANALYSES OF SITE DISTANCES

Site Clusters

Appendix F contains the results of the cluster analyses performed on site distances from each other. Distance measurements between archaeological sites were computed for each Ochoco National Forest district. These measurements were based upon township, range and section data, thus the smallest unit of measurement used for recording distance was a 640 acre section(one square mile). Using this scale of measurement does not yield specific distributions of sites, but rather a general picture of the placement of sites across a large area. The distance measurements were compiled into a matrix format and each district was clustered using a squared Euclidean measurement, and single linkage (nearest neighbor technique). The only exception to this was the Snow Mountain district which contained a large number of sites, so a within average linkage methiod was used.

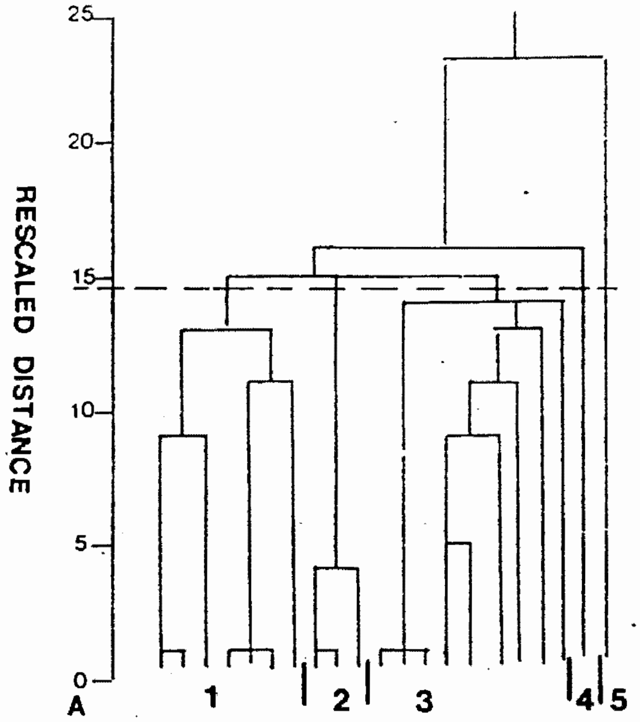


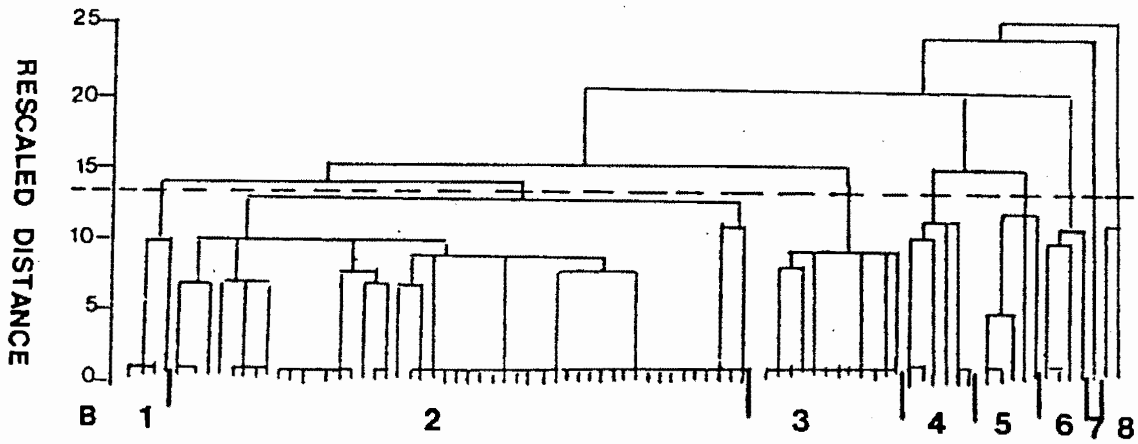
Cluster Analysis of Site Distances (District 1: Big Summit) using a Euclidean method and single linkage measure. The numbers refer to the resulting clusters. The cluster analysis reads from left to right with parts A and B attached.

Cluster Analysis of Site Distances (District 2: Paulina), using a Euclidean method, and an single linkage method. The dendrogram reads from left to right with parts A and B attached. The numbers refer to the resulting clusters.

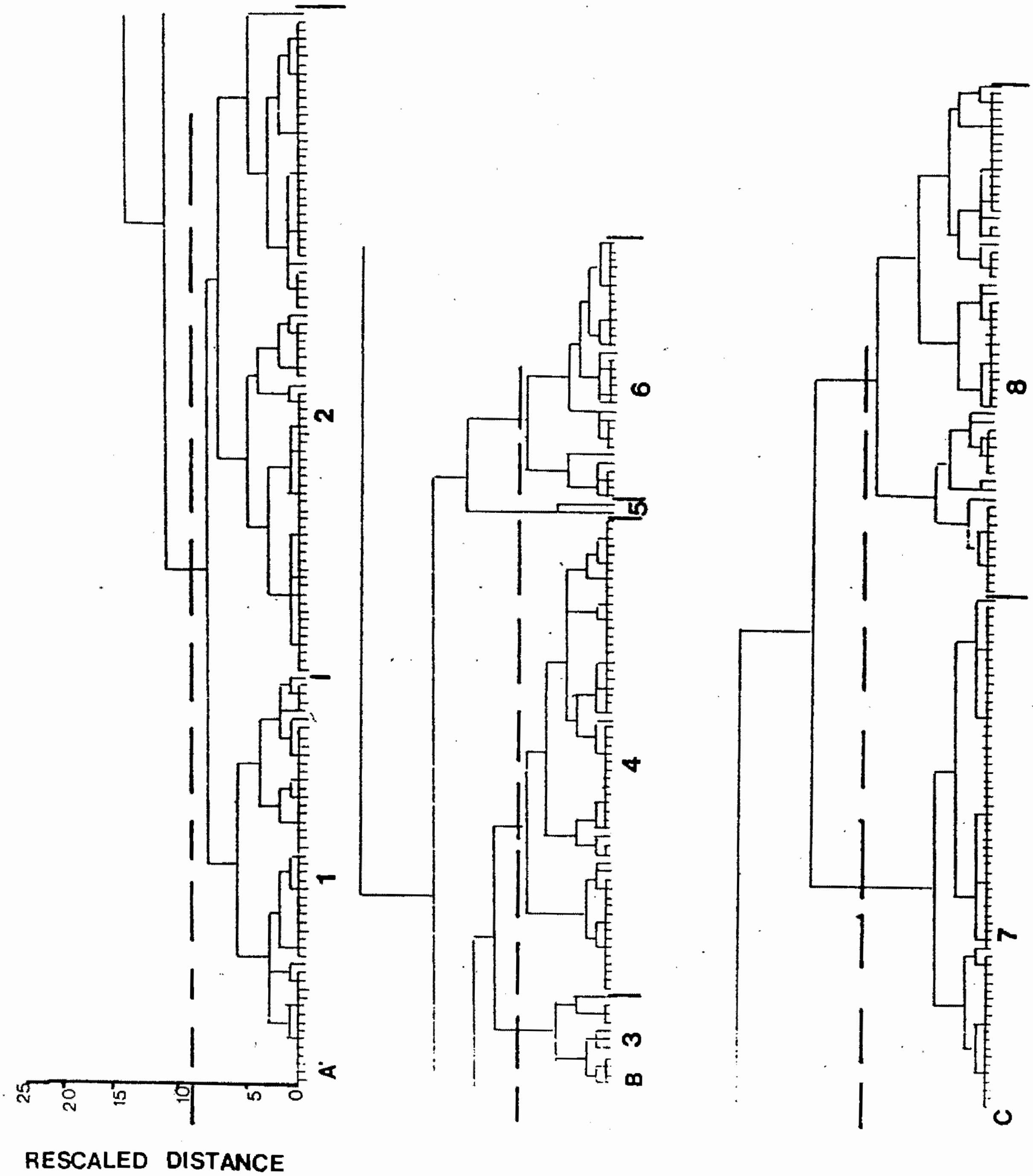

A
1
RESCALED DISTANCE
25
20
15
10
5
0
B
2
3
4
5
6
7
8
9
10
RESCALED DISTANCE
25
20
15
10
5
0

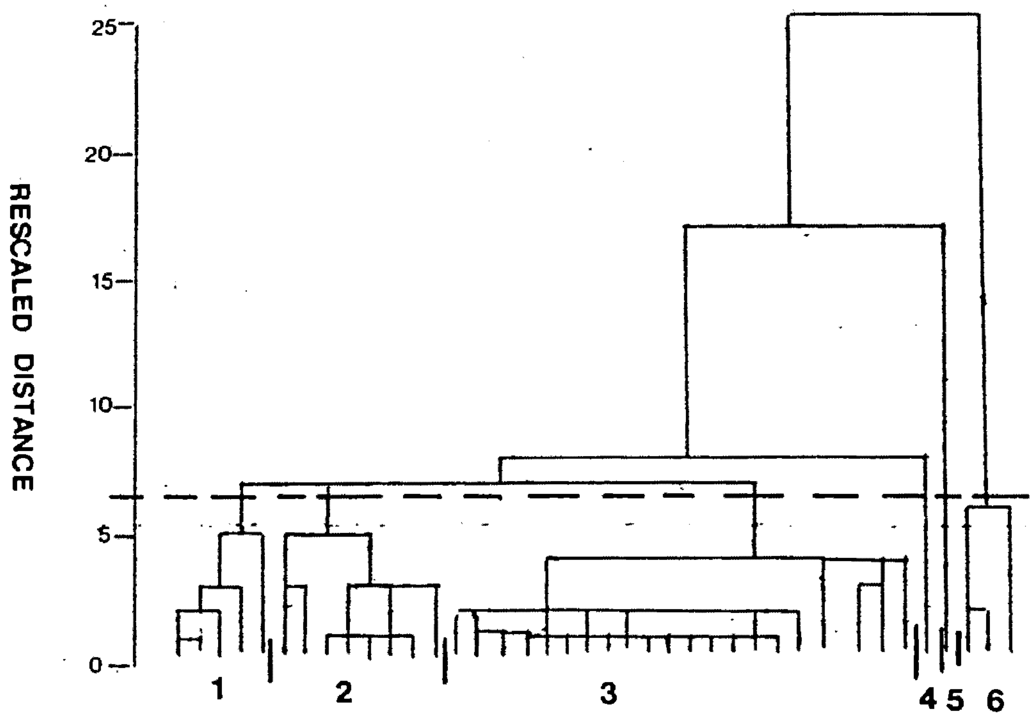
Cluster Analysis of Site Distances (District 3: Prineville), using a Euclidean method, and a single linkage method. The dendrogram reads from left to right with part A a cluster analysis of the north half of the Prineville district, and B the southern half . The numbers refer to the resulting clusters.


RESCALED DISTANCE
25
20
15
10
5
0
A
1
2
3
4
5


RESCALED DISTANCE
25
20
15
10
5
0
B
1
2
3
4
5
6
7
8

Cluster Analysis of Site Distances (District 4: Snow Mountain), using a Euclidean method, and an average within group linkage method. The dendrogram reads from left to right with parts A,B, and C attached. The numbers refer to the resulting clusters.


25
20
15
10
5
0
A
1
2
B
3
4
5
6
C
7
8
RESCALED DISTANCE



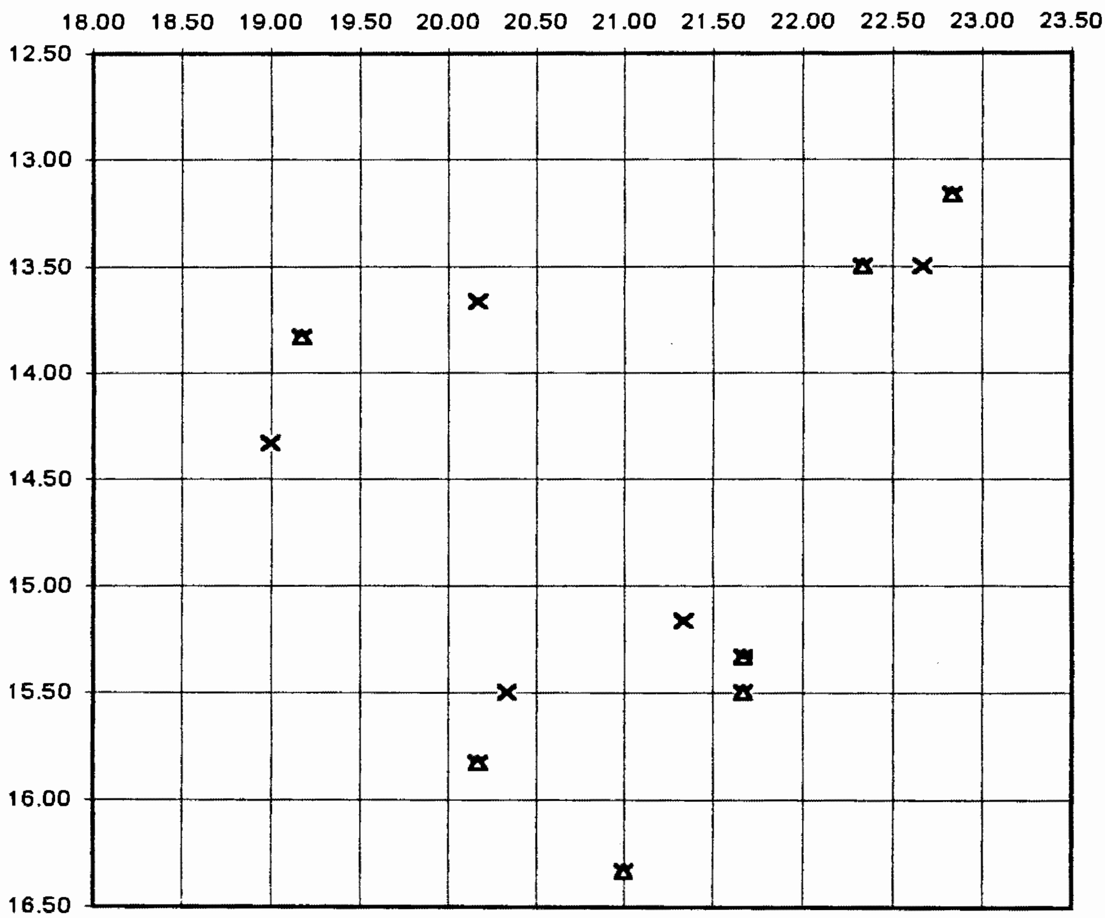
Cluster Analysis of Site Distances (District 5: the Grasslands) using a Euclidean method and single linkage measure. The numbers refer to the resulting clusters.

APPENDIX G

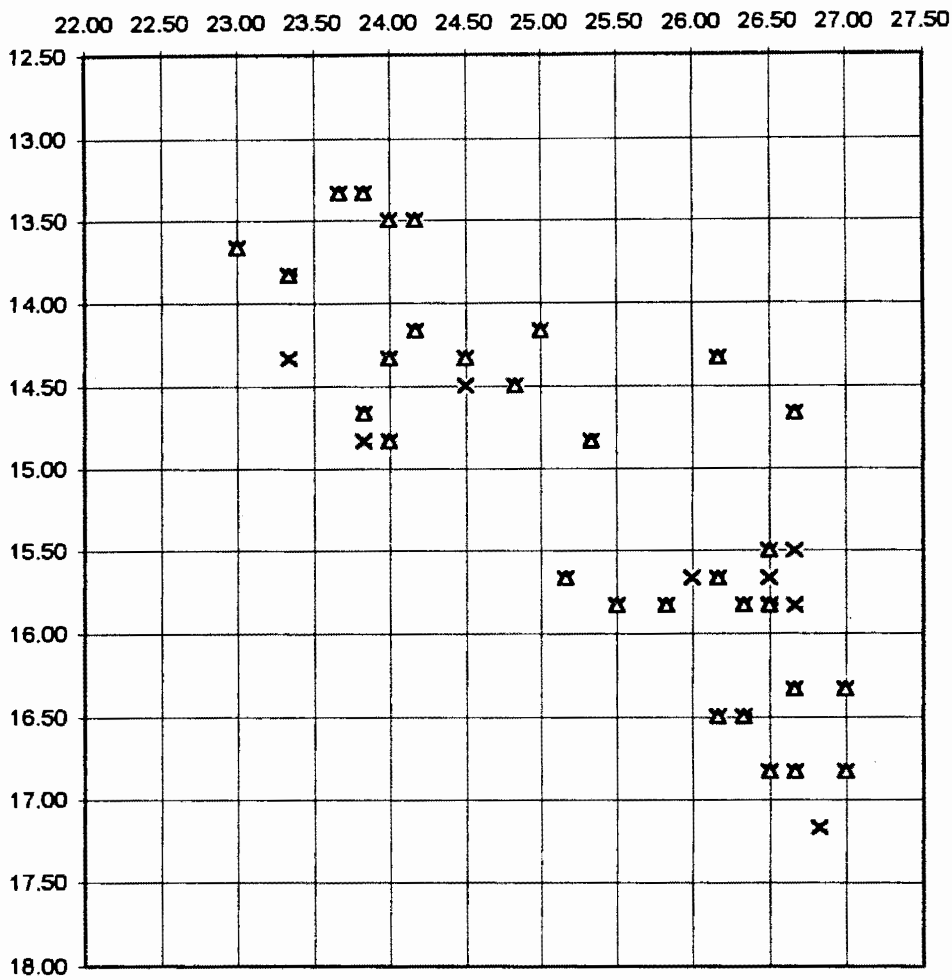
SPATIAL DISTRIBUTION OF EARLY MIDDLE AND LATE ARCHAIC SITE OCCUPATIONS

Spatial Distributions of Early Middle and Late Archaic Occupations

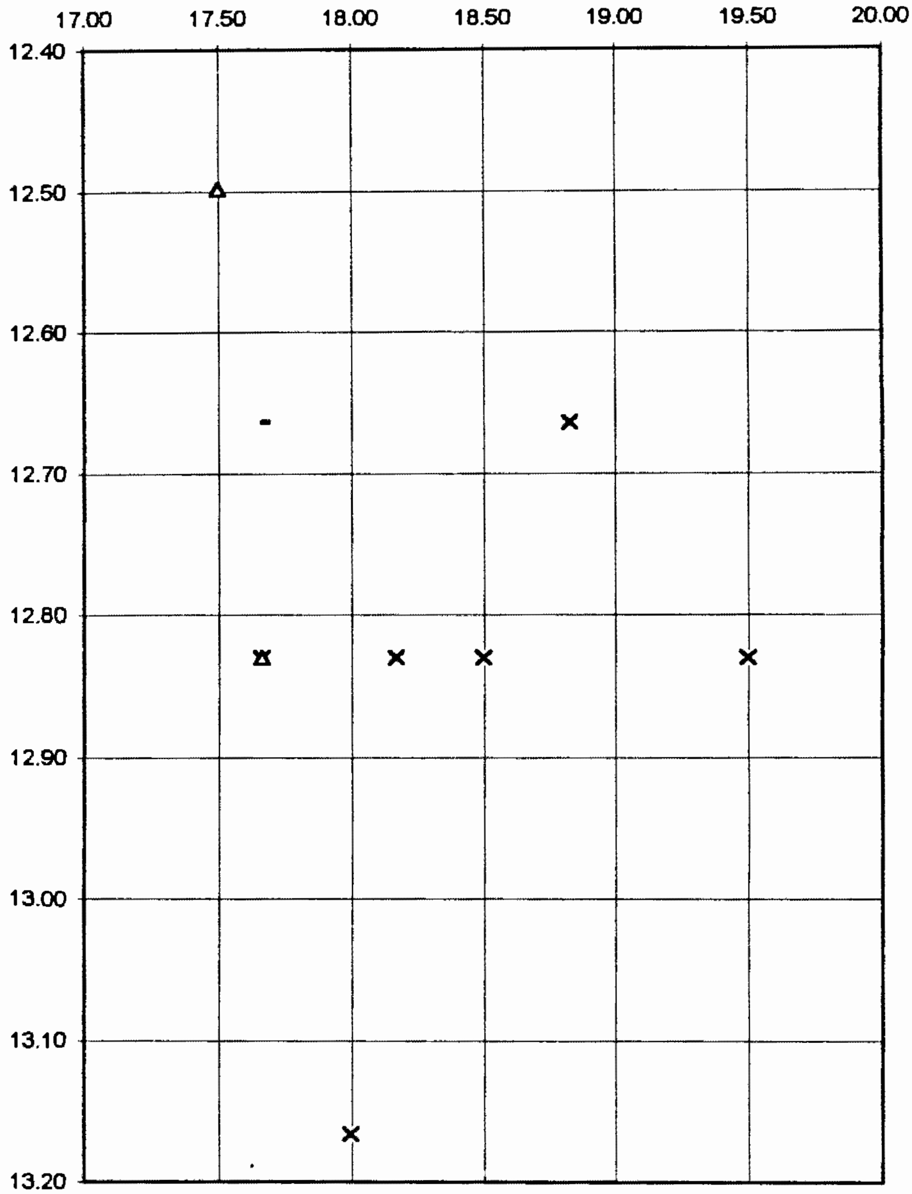
Appendix G contains spatial distribution maps for Early, Middle, and Late Archaic occupations. There is a map for each district of the Ochoco National Forest. Each map contains an x/y scatter plot of distances between occupations, with township, range, and section data as the scaled axis. A dash on the map indicates an Early Archaic occupation, an x signifies a Middle Archaic occupation, and a triangle indicates a Late Archaic occupation. These maps indicate that the same general areas were being used over a long period of time, which represents stability of plant and animal resources.



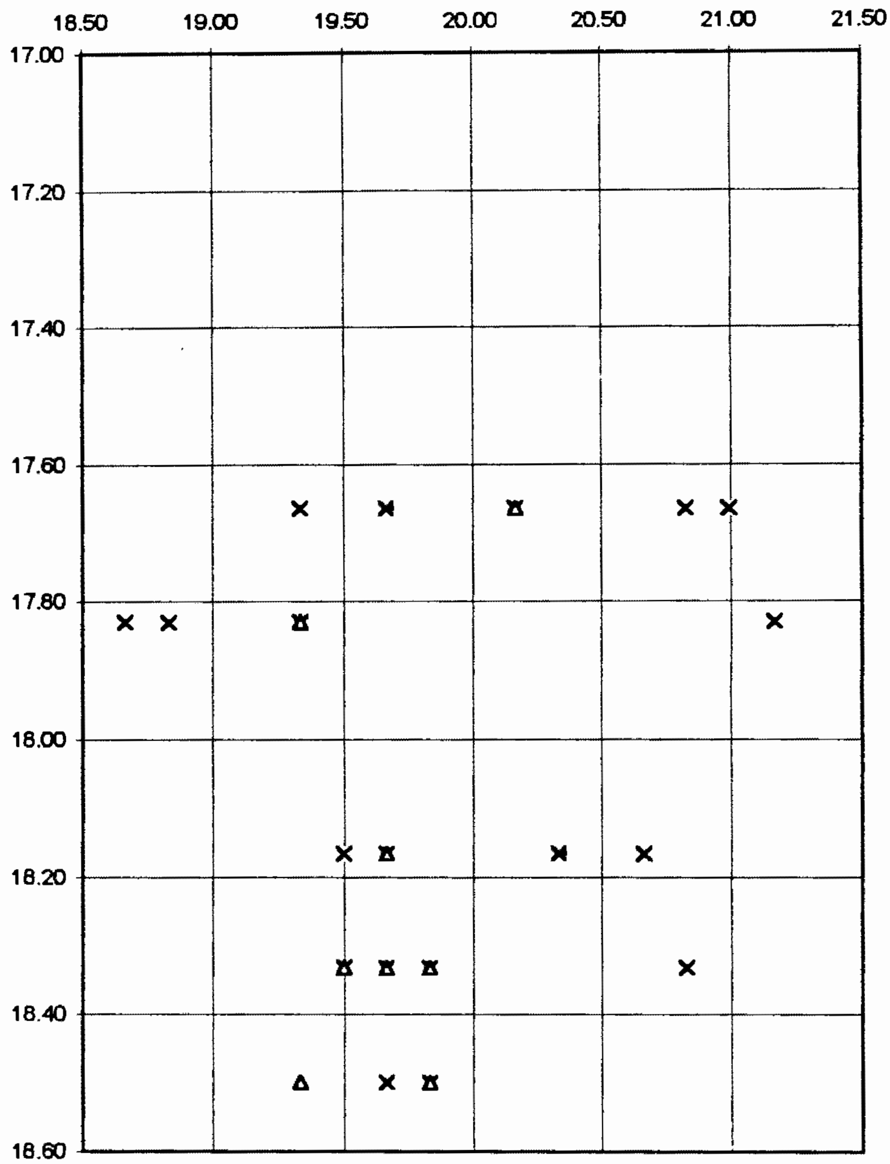
Distribution of Early Middle and Late Archaic occupations on the Big Summit District. A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.



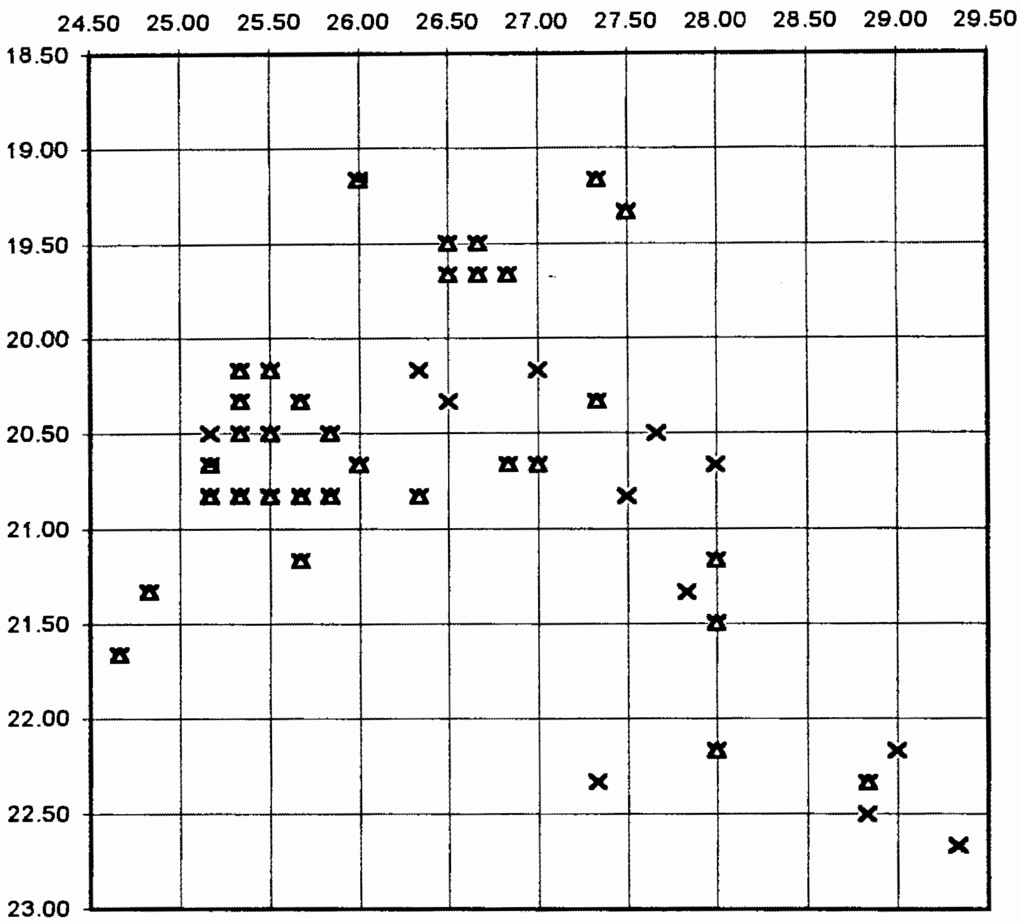
Distribution of Early Middle and Late Archaic occupations on the Paulina District
A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.



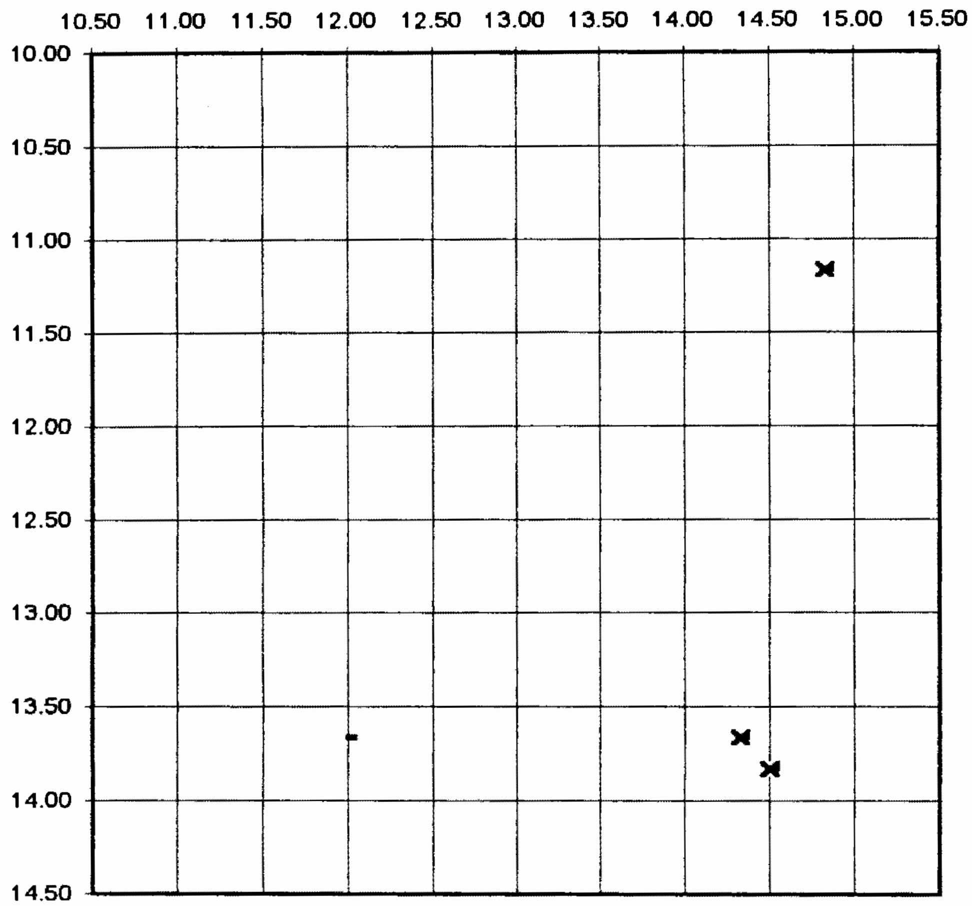
Distribution of Early Middle and Late Archaic occupations on the Prineville District (north half). A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.



Distribution of Early Middle and Late Archaic occupations on the Prineville District (south half). A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.



Distribution of Early Middle and Late Archaic occupations on the Snow Mountain District. A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.



Distribution of Early Middle and Late Archaic occupations on the Grassland District. A dash indicates an Early Archaic occupation, an x indicates a Middle Archaic occupation, and a triangle a Late Archaic occupation. Scale: 1 block = 3 square miles. Combined symbols indicate that multiple occupation types exist within the same 640 acre section, the smallest unit used in this analysis.

APPENDIX H

SITE CLUSTER DATA

Site Data

Appendix H is a listing of the data for each site used in this analysis sorted by Ochoco National Forest District and site clusters. With this data it is possible to view the characteristics of site groupings, as well as individual sites within each cluster.

APPENDIX H Summary of site clusters[a]

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
54	1	53	0.00	1.19	1	0	1	1
160	1	48	0.00	1.70	1	2	2	1
15	1	49	0.00	0.23	1	0	2	1
4	1	48	0.01	0.08	1	2	1	1
11	1	49	0.01	0.69	1	2	1	1
19	1	48	0.01	0.21	1	2	2	1
51	1	48	0.01	2.57	1	2	2	1
138	1	50	0.01	5.00	1	1	2	1
66	1	51	0.01	0.21	1	2	2	1
134	1	51	0.01	0.25	1	2	2	1
65	1	51	0.01	0.56	1	2	2	1
98	1	48	0.01	0.30	1	1	3	1
12	1	49	0.01	0.41	1	2	3	1
132	1	51	0.01	2.00	1	1	3	1
33	1	47	0.01	0.43	1	2	5	1
177	1	52	0.01	1.20	1	2	5	1
35	1	54	0.01	0.62	1	2	5	1
34	1	50	0.02	0.38	1	1	3	1
60	1	53	0.03	46.61	1	1	2	1
18	1	48	0.05	0.04	1	2	2	1
139	1	50	0.05	20.00	1	1	5	1
93	1	45	0.08	3.11	1	2	4	1
94	1	46	0.09	2.22	1	2	2	1
14	1	49	0.09	1.24	1	2	2	1
133	1	51	0.10	1.50	1	1	2	1
13	1	49	0.13	0.06	1	2	2	1
7	1	48	0.14	0.52	1	2	2	1
10	1	49	0.14	1.85	1	2	2	1
91	1	45	0.16	1.08	1	2	3	1
92	1	45	0.20	1.27	1	2	3	1
146	1	46	0.25	6.50	1	2	1	1
123	1	51	0.25	0.25	1	1	2	1
20	1	46	0.25	0.20	1	2	4	1
25	1	44	0.28	0.13	1	2	2	1
178	1	51	0.30	1.20	1	2	4	1
23	1	47	0.50	0.19	1	2	2	1
22	1	47	0.50	0.22	1	2	2	1
24	1	47	0.50	0.30	1	2	2	1
21	1	47	0.50	0.20	1	2	3	1
156	1	47	0.00	4.20	2	1	5	1
2	1	47	0.01	5.00	2	1	1	1
3	1	48	0.01	0.99	2	2	1	1
1	1	49	0.01	0.03	2	2	1	1
99	1	52	0.01	0.20	2	1	2	1
95	1	47	0.01	30.69	2	2	3	1
67	1	51	0.01	28.76	2	2	4	1
8	1	48	0.14	0.41	2	2	1	1
61	1	54	0.16	0.61	2	1	2	1
5	1	48	0.16	0.28	2	2	3	1
26	1	46	0.20	0.11	2	2	4	1

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
52	1	47	0.00	0.62	3	0	1	1
151	1	40	0.00	4.00	3	2	2	1
161	1	45	0.00	1.60	3	2	2	1
6	1	49	0.00	1.53	3	2	2	1
170	1	51	0.00	1.50	3	2	2	1
150	1	45	0.00	50.00	3	2	3	1
167	1	50	0.00	5.00	3	2	3	1
168	1	50	0.00	9.00	3	2	4	1
96	1	46	0.01	0.30	3	2	1	1
136	1	51	0.01	4.00	3	1	1	1
100	1	47	0.01	0.79	3	2	2	1
159	1	48	0.01	1.10	3	2	2	1
131	1	49	0.01	1.50	3	2	2	1
174	1	50	0.01	0.50	3	2	2	1
101	1	46	0.01	0.74	3	2	3	1
40	1	47	0.01	0.78	3	2	3	1
97	1	46	0.01	3.95	3	2	5	1
36	1	46	0.01	12.36	3	2	5	1
48	1	47	0.02	0.40	3	2	1	1
50	1	47	0.05	0.62	3	2	2	1
49	1	47	0.05	9.88	3	2	4	1
39	1	47	0.06	0.78	3	2	3	1
135	1	51	0.06	2.25	3	1	3	1
157	1	48	0.10	2.30	3	2	1	1
130	1	50	0.10	3.00	3	1	4	1
164	1	50	0.00	23.00	4	2	2	1
158	1	48	0.00	17.00	4	1	3	1
166	1	50	0.00	8.60	4	2	3	1
165	1	50	0.00	28.00	4	2	4	1
102	1	48	0.01	0.52	4	2	1	1
137	1	49	0.01	0.20	4	1	1	1
9	1	49	0.01	0.98	4	2	1	1
147	1	48	0.01	2.50	4	2	2	1
169	1	50	0.01	18.00	4	2	3	1
176	1	51	0.01	5.50	4	2	4	1
171	1	50	0.01	9.00	4	2	5	1
173	1	50	0.01	11.80	4	2	5	1
172	1	50	0.01	13.00	4	2	5	1
152	1	49	0.10	50.00	4	2	1	1
153	1	46	0.10	25.00	4	2	3	1
175	1	51	0.40	0.50	4	2	3	1
30	1	48	0.01	0.01	0	2	3	2
28	1	51	0.40	0.08	1	1	1	2
74	1	54	0.01	0.02	1	1	1	2
78	1	49	0.01	0.26	1	2	1	2
85	1	51	0.03	0.17	1	2	1	2
186	1	50	0.16	4.94	1	2	2	2
142	1	51	0.01	0.50	1	2	2	2
86	1	52	0.25	0.21	1	2	2	2
87	1	52	0.25	2.17	1	2	2	2
77	1	54	0.01	1.38	1	2	2	2
80	1	59	0.01	0.10	1	2	2	2
76	1	53	0.01	0.41	1	2	3	2
84	1	59	0.01	5.32	1	2	4	2
120	1	46	0.01	18.00	1	2	5	2
27	1	51	0.01	0.14	2	1	4	2

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
141	1	56	0.01	0.50	2	2	1	2
69	1	51	0.01	0.05	2	2	3	2
124	1	46	0.06	0.02	3	1	2	2
143	1	49	0.01	5.00	3	1	2	2
90	1	43	0.11	0.44	3	2	1	2
38	1	45	0.01	0.74	3	2	2	2
140	1	56	0.01	2.50	3	2	3	2
70	1	51	0.01	1.05	3	2	4	2
81	1	59	0.01	1.28	3	2	5	2
82	1	58	0.60	1.22	4	1	3	2
121	1	46	0.10	1.00	4	2	4	2
79	1	57	0.01	99.99	4	2	5	2
145	1	47	0.24	1.20	1	2	3	3
122	1	63	0.01	2.06	4	2	2	3
72	1	60	0.87	1.27	4	1	2	4
88	1	53	0.01	0.59	2	1	2	5
89	1	53	0.12	0.20	2	1	2	5
115	1	52	0.01	0.08	2	2	5	6
32	1	40	0.20	0.12	1	2	4	7
31	1	42	0.01	0.10	2	1	1	7
104	1	34	0.01	0.01	3	2	1	7
105	1	36	0.01	0.01	3	2	1	7
106	1	36	0.01	0.01	3	2	1	7
110	1	40	0.01	0.01	3	2	1	7
37	1	41	0.01	0.12	3	2	1	7
107	1	37	0.01	0.03	3	2	2	7
108	1	37	0.01	0.10	3	2	2	7
109	1	40	0.01	0.03	3	2	3	7
111	1	42	0.01	0.05	3	2	4	7
445	2	44	0.12	1.48	0	0	2	1
291	2	45	0.10	0.57	0	0	3	1
230	2	45	0.18	0.38	0	1	1	1
444	2	40	0.01	0.61	0	2	2	1
265	2	50	0.12	0.02	0	2	2	1
189	2	43	0.06	0.10	0	2	3	1
406	2	43	0.01	0.10	1	1	1	1
447	2	44	0.12	0.01	1	1	1	1
396	2	44	0.01	0.51	1	1	2	1
272	2	44	0.06	0.25	1	1	2	1
448	2	45	0.01	0.01	1	1	2	1
318	2	46	0.08	0.52	1	1	2	1
266	2	47	0.12	0.01	1	1	2	1
411	2	41	0.01	1.24	1	1	3	1
264	2	47	0.25	0.04	1	1	5	1
348	2	38	0.03	0.37	1	2	1	1
341	2	40	0.01	0.00	1	2	1	1
414	2	41	0.01	0.01	1	2	1	1
372	2	43	0.01	0.01	1	2	1	1
409	2	43	0.25	0.01	1	2	1	1
433	2	44	0.01	0.37	1	2	1	1
233	2	44	0.01	0.49	1	2	1	1
229	2	45	0.12	0.10	1	2	1	1
466	2	46	0.01	0.66	1	2	1	1
194	2	46	0.09	88.96	1	2	1	1
193	2	46	0.12	9.88	1	2	1	1
365	2	48	0.08	0.23	1	2	1	1

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
190	2	48	0.37	2.00	1	2	1	1
361	2	49	0.01	0.00	1	2	1	1
377	2	49	0.01	0.01	1	2	1	1
394	2	43	0.01	1.23	1	2	2	1
187	2	43	0.03	7.41	1	2	2	1
228	2	44	0.01	0.02	1	2	2	1
278	2	44	0.01	0.03	1	2	2	1
277	2	44	0.01	0.09	1	2	2	1
227	2	44	0.01	0.31	1	2	2	1
315	2	46	0.01	9.88	1	2	2	1
300	2	48	0.16	0.10	1	2	2	1
355	2	0	0.06	0.05	1	2	3	1
345	2	41	0.04	0.59	1	2	3	1
330	2	43	0.06	2.47	1	2	3	1
446	2	43	0.19	1.23	1	2	3	1
346	2	44	0.01	0.22	1	2	3	1
312	2	45	0.01	1.93	1	2	3	1
449	2	45	0.03	0.31	1	2	3	1
281	2	45	0.38	13.84	1	2	3	1
463	2	46	0.01	0.30	1	2	3	1
192	2	46	0.25	0.04	1	2	3	1
191	2	46	0.62	0.05	1	2	3	1
363	2	48	0.04	11.50	1	2	3	1
282	2	44	0.01	3.00	1	2	4	1
342	2	44	0.12	0.17	1	2	4	1
404	2	45	0.50	0.37	1	2	4	1
468	2	46	0.01	2.10	1	2	4	1
290	2	44	0.01	13.77	1	2	5	1
461	2	46	0.15	0.60	1	2	5	1
226	2	44	0.06	25.51	1	2	6	1
464	2	45	0.10	6.00	1	2	6	1
467	2	46	0.01	0.00	1	2	6	1
465	2	46	0.01	1.98	1	2	7	1
388	2	47	0.01	0.49	1	2	7	1
410	2	42	0.01	0.01	2	1	2	1
316	2	46	0.01	12.60	2	1	4	1
356	2	0	0.11	0.23	2	2	1	1
432	2	45	0.06	0.01	2	2	1	1
364	2	49	0.01	3.70	2	2	1	1
403	2	43	0.06	0.22	2	2	2	1
402	2	44	0.04	0.01	2	2	2	1
274	2	46	0.05	1.85	2	2	2	1
349	2	47	0.01	0.79	2	2	2	1
297	2	51	0.25	1.00	2	2	2	1
358	2	70	0.25	25.00	2	2	2	1
357	2	0	0.04	16.00	2	2	3	1
231	2	43	0.01	0.46	2	2	3	1
279	2	44	0.01	0.37	2	2	3	1
387	2	48	0.01	1.33	2	2	4	1
393	2	47	0.01	14.00	2	2	5	1
390	2	46	0.01	0.37	3	1	2	1
283	2	46	0.01	4.91	3	1	2	1
369	2	55	0.25	2.00	3	1	2	1
273	2	45	0.03	0.87	3	1	3	1
302	2	0	0.01	75.00	3	1	4	1
397	2	56	0.03	0.07	3	1	4	1

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
395	2	43	0.05	0.89	3	2	1	1
408	2	43	0.25	0.12	3	2	1	1
350	2	44	0.01	0.01	3	2	1	1
360	2	46	0.01	0.01	3	2	1	1
196	2	46	0.01	9.88	3	2	1	1
391	2	47	0.06	0.01	3	2	1	1
352	2	0	0.01	2.70	3	2	2	1
323	2	41	0.01	0.74	3	2	2	1
324	2	41	0.01	0.74	3	2	2	1
374	2	43	0.01	0.15	3	2	2	1
375	2	43	0.01	0.15	3	2	2	1
232	2	44	0.01	0.20	3	2	2	1
319	2	44	0.03	1.48	3	2	2	1
314	2	45	0.01	1.98	3	2	2	1
299	2	46	0.01	2.00	3	2	2	1
389	2	47	0.07	2.00	3	2	2	1
354	2	0	0.01	0.10	3	2	3	1
280	2	42	0.01	1.48	3	2	3	1
313	2	45	1.73	0.99	3	2	3	1
359	2	46	0.00	0.12	3	2	3	1
362	2	48	0.05	0.00	3	2	3	1
243	2	49	0.01	3.00	3	2	3	1
469	2	50	0.01	40.74	3	2	3	1
351	2	60	0.01	7.50	3	2	3	1
242	2	0	0.01	3.00	3	2	4	1
376	2	43	0.06	0.01	3	2	4	1
329	2	43	0.06	18.53	3	2	4	1
347	2	40	0.01	1.24	3	2	5	1
225	2	42	0.01	0.10	3	2	5	1
317	2	44	0.01	9.88	3	2	5	1
454	2	45	0.01	0.12	3	2	5	1
223	2	45	0.03	1.91	3	2	5	1
320	2	45	0.01	23.23	3	2	6	1
197	2	45	0.01	4.00	3	2	8	1
455	2	46	0.03	0.61	4	0	3	1
322	2	43	0.02	0.69	4	1	2	1
405	2	43	0.12	0.45	4	1	2	1
470	2	45	0.15	0.37	4	1	2	1
462	2	46	0.15	0.40	4	2	1	1
460	2	46	0.10	0.70	4	2	4	1
392	2	48	0.01	3.71	4	2	7	1
307	2	50	2.00	0.00	2	1	1	2
287	2	57	0.02	0.01	2	2	1	2
285	2	56	0.03	0.61	2	2	2	2
289	2	60	0.01	0.85	2	2	2	2
286	2	57	0.01	0.24	2	2	3	2
366	2	50	0.01	70.00	2	2	5	2
459	2	44	0.01	8.80	3	1	6	3
370	2	44	0.01	1.40	3	2	1	3
334	2	42	0.01	0.03	1	1	1	4
332	2	46	0.01	0.06	1	2	1	4
336	2	45	0.01	2.00	1	2	2	4
335	2	44	0.09	2.78	1	2	3	4
333	2	45	0.01	0.19	2	0	1	4
338	2	44	0.01	1.98	2	1	1	4
337	2	45	0.01	1.24	2	1	1	4

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
310	2	40	0.00	0.00	3	1	1	4
311	2	50	0.01	0.50	4	2	4	4
251	2	58	0.01	2.99	1	1	1	5
252	2	57	0.01	0.89	1	2	2	5
293	2	59	0.01	3.71	1	2	2	5
248	2	55	0.01	1.11	2	1	1	5
253	2	57	0.01	3.46	2	2	6	5
200	2	51	0.03	39.54	3	2	1	5
259	2	55	0.01	0.01	3	2	2	5
367	2	58	0.50	0.01	4	2	2	5
240	2	49	0.25	0.01	1	2	3	6
255	2	58	0.01	9.88	1	2	3	6
339	2	57	0.01	0.22	2	1	1	6
306	2	70	0.50	0.00	2	1	2	6
254	2	56	0.01	7.41	2	1	4	6
239	2	56	0.01	99.99	2	1	6	6
327	2	60	0.25	0.01	2	2	1	6
340	2	57	0.75	1.85	2	2	3	6
296	2	58	0.01	2.00	3	2	2	6
241	2	57	0.01	1.73	3	2	4	6
213	2	50	0.50	0.05	1	2	1	7
210	2	51	0.50	4.00	1	2	1	7
257	2	53	0.01	0.01	1	2	1	7
201	2	51	0.06	1.24	1	2	2	7
436	2	50	0.40	5.56	1	2	3	7
214	2	50	0.00	2.00	1	2	4	7
247	2	55	0.03	0.44	1	2	5	7
441	2	55	0.01	0.07	2	0	2	7
438	2	51	0.05	0.11	2	1	1	7
258	2	57	0.01	3.00	2	1	1	7
305	2	58	0.01	1.50	2	1	1	7
244	2	55	0.01	4.75	2	1	2	7
308	2	0	2.50	0.00	2	1	3	7
237	2	57	0.01	1.85	2	1	3	7
437	2	51	0.01	0.01	2	2	1	7
435	2	57	0.12	0.05	2	2	1	7
236	2	55	0.03	1.23	2	2	2	7
295	2	57	0.01	2.00	2	2	3	7
275	2	51	0.06	7.41	2	2	5	7
303	2	57	0.01	1.50	3	1	1	7
245	2	55	0.10	0.49	3	1	2	7
456	2	51	0.01	3.71	3	1	3	7
292	2	57	0.01	0.01	3	2	1	7
234	2	55	0.01	0.89	3	2	2	7
238	2	57	0.01	0.14	3	2	2	7
246	2	55	0.01	0.74	3	2	4	7
208	2	51	0.16	0.25	4	2	3	7
207	2	51	0.16	0.25	4	2	4	7
209	2	51	0.19	0.01	4	2	4	7
386	2	49	0.06	0.01	1	2	1	8
326	2	52	0.01	1.24	1	2	4	8
276	2	50	0.01	0.30	2	2	2	8
284	2	46	0.01	1.61	3	1	3	8
379	2	50	0.01	3.71	3	2	1	8
256	2	54	0.01	0.15	3	2	4	8
385	2	49	0.03	0.01	4	2	1	8

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
380	2	50	0.01	0.01	4	2	1	8
188	2	32	0.04	0.14	0	2	2	9
267	2	30	0.01	0.01	3	2	1	9
268	2	31	0.01	0.37	3	2	2	9
270	2	33	0.12	0.09	3	2	5	9
321	2	53	0.01	4.94	2	1	3	10
496	3N	55	0.01	0.51	1	1	4	1
495	3N	55	0.15	0.00	1	1	4	1
545	3N	56	0.01	3.95	2	1	3	1
486	3N	54	0.03	11.48	2	1	4	1
487	3N	55	0.02	0.54	3	1	3	1
506	3N	43	0.01	0.22	3	2	1	1
586	3N	37	0.01	3.00	3	2	2	1
585	3N	38	0.01	4.20	3	2	2	1
511	3N	54	0.01	0.01	1	1	2	2
510	3N	54	0.01	0.44	1	1	2	2
512	3N	54	0.01	0.02	1	2	1	2
587	3N	50	0.01	8.90	1	1	4	3
489	3N	56	0.10	6.50	2	1	2	3
499	3N	43	0.01	0.12	3	1	2	3
516	3N	40	0.01	1.65	3	2	4	3
591	3N	49	0.31	6.70	4	1	3	3
590	3N	51	0.47	0.20	4	1	3	3
544	3N	56	0.01	2.70	4	1	3	3
534	3N	47	0.01	0.01	1	1	1	4
589	3N	61	0.10	2.20	4	1	1	5
490	3	49	0.04	0.15	1	2	1	1
599	3	49	0.01	3.10	3	1	5	1
598	3	47	0.07	6.00	3	2	3	1
600	3	42	0.06	1.50	3	2	5	1
491	3	53	0.50	80.01	1	1	1	2
520	3	55	0.01	0.01	1	1	1	2
492	3	55	0.01	1.27	1	1	1	2
530	3	58	0.12	0.01	1	1	1	2
528	3	58	0.19	0.03	1	1	3	2
531	3	58	0.21	0.12	1	1	3	2
502	3	51	0.01	0.23	1	1	4	2
574	3	53	0.04	7.30	1	1	4	2
472	3	58	0.11	2.37	1	1	4	2
566	3	51	0.07	0.52	1	2	2	2
555	3	50	0.19	4.34	1	2	3	2
570	3	51	0.50	1.10	1	2	3	2
553	3	52	0.36	22.27	1	2	3	2
500	3	56	0.01	0.50	2	1	1	2
474	3	50	0.01	0.43	2	1	4	2
488	3	57	0.01	32.00	2	1	6	2
561	3	49	0.00	1.25	3	1	1	2
572	3	52	0.15	0.60	3	1	1	2
527	3	53	0.14	0.17	3	1	1	2
577	3	56	0.01	1.30	3	1	1	2
548	3	52	0.00	1.20	3	1	2	2
549	3	50	0.00	1.60	3	1	3	2
565	3	50	0.02	4.00	3	1	3	2
578	3	54	0.01	1.00	3	1	3	2
567	3	48	0.03	3.20	3	1	4	2
575	3	52	0.01	2.60	3	1	4	2

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
576	3	51	0.01	0.00	3	1	5	2
517	3	56	0.01	2.66	3	1	5	2
471	3	57	0.01	3.70	3	1	5	2
562	3	48	0.00	7.41	3	2	1	2
573	3	52	0.16	0.90	3	2	1	2
547	3	52	0.00	4.50	3	2	3	2
505	3	54	0.00	0.34	4	0	3	2
552	3	52	0.03	1.10	4	1	1	2
554	3	57	0.00	2.73	4	1	1	2
579	3	57	0.40	1.50	4	1	1	2
564	3	50	0.20	0.64	4	1	2	2
501	3	58	0.02	0.34	4	1	2	2
526	3	58	0.06	0.12	4	1	2	2
568	3	40	0.10	0.80	4	1	3	2
529	3	59	0.24	0.75	4	1	3	2
485	3	54	0.01	9.56	4	1	6	2
569	3	49	0.05	1.50	4	2	2	2
475	3	53	0.08	0.22	4	2	2	2
550	3	49	0.01	65.00	4	2	3	2
551	3	51	0.03	1.00	4	2	3	2
571	3	52	0.50	3.70	4	2	3	2
473	3	53	0.05	1.90	4	2	4	2
557	3	43	0.15	1.33	0	2	1	3
539	3	49	0.40	2.20	1	1	2	3
540	3	49	0.50	1.30	1	1	2	3
592	3	53	0.19	0.04	1	1	3	3
593	3	55	0.67	0.44	3	1	3	3
537	3	42	0.01	7.10	3	2	2	3
560	3	44	0.01	1.19	3	2	2	3
494	3	56	0.01	1.91	3	2	4	3
541	3	47	0.23	0.13	4	1	1	3
543	3	43	0.07	0.95	4	1	2	3
542	3	48	0.38	4.70	4	1	2	3
588	3	54	0.63	0.50	4	1	2	3
559	3	46	0.01	0.74	1	1	4	4
581	3	47	0.01	0.80	3	1	1	4
583	3	47	0.10	1.80	4	1	2	4
582	3	49	0.30	1.30	4	1	2	4
580	3	47	1.80	3.50	4	1	3	4
478	3	53	0.01	0.63	1	1	2	5
483	3	52	0.01	0.01	1	2	1	5
484	3	53	0.01	0.02	1	2	1	5
497	3	52	0.01	1.02	3	1	2	5
523	3	50	0.01	0.00	3	2	1	5
558	3	46	0.01	4.74	3	1	3	6
556	3	43	0.01	0.30	3	2	3	6
601	3	50	0.95	0.80	4	1	5	6
515	3	60	0.20	0.05	4	2	1	6
518	3	47	0.01	9.88	2	1	3	7
519	3	55	0.01	0.10	0	0	1	8
522	3	48	0.01	9.88	3	1	1	8
1029	4	56	0.01	2.30	1	0	2	1
1039	4	56	0.22	0.18	1	0	2	1
1038	4	56	0.05	0.40	1	0	4	1
1026	4	56	0.04	0.15	1	1	1	1
1022	4	57	0.13	0.08	1	1	1	1

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
768	4	58	0.01	0.01	1	1	1	1
641	4	60	0.01	0.01	1	1	1	1
788	4	52	0.01	0.01	1	1	2	1
898	4	52	0.01	3.00	1	1	2	1
745	4	56	0.01	0.24	1	1	3	1
783	4	56	0.01	2.00	1	1	3	1
1027	4	56	0.03	0.83	1	1	3	1
747	4	57	0.01	0.04	1	1	3	1
1019	4	57	0.25	10.00	1	1	3	1
823	4	58	0.13	5.00	1	1	3	1
654	4	53	0.01	0.01	1	2	1	1
662	4	53	0.01	0.01	1	2	1	1
786	4	54	0.01	9.00	1	2	1	1
1040	4	54	0.13	0.15	1	2	1	1
1041	4	54	0.31	0.31	1	2	1	1
1031	4	56	0.01	0.10	1	2	1	1
1025	4	56	0.04	0.19	1	2	1	1
644	4	53	0.01	35.00	1	2	2	1
785	4	55	0.01	0.01	1	2	2	1
784	4	57	0.01	3.00	1	2	2	1
1035	4	59	0.13	0.20	1	2	2	1
645	4	53	0.01	99.99	1	2	3	1
811	4	58	0.50	0.20	2	1	1	1
782	4	57	0.01	2.00	2	1	2	1
739	4	50	0.01	7.00	2	1	3	1
958	4	58	0.01	15.00	2	1	4	1
1032	4	59	0.05	0.17	2	2	2	1
1030	4	56	0.01	0.56	3	0	1	1
1037	4	56	0.01	0.76	3	0	1	1
1028	4	56	0.04	0.21	3	0	1	1
787	4	52	0.01	0.01	3	1	1	1
780	4	58	0.01	0.01	3	1	1	1
1024	4	56	0.02	1.90	3	1	2	1
1023	4	56	0.04	0.04	3	1	2	1
1020	4	57	0.01	0.05	3	1	2	1
781	4	54	0.01	8.00	3	1	3	1
791	4	56	0.01	5.00	3	1	3	1
652	4	56	0.01	65.00	3	1	3	1
740	4	57	0.01	1.00	3	1	3	1
790	4	50	0.01	2.50	3	1	5	1
663	4	50	0.01	0.01	3	2	1	1
664	4	52	0.01	0.01	3	2	1	1
792	4	54	0.01	0.01	3	2	1	1
793	4	56	0.01	0.01	3	2	1	1
1017	4	56	0.01	0.52	3	2	1	1
1016	4	56	0.10	0.17	3	2	1	1
1021	4	57	0.02	0.17	3	2	1	1
836	4	57	0.50	0.10	3	2	1	1
1033	4	58	0.03	0.18	3	2	1	1
661	4	51	0.01	0.01	3	2	2	1
1034	4	57	0.01	0.13	3	2	2	1
1018	4	57	0.01	0.19	3	2	2	1
1015	4	56	0.01	5.10	3	2	4	1
646	4	53	0.00	0.07	4	2	1	1
655	4	53	0.01	0.01	4	2	1	1
602	4	54	0.12	0.09	4	2	3	1

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
990	4	50	0.03	0.86	0	1	3	2
908	4	50	0.37	0.20	1	0	2	2
608	4	52	0.01	4.95	1	0	2	2
964	4	52	0.04	1.40	1	0	2	2
1013	4	50	0.10	0.37	1	0	3	2
603	4	52	0.01	99.99	1	0	7	2
876	4	52	0.19	0.18	1	1	1	2
865	4	52	0.31	0.03	1	1	1	2
880	4	54	0.37	1.20	1	1	1	2
789	4	52	0.01	10.00	1	1	2	2
960	4	52	0.01	48.00	1	1	2	2
604	4	52	0.62	0.10	1	1	2	2
864	4	50	0.02	1.24	1	1	3	2
1006	4	51	0.16	25.00	1	1	3	2
883	4	53	0.25	0.30	1	1	3	2
884	4	53	0.25	1.90	1	1	3	2
1002	4	53	0.62	0.04	1	1	3	2
873	4	54	0.13	0.90	1	1	3	2
741	4	53	0.00	0.75	1	1	5	2
998	4	48	0.20	0.02	1	2	1	2
1005	4	50	0.20	31.00	1	2	1	2
859	4	50	0.31	0.07	1	2	1	2
975	4	51	0.01	1.80	1	2	1	2
1004	4	51	0.44	0.01	1	2	1	2
969	4	52	0.25	0.20	1	2	1	2
986	4	52	0.47	0.06	1	2	1	2
855	4	52	0.56	0.01	1	2	1	2
860	4	52	0.62	0.01	1	2	1	2
870	4	54	0.37	0.30	1	2	1	2
881	4	54	1.00	0.05	1	2	1	2
910	4	50	0.25	0.02	1	2	2	2
907	4	50	1.00	0.30	1	2	2	2
1007	4	51	0.01	6.00	1	2	2	2
862	4	51	0.37	0.05	1	2	2	2
989	4	52	0.02	2.50	1	2	2	2
974	4	52	0.03	0.20	1	2	2	2
966	4	52	0.20	12.00	1	2	2	2
866	4	52	0.25	0.20	1	2	2	2
979	4	52	0.31	0.70	1	2	2	2
877	4	52	0.37	0.89	1	2	2	2
867	4	52	0.38	0.04	1	2	2	2
988	4	52	0.40	0.10	1	2	2	2
987	4	52	0.50	0.01	1	2	2	2
861	4	52	0.62	0.07	1	2	2	2
970	4	53	0.13	40.00	1	2	2	2
869	4	53	0.37	0.75	1	2	2	2
972	4	53	0.44	2.20	1	2	2	2
882	4	54	1.00	0.75	1	2	2	2
999	4	50	0.20	0.20	1	2	3	2
992	4	52	0.20	0.20	1	2	3	2
976	4	52	0.25	45.00	1	2	3	2
984	4	52	0.52	1.25	1	2	3	2
909	4	51	0.50	0.64	1	2	4	2
971	4	52	0.44	2.30	1	2	4	2
878	4	53	0.06	0.22	1	2	4	2
875	4	53	0.37	0.89	1	2	4	2

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
868	4	54	0.12	0.46	1	2	4	2
605	4	52	1.00	0.49	2	0	1	2
609	4	52	0.01	0.01	2	0	2	2
606	4	52	0.06	0.77	2	0	3	2
607	4	52	0.47	1.23	2	0	4	2
872	4	53	0.01	3.00	2	1	3	2
885	4	53	0.00	0.00	2	2	1	2
863	4	51	0.01	9.00	2	2	4	2
963	4	52	0.04	2.00	3	0	1	2
991	4	51	0.31	0.26	3	2	1	2
985	4	50	0.01	25.00	3	2	2	2
981	4	51	0.01	11.00	3	2	2	2
852	4	51	0.03	0.20	3	2	2	2
982	4	52	0.01	19.00	3	2	2	2
1014	4	51	0.01	6.20	3	2	3	2
968	4	53	0.01	50.00	3	2	5	2
856	4	51	0.37	0.20	4	2	1	2
725	4	52	0.01	0.01	4	2	1	2
857	4	52	0.37	0.23	4	2	1	2
858	4	52	0.37	0.25	4	2	1	2
967	4	53	0.20	0.26	4	2	1	2
610	4	52	0.06	0.24	4	2	2	2
965	4	52	0.06	0.50	4	2	2	2
983	4	52	0.31	22.00	4	2	3	2
879	4	53	0.01	4.00	4	2	3	2
1008	4	54	0.01	0.90	1	1	1	3
850	4	60	0.25	0.30	1	1	1	3
1010	4	53	0.02	1.33	1	1	2	3
1011	4	53	0.01	0.10	1	2	1	3
638	4	55	0.01	0.01	1	2	3	3
1009	4	60	0.01	1.33	2	1	2	3
637	4	56	0.01	0.01	2	2	2	3
776	4	55	0.01	1.00	2	2	3	3
636	4	61	0.01	0.24	2	2	3	3
851	4	0	0.50	0.20	4	1	1	3
774	4	55	0.01	16.00	4	1	5	3
773	4	58	0.01	17.00	0	1	2	4
764	4	54	0.01	1.00	1	1	1	4
756	4	55	0.01	20.00	1	1	1	4
755	4	56	0.01	1.00	1	1	1	4
772	4	54	0.01	0.01	1	1	2	4
948	4	54	0.45	0.75	1	1	2	4
760	4	55	0.01	5.00	1	1	2	4
800	4	54	0.01	2.50	1	1	3	4
766	4	55	0.01	5.00	1	1	3	4
642	4	54	0.01	10.00	1	1	4	4
799	4	54	0.01	1.00	1	2	1	4
949	4	54	0.55	0.40	1	2	1	4
794	4	55	0.00	0.20	1	2	1	4
748	4	53	0.01	2.55	1	2	2	4
950	4	54	0.22	0.15	1	2	2	4
918	4	54	0.85	0.01	1	2	2	4
919	4	52	0.19	30.00	1	2	3	4
913	4	54	0.34	0.78	1	2	3	4
630	4	53	0.01	18.00	1	2	4	4
917	4	53	0.74	0.06	1	2	4	4

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
912	4	54	0.42	2.70	1	2	4	4
631	4	53	0.01	0.37	1	2	5	4
798	4	54	0.01	14.00	1	2	5	4
758	4	56	0.00	15.00	2	1	3	4
796	4	53	0.01	13.00	2	1	4	4
750	4	54	0.01	1.27	2	2	2	4
705	4	50	0.01	0.01	3	1	1	4
665	4	51	0.01	0.01	3	1	2	4
762	4	57	0.01	1.00	3	1	2	4
749	4	52	0.01	0.15	3	2	1	4
825	4	52	0.15	0.50	3	2	1	4
797	4	54	0.01	7.00	3	2	1	4
822	4	51	0.01	0.01	3	2	2	4
1043	4	51	0.01	0.08	3	2	2	4
824	4	54	0.01	0.40	3	2	2	4
915	4	50	0.02	0.24	3	2	3	4
914	4	54	0.12	0.47	3	2	3	4
700	4	52	0.01	0.01	4	1	1	4
703	4	52	0.01	0.01	4	1	1	4
707	4	52	0.01	0.01	4	1	1	4
710	4	52	0.01	0.01	4	1	1	4
712	4	52	0.01	0.01	4	1	1	4
757	4	54	0.01	0.01	4	1	1	4
779	4	55	0.01	0.01	4	1	1	4
708	4	51	0.01	0.01	4	1	2	4
704	4	52	0.01	0.01	4	1	2	4
709	4	52	0.01	0.01	4	1	2	4
711	4	52	0.01	0.01	4	1	2	4
706	4	51	0.01	38.00	4	1	3	4
673	4	51	0.01	0.01	4	2	1	4
672	4	52	0.01	0.01	4	2	1	4
696	4	52	0.01	0.01	4	2	1	4
702	4	52	0.01	0.01	4	2	1	4
674	4	50	0.01	0.01	4	2	2	4
671	4	52	0.01	0.01	4	2	2	4
670	4	51	0.01	65.00	4	2	4	4
744	4	53	0.01	7.00	1	1	3	5
839	4	52	0.01	1.10	1	2	1	5
848	4	53	0.02	2.00	1	2	1	5
775	4	52	0.01	0.01	1	2	3	5
844	4	53	0.01	5.00	1	2	3	5
643	4	53	0.01	0.01	2	2	2	5
656	4	54	0.01	7.00	3	1	4	5
830	4	50	0.01	5.00	3	2	1	5
846	4	50	0.01	5.00	3	2	1	5
853	4	50	0.25	2.00	3	2	1	5
849	4	51	0.01	1.00	3	2	1	5
843	4	51	0.01	10.00	3	2	1	5
837	4	52	0.01	0.01	3	2	1	5
840	4	52	0.02	0.10	3	2	1	5
854	4	49	0.03	0.20	3	2	2	5
834	4	50	0.00	25.00	3	2	2	5
827	4	53	0.01	11.00	3	2	2	5
831	4	51	0.05	22.00	3	2	4	5
763	4	50	0.01	10.50	4	1	3	5
801	4	49	0.01	0.01	4	2	1	5

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
847	4	49	0.20	2.00	4	2	1	5
838	4	52	0.10	2.00	4	2	1	5
845	4	53	0.10	2.00	4	2	1	5
614	4	48	0.01	0.01	4	2	2	5
832	4	50	0.05	0.10	4	2	2	5
828	4	51	0.01	1.80	4	2	2	5
829	4	51	0.01	2.50	4	2	2	5
777	4	52	0.01	0.02	4	2	2	5
841	4	52	0.10	0.10	4	2	2	5
842	4	50	0.01	4.00	4	2	3	5
826	4	52	0.05	29.00	4	2	3	5
742	4	54	0.01	0.24	4	2	3	5
743	4	53	0.01	0.24	4	2	5	5
746	4	56	0.01	0.02	0	0	3	6
805	4	47	0.06	0.10	0	2	1	6
804	4	48	0.03	0.10	0	2	1	6
810	4	49	0.01	0.00	0	2	1	6
713	4	54	0.40	6.25	0	2	1	6
634	4	50	0.01	0.25	0	2	2	6
806	4	51	0.10	8.00	0	2	2	6
624	4	51	0.01	0.03	1	0	2	6
623	4	51	0.01	1.24	1	0	4	6
903	4	50	0.25	0.20	1	1	1	6
693	4	50	0.50	0.19	1	1	1	6
611	4	49	0.01	0.02	1	1	2	6
640	4	50	0.23	0.15	1	1	2	6
899	4	50	0.50	0.22	1	1	2	6
887	4	51	0.01	1.85	1	1	2	6
633	4	52	0.01	0.49	1	1	4	6
905	4	49	0.15	2.00	1	1	5	6
650	4	50	0.01	0.04	1	2	1	6
690	4	50	0.01	0.09	1	2	1	6
651	4	50	0.01	0.20	1	2	1	6
809	4	50	0.10	0.30	1	2	1	6
892	4	51	0.04	0.30	1	2	1	6
692	4	52	0.01	0.12	1	2	1	6
688	4	52	0.01	10.00	1	2	1	6
886	4	55	0.10	0.30	1	2	1	6
890	4	55	0.25	0.10	1	2	1	6
685	4	48	0.25	5.00	1	2	2	6
612	4	49	0.01	0.49	1	2	2	6
620	4	52	0.01	0.49	1	2	2	6
754	4	52	0.01	1.00	1	2	2	6
687	4	52	0.01	4.00	1	2	2	6
894	4	52	0.05	1.48	1	2	2	6
893	4	55	0.20	1.50	1	2	2	6
900	4	48	0.01	0.50	1	2	3	6
904	4	48	0.25	0.80	1	2	3	6
689	4	50	0.01	10.00	1	2	3	6
888	4	54	0.01	15.50	1	2	3	6
686	4	48	0.13	0.24	1	2	4	6
906	4	50	0.07	3.00	1	2	4	6
618	4	52	0.01	0.74	1	2	4	6
619	4	52	0.01	0.74	1	2	4	6
891	4	53	0.20	0.80	1	2	4	6
626	4	52	0.01	0.12	1	2	5	6

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
617	4	51	0.01	0.62	1	2	6	6
621	4	49	0.01	0.03	2	2	4	6
625	4	51	0.01	0.17	3	2	2	6
889	4	54	0.05	0.40	3	2	2	6
1012	4	47	0.01	1.45	3	2	3	6
902	4	48	0.03	0.02	3	2	3	6
622	4	49	0.01	0.09	3	2	4	6
648	4	40	0.01	2.00	4	1	4	6
649	4	50	0.01	0.01	4	2	1	6
714	4	51	0.40	0.10	4	2	1	6
691	4	52	0.01	0.40	4	2	1	6
896	4	53	0.05	0.07	4	2	1	6
897	4	53	0.05	0.10	4	2	1	6
802	4	50	0.12	0.01	4	2	2	6
724	4	51	0.01	12.00	4	2	2	6
901	4	49	0.25	0.01	4	2	3	6
753	4	52	0.01	30.00	4	2	3	6
627	4	45	0.01	0.19	0	2	3	7
628	4	50	0.01	0.19	0	2	3	7
657	4	51	0.01	80.00	0	2	4	7
944	4	53	0.20	4.40	1	0	2	7
931	4	49	0.01	3.75	1	1	1	7
921	4	50	0.01	0.12	1	1	1	7
946	4	53	0.01	23.00	1	1	2	7
733	4	49	0.01	0.01	1	2	1	7
734	4	49	0.01	0.01	1	2	1	7
932	4	49	0.12	0.09	1	2	1	7
926	4	50	0.10	0.20	1	2	1	7
940	4	50	0.17	12.50	1	2	1	7
935	4	51	0.08	1.00	1	2	1	7
928	4	51	0.15	0.20	1	2	1	7
951	4	52	0.08	0.20	1	2	1	7
957	4	54	0.05	0.60	1	2	1	7
933	4	50	0.01	11.50	1	2	2	7
956	4	50	0.50	0.35	1	2	2	7
934	4	51	0.13	2.70	1	2	2	7
939	4	52	0.15	4.80	1	2	2	7
953	4	54	0.05	15.50	1	2	2	7
924	4	50	0.07	7.00	1	2	3	7
930	4	51	0.02	17.00	1	2	3	7
943	4	52	0.13	0.07	1	2	3	7
947	4	52	0.01	30.00	1	2	4	7
732	4	49	0.01	0.01	2	2	1	7
954	4	51	0.01	50.00	3	0	3	7
955	4	50	0.01	0.06	3	1	2	7
735	4	49	0.01	1.01	3	2	1	7
927	4	50	0.01	0.20	3	2	1	7
736	4	50	0.01	1.01	3	2	1	7
737	4	51	0.01	2.00	3	2	1	7
925	4	52	0.01	0.20	3	2	1	7
923	4	48	0.10	0.20	3	2	2	7
938	4	51	0.01	0.01	3	2	2	7
922	4	49	0.01	5.60	3	2	3	7
920	4	51	0.01	99.99	3	2	4	7
945	4	52	0.20	20.00	4	0	2	7
720	4	49	0.01	1.00	4	2	1	7

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
717	4	50	0.01	0.01	4	2	1	7
718	4	50	0.01	0.01	4	2	1	7
727	4	50	0.01	0.01	4	2	1	7
728	4	50	0.01	0.01	4	2	1	7
729	4	50	0.01	0.01	4	2	1	7
738	4	50	0.01	0.01	4	2	1	7
730	4	50	0.01	1.01	4	2	1	7
715	4	50	0.01	2.00	4	2	1	7
731	4	51	0.01	2.00	4	2	1	7
659	4	51	0.01	5.00	4	2	1	7
658	4	52	0.01	3.00	4	2	1	7
942	4	52	0.05	2.75	4	2	1	7
937	4	54	0.37	2.60	4	2	1	7
936	4	54	0.50	0.70	4	2	1	7
929	4	50	0.13	0.10	4	2	2	7
721	4	50	0.01	30.00	4	2	3	7
941	4	54	0.26	51.00	4	2	3	7
952	4	53	0.13	0.30	4	2	4	7
1076	5	35	0.04	0.07	0	1	2	1
1113	5	34	0.00	0.01	1	0	1	1
1066	5	33	0.25	0.01	1	1	1	1
1082	5	36	0.01	0.05	1	1	1	1
1116	5	39	0.01	0.59	1	1	4	1
1060	5	33	0.01	0.01	1	2	1	1
1071	5	35	0.04	0.06	1	2	2	1
1080	5	36	0.01	0.07	1	2	2	1
1075	5	34	0.01	0.20	1	2	3	1
1081	5	36	0.09	0.06	3	1	1	1
1074	5	36	0.09	0.99	3	1	2	1
1073	5	35	0.02	2.47	3	2	1	1
1068	5	32	0.01	0.01	3	2	2	1
1115	5	32	0.25	0.01	3	2	2	1
1067	5	34	0.01	1.02	3	2	2	1
1083	5	35	0.01	0.12	3	2	2	1
1077	5	36	0.01	0.01	4	1	1	1
1078	5	40	0.25	0.01	4	1	2	1
1079	5	40	0.03	0.20	4	1	3	1
1063	5	40	0.01	0.25	4	2	1	1
1070	5	32	0.00	9.88	4	2	3	1
1069	5	32	0.04	0.10	4	2	3	1
1118	5	31	0.01	0.20	0	1	2	2
1057	5	31	0.01	0.01	0	2	1	2
1120	5	31	0.01	48.19	0	2	1	2
1119	5	30	0.01	0.01	0	2	2	2
1088	5	31	0.01	1.85	0	2	3	2
1058	5	31	0.12	0.25	1	2	1	2
1085	5	32	0.31	0.10	1	2	1	2
1059	5	31	0.01	0.00	1	2	3	2
1056	5	31	0.01	0.01	3	2	1	2
1061	5	28	0.00	0.01	0	0	3	3
1108	5	28	0.01	0.06	0	1	2	3
1109	5	29	0.01	0.34	0	1	3	3
1065	5	28	0.07	9.51	0	1	6	3
1106	5	32	0.12	0.10	1	1	1	3
1062	5	30	0.01	10.00	3	1	4	4
1112	5	34	0.25	0.59	3	2	2	5

Case	Forest District	Site Elevation	Distance to Nearest Source of Water	Site Size	Site Landform	Type of Water Source	Number of Tool Types	Site Cluster
1064	5	28	0.75	0.01	1	2	5	6
1051	5	25	0.01	0.04	3	2	2	6
1052	5	25	0.50	0.24	3	2	5	6

[a]. Site elevationsare listed in hundreds of feet, distance to nearest water source in miles, site size in acres. Forest districts are recorded from 1 to 5, with 1= Big Summit, 2 = Paulina, 3 = Prineville, 4 = Snow Mountain, and 5 = Grasslands. Site landform is recorded as 1= rolling plain/sagebrush, 2 = meadows, 3 = drainages/bench, and 4 = ridge/saddles. Under types of water source 1 = springs, and 2 = river/streams. For tool types 1 and 2 = limited act, 3 and 4 = moderate activity, and 5 and above = high activity.

BIBLIOGRAPHY

Aikens, C. M.
1993 Archaeology of Oregon. 3rd ed. U.S. Department of Interior Bureau of Land Management, Portland, Oregon.

Aikens, C. M., D. L. Cole, and R. Stuckenrath
1977 Excavations at The Dirty Shame Rockshelter, Southeastern Oregon. Tebiwa: Miscellaneous Papers of the Idaho State University Museum of Natural History 4. Pocatello, Idaho.

Aikens, C. M., D. K. Grayson, and P. J. Mehringer, Jr.
1982 Final Project Report to the National Science Foundation on the Steens Mountain Prehistory Project, Part III, Technical Description of the Project Results. Department of Anthropology, University of Oregon, Eugene, Oregon.

Aikens, C. M., and D. L. Jenkins (editors)
1994 Archaeological Researches in the Northern Great Basin: Fort Rock Archaeology Since Cressman. University of Oregon Anthropological Papers, in press. Eugene, Oregon.

Aikens, C. M., and R. Minor
1978 Obsidian Hydration for Klamath Prehistory. Tebiwa 11:1-17.

Ambrose, W.
1976 Intrinsic Hydration Rate Dating of Obsidian. In Advances in Obsidian Glass Studies, pp. 81-105, edited by R. E. Taylor. Noyes Press, Park Ridge, New Jersey.

Ames, K., and A. G. Marshall
1981 Village Demography and Subsistence Intensification on the Southern Columbia Plateau. North American Archaeologist 2(1):25-52.

Antevs, E.
1955 Geologic-Climatic Dating in the West. American Antiquity, 20:317-335.

Armitage, C. L.
1983 An Archaeological Model of Settlement and Subsistence for the Central Oregon Northern Pauite. M.A. thesis, Department of Anthropology Idaho State University, Pocatello, Idaho.

Armitage, C. L., and T. Burge
1986 Archaeological Investigations in the Wind Creek Drainage, East-Central Oregon. Paper presented at the Northwest Anthropological Conference, Moscow, Idaho, March 27-29, 1986.

Bailey, V.
1936 The Mammals and Life Zones of Oregon. U.S. Department of Agriculture, Bureau of Biological Survey, North American Fauna 55. Washington, D.C.

Baldwin, E. M.
1992 Geology of Oregon. 4th ed. Kendall/Hunt Publishing Company, Dubugue, Iowa.

Balls, E. K.
1972 Early Uses of California Plants. University of California Press, Berkeley, California.

Bean, L. J., and K. Saubel
1972 Temalpakh. Malki Museum Press, Banning California.

Beck, C.
1984 Steens Mountain Surface Archaeology: the Sites. Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Bedwell, S. F.
1973 Fort Rock Basin: Prehistory and Environment. University of Oregon Books. Eugene, Oregon.

Berreman, J. V.
1937 Tribal Distributions in Oregon. American Anthropological Association Memoir 47.

Binford, L.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity (45):4-20.

Blyth, B.
1938 Northern Paiute Bands in Oregon. American Anthropologist 40:402-405.

Byram, S.
1993 Letter Report Regarding the Obsidian Hydration of a Sample of Projectile Points from Central Oregon. State Museum of Anthropology Obsidian Hydration Analysis Report Project 91-2. Ms on file State Museum of Anthropology, University of Oregon, Eugene, Oregon.

Callahan, E.
1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flint Knappers and Lithic Analysts. Archaeology of Eastern North America 7(1):1-80. Eastern States Archaeological Federation.

Chaplin, R. E.
1971 The Study of Animal Bones from Archaeological Sites. Seminar Press, London.

Churchill, T. E., and P. C. Jenkins
1986 An Archaeological Description of the Testing of Five Prehistoric Sites Within the Wind Creek Timber Sale. Cultural Resource Report No. 1 Ochoco National Forest, Portland, Oregon.

Clelow, C. W. Jr.
1967 Time and Space Relations of Some Great Basin Projectile Point Types. University of California Archaeological Survey Reports 70:141-149, Berkeley.

Cole, D.
1969 1967 and 1968 Archaeological Excavations of the Mack Canyon Site. University of Oregon, Museum of Natural History, Eugene, Oregon.

1977 Archaeological Explorations at Sunriver, Deschutes County, Oregon. University of Oregon, Museum of Natural History, Eugene, Oregon.

Colville, F. V.
1985 Notes on the Plants Used by the Klamath Indians of Oregon Contributions from the U.S. National Herbarium Vol. V No. 2. USDA Division of Botany, Washington, D.C.

Connolly, T. J., D. L. Jenkins, and J. Benjamin
1993 Archaeology of Mitchell Cave (35WH122): A Late Period Hunting Camp in the Ochoco Mountains, Wheeler County, Oregon. University of Oregon Anthropological Papers 46. Eugene, Oregon.

Couture, M.
1978 Recent and Contemporary Foraging Practices of the Harney Valley Paiute. M.A. thesis Portland State University. Portland, Oregon.

Couture, M., M. R. Ricks, and L. Housley
1986 Foraging Behavior of a Contemporary Northern Great Basin Population. Journal of California and Great Basin Anthropology 8 (2):150-160.

Cressman, L. S.
1936 Archaeological Survey of the Guano Valley Region in South Eastern Oregon. Studies in Anthropology 1, University of Oregon Monographs, Eugene, Oregon.

1939 Early Man and Culture in the Nothern Great Basin Region of South Central Oregon. Carnegie Institution of Washington Yearbook No. 38, pp. 314-317. Washington D.C.

1942 Archaeological Researches in the Northern Great Basin. Carneigie Institute of Washington Publications 538.

Cressman, L. S., D. L. Cole, W. A. Davis, T. M. Newman, and D. J. Scheans
1960 Cultural Sequences at the Dalles, Oregon: A Contribution to Pacific Northwest Prehistory. Transactions of the American Philsophical Society 50(10). Philadelphia.

Daugherty, Richard
1960 An Archaeological Survey of Pacific Gas Transmission Companys Alberta to California Pipeline System: Idaho, Oregon, Washington. Ms on file, Washington State University, Pulman, Washington.

Davis, P.
1988 Holocene Glacier Fluctuations in the American Cordillera. Quaternary Science Reviews (7): 129-157.

Deevey, E., and R. F. Flint
1957 Postglacial Hypstithermal Interval. Science 125: 182-184.

Dickson, E.
1946 Food Plants of Western Oregon Indians. Unpublished M.A. thesis Leland Stanford Junior University. Stanford, California.

Driver, H., and W. Massey
1957 Comparitive Studies of North American Indians. Transactions of the American Philosophical Society 67:165-456.

Dumond, D. E. and R. Minor
1983 Archaeology in the John Day Reservoir: The Wildcat Canyon Site, 35CR-616. University of Oregon Anthropological Papers 30. Eugene, Oregon.

Easterbrook, D. J.
1986 Stratigraphy and Chronology of Quaternary Deposits of the Puget Lowlands and Olympic Mountains of Washington and the Cascade Mountains of Washington and Oregon.. In Quaternary Glaciations in the Northern Hemisphere 145-162, edited by V. Sibriva, D. Q. Bowen, and G. M. Richmond. Pergamon Press.

Endzweig, P.
1992 Canyons and Crests: An Archaeological Survey of the Pine Creek Basin, North-Central Oregon. Oregon State Museum of Anthropology, University of Oregon 92-2.

1994 Late Archaic Variability and Change on the Southern Columbia Plateau: Archaeological Investigations in the Pine Creek Drainage of the Middle John Day River, Wheeler County, Oregon. Unpublished PhD. Dissertation, Department of Anthropology, University of Oregon.

Fagan, J. L.
1974 Altithermal Occupation of Spring Sites in the Northern Great Basin. University of Oregon Anthropological Papers 6. Eugene, Oregon.

1975 Obsidian Hydration Analysis of Three Sites in Western Oregon. In Archaeological Studies in the Willamette Valley Oregon, edited by C.M. Aikens. University of Oregon Anthropological Papers 8, pp. 505-520. Eugene, Oregon.

Flenniken, J. J., T. L. Ozbun, and J. A. Markos
1992 Archaeological Testing and Evaluation of the Rough Site 35CR-616. Lithic Analysts Research Report 27. Ms on file Ochoco Naional Forest, Prineville, Oregon.

Folk, R. L. and W. C. Ward
1956 A Study in the Significance of Grain Size Parameters. Journal of Sedimentology and Petrology. 27:3-26.

Fowler, Don D. (editor)
1993 Archaeological Investigations in Warner Valley, Oregon, 1989-1992 An Interim Report. University of Nevada, Reno Department of Anthropology Technical Reports 93-1.

Fowler, C.S., and J. Leland
1967 Some Northern Paiute Native Categories. Ethnology, 6:381-404.

Fowler, C. S., and Sven Liljeblad
1986 Northern Paiute. In Great Basin, edited by Warren d'Azevedo, pp. 435-465. Handbook of North American Indians, vol. 11, William Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

French, D., and K. French
n.d. Field Notes, Wasco and Sahaptin, Warm Springs Reservation. Manuscript in possession of the authors.

Friedman, I.
1968 Hydration Rind Dates of Rhyolite Flows. Science, 159:878-880.

Friedman, I., and R. L. Smith
1960 American Antiquity. 25:476.

Gibson, E.
1989 A Cultural Resource Survey of the FY 1990 La Pine, Oregon Timber Sale. Infotec Research Inc., Eugene, Oregon. Report on file, USDI Bureau of Land Management, Prineville District, Prineville, Oregon.

Gordus, A. A., G. A. Wright, and J. B. Griffen
1968 Obsidian Sources Characterized By Neutron Activation Analysis Science. 161:382-384.

Hansen, H. P.
1947 Postglacial Forest Succession, Climate, and Chronology in the Pacific Northwest. Tranactions of the American Philosophical Society 37. Philadelphia.

Heizer, R. F., and M. A. Baumhoff
1961 The Archaeology of Two Sites at Eastgate, Churchill County, Nevada. I. Wagon Jack Shelter. University of California Archaeological Record, 20(4).

Heizer, R. F., and T. R. Hester
1978 Great Basin. In Chronologies in New World Archaeology, edited by R.E. Taylor, and C.W. Meighan, pp. 147-200. Academic Press, New York.

Hemphill, C., C. L. Armitage, N., Heupel, and M. Hemphill
1993 Cultural Resource Survey of the Sam Planning Area, Paulina Ranger District, Ochoco National Forest. Continuum Cultural Resource Consultants, Inc. Report on file, Ochoco National Forest, Prineville, Oregon.

Heusser, C. J.
1960 Late Pleistocene Environments of North Pacific America. American Geographical Society Special Publication, 35.

Hibbs, C., and C. Willard
1976 Deschutes River Cultural Resource Survey. Ms. on file Prineville Office Bureau of Land Management. Prineville, Oregon.

Holmer, R. N.
1978 A Mathematical Typology for Archaic Projectile Points of the Eastern Great Basin. Ph.D. dissertation, Department of Anthropology, University of Utah,. Salt Lake City, Utah.

1986 Common Projectile Points of the Intermountain West. In Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings, edited by C.J. Condie and Don D. Fowler, pp. 89-115. University of Utah Anthropological Papers 110. Salt Lake City.

Hughes, R. E.
1984 Obsidian Studies In the Great Basin. Contributions of the University of California Archaeological Research Facility No. 45.

1985 X-ray Fluorescence Analysis of Obsidian From Five Localities Along the Sycan and Sprague Rivers, Winema National Forest, Klamath County, Oregon. Report on file, Winema National Forest, Klamath Falls, Oregon.

1986a Energy Dispersive x-ray Flourescence Analysis of Obsidian From Dog Hill and Burns Butte, Oregon. Northwest Science. 60(2):73-80.

1986b Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and South Central Oregon. University of California Publications in Anthropology. Vol. 17.

1987 X-ray Fluorescence Analysis of Obsidian Source Specimens and Artifacts from the Wind Creek Sites. Letter report on file, Ochoco National Forest, Prineville, Oregon.

1993 X-ray Fluorescence Analysis of Obsidian Source Specimens from Central Oregon. Letter report on file, Ochoco National Forest, Prineville, Oregon.

Hughes, R. E., and P. Mikkelsen
1986 Trace Element Geochemistry of Obsidian Along the Sycan and Sprague Rivers, Winema National Forest, Oregon. Report on file, Winema National Forest, Klamath Falls, Oregon.

Jack, R. N.
1976 Prehistoric Obsidian in California 1: Geochemical Aspects. In Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives, pp. 183-217, edited by R.E. Taylor. Noyes Press, Park Ridge, New York.

Jack, R. N., and I. S. E. Charmichael
1969 The Chemical "Fingerprinting" of Acid Volcanic Rocks. California Division of Mines and Geology, Special Report 100:17-32. San Francisco.

Jenkins, D. L.
1994 Settlement-Subsistence Patterns in the Fort Rock Basin: A Cultural-Ecological Perspective on Human Responses to Fluctuating Wetlands Resources of the Last 5000 Years. In Archaeological Researches in the Northern Great Basin: Fort Rock Archaeology Since Cressman, edited by C.M. Aikens and D.L. Jenkins. University of Oregon Anthropological Papers, in press.

Jennings, J. D.
1957 Danger Cave. University of Utah Anthropological Papers 27. Salt Lake City.

Jochim, M. A.
1991 Archaeology as Long-Term Ethnography. American Anthropologist (93):309-321.

Johnson, L.
1969 Obsidian Hydration Rates for the Klamath Basin of California and Oregon. Science. 165: 1354-56.

Jones, G. T.
1984 Prehistoric Land Use in the Steens Mountain Area, Southeastern Oregon. Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Jorgensen, J.
1980 Western Indians: Comparitive Environments, Languages, and Cultures of 172 Western American Indian Tribes. W.H. Freeman, San Francisco.

Krieger, A. D.
1938 University of Oregon Archaeological Reconnaissance in North Central Oregon. Manuscript on file, University of Oregon, Eugene, Oregon.

Layton, T.
1972a Lithic Chronology in the Fort Rock Valley. Tebiwa. 15 (2):1-21.

1972b A 12,000 Year Obsidian Hydration Record of Occupation, Abandonment, and Lithic Change From the Northwest Great Basin. Tebiwa. 15(2):22-28.

1979 Lithic Chronology in the Fort Rock Valley, Oregon: An Obsidian Hydration study from Couger Mountain Cave. Tebiwa 13(15):1-22.

Lebow, C. G., R. M. Pettigrew, J. M. Silvermoon, D. L. Chance, R. Boyd, Y. Hajda, and H. Zenk
1990 A Cultural Resource Overview for the 1990's, BLM Prineville District, Oregon: Volume 1. Infotec Research Inc. Report submitted to and on file, USDI Bureau of Land Management Prineville District, Prineville, Oregon.

Leonhardy, F. C., and D. G. Rice
1970 A Proposed Typology for the Lower Snake River Region. Northwestern Anthropological Research Notes 4(1):1-29.

Lohse, E.
1984 Rufus Woods Lake Projectile Point Chronology. In Summary and Results, Chief Joseph Dam Cultural Resource Project, edited by M.E.W. Jaehnig and S.K. Campbell. Office of Public Archaeology. Seattle, Washington.

Lyman, R. L., M. A. Gallagher, C. G. Lebow, and M. K. Weber
1983 Cultural Resource Reconnaissance in the Redmond Training Area, Central Oregon. Report to the Oregon Military Department, Salem, and the USDI Bureau of Land Management. Report on file USDI, Bureau of Land Management, Prineville District, Prineville, Oregon.

McDonald, S. A.
1986 Aboriginal Procurement of Dooley Mountain Obsidian: A Chronological Perspective. In K.M. Ames (edition) Contributions to the Archaeology of Oregon 1983-1986 Association of Oregon Archaeologists Occasional Paper. No. 3. pp. 165-189.

McFarland, J.
1989 An Analysis of Two Post Mazama Prehistoric Flake Stone Scatters in the Upper Deschutes River Basin of Central Oregon. Master's thesis, Oregon State University, Corvallis, Oregon.

Mahor, J.
1954 Ethnobotany of the Oregon Paiute of the Warm Springs Reservation. B.A. thesis Reed College, Portland, Oregon.

Mason, O. T.
1896 Influence of Environments Upon Human Industries and Art. Annual Report of the Smithsonian Institution for 1895, pp. 639-665.

Mehringer, P., J., Jr.
1985 Late Quaternary Pollen Records From the Interior Pacific Northwest and the Northern Great Basin of the United States. In Pollen Records of the Late Quaternary North American Sediments, edited by V.A. Bryant and R.G. Holloway, pp. 167-189. American Association of Stratigraphic Palynologists, Dallas, Texas.

Mehringer, P., J., Jr., and K. C. Reid
1988 Sediment Sequence from Twin Lakes Wallowa-Whitman National Forest, Oregon. Center for Northwest Anthropology Contributions in Cultural Resource Management 25. Washington State University, Pullman, Washington.

Michels, J. W.
1967 Archaeology and Dating by Hydration of Obsidian. Science. 158, no. 3798: 211-214.

Michels, J. W., and I. S. T. Tsong
1980 Obsidian Hydration Dating: A Coming of Age. In Advances In Archaeological Method and Theory. Vol. 3, edited by Michael Schiffer, pp. 405-444. Academic Press.

Minor, R. (editor)
1980 A Survey For Cultural Resources For the Joint Venture Project, Southern Malheur County, Oregon. Report on file Oregon State Museum of Anthropology, Eugene, Oregon.

Minor, R., S. D. Beckham, K. A. Toepel, and R. Greenspan
1987 Prehistory and History of the Ochoco National Forest: Part I Overview. Ochoco National Forest Cultural Resource Report No. 3. Report on file, Ochoco National Forest, Prineville, Oregon.

Minor, R., and K. A. Toepel
1984 Lava Island Rockshelter: An Early Hunting Camp in Central Oregon. Occasional Papers of the Idaho Museum of Natural History 34. Pocatello, Idaho.

Moerman, D.
1982 Geraniums for the Iroquois. Reference Publications Inc.

Moss, M.
1984 Data Recovery Plan For Six Archaeological Sites in the Wind Creek Timber Sale. Manuscript on file Ochoco National Forest, Prineville, Oregon.

Murphey, E.
1959 Native Uses of Native Plants. Mendocino County Historical Society.

Musil, R.
1992 Adaptive Transitions and Environmental Change in the Northern Great Basin: A View from Diamond Swamp. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.

Norusis, M., J.
1988 SPSS/PC+ V2.0 Advanced Statistics. SPSS Inc.

Newman, T. M., R. Bye, C. D. Carley, R. D. McGilva, and D. Moretty
1974 Archaeological Reconnaissance of the Malheur National Wildlife Refuge, Harney County, Oregon: 1974. Manuscript on file, Oregon State Museum of Natural History, University of Oregon, Eugene, Oregon.

Nelson, C. M..
1969 The Sunset Creek Site (45KT-28) and its Place in Plateau Prehistory. Washington State University Laboratory of Anthropology Reports of Investigations 47. Pullman, Washington.

Oetting, A. C.
1989 Villages and Wetland Adaptations in the Northern Great Basin: Chronology and Land Use in the Lake Abert-Chewaucan Marsh Basin, Lake County, Oregon. University of Oregon Anthropological Papers 41, Eugene, Oregon.

Oetting, A. C., and R. M. Pettigrew
1985 An Archaeological Survey in the Lake Abert-Chewaucan Basin Lowlands, Lake County, Oregon. Oregon State Museum of Anthropology Survey Report 85-5. Eugene, Oregon.

Oregon State University Extension Circular 809
1972 Nutritive Values of Native Foods of Warm Springs Indians. Extension Services, Oregon State University, July 1972. Corvallis, Oregon.

Origer, T.
1987 Obsidian Hydration of Obsidian Specimens from the Wind Creek Sites. Letter report on file, Ochoco National Forest, Prineville, Oregon.

Orton, C.
1980 Mathematics in Archaeoogy. Cambridge University Press.

Paulson, D. J.
1977 Ochoco National Forest Soil Resource Inventory: Pacific Northwest Region. USDA Forest Service, Portland.

Pettigrew, R. M., and R. L. Spear
1984 Archaeological Investigations of Two Sites (35DS-56 and 57) on the Cascades Lakes Highway, Deschutes County, Oregon. Oregon State Museum of Anthropology Survey Report 84-2. University of Oregon, Eugene, Oregon.

Polk, M. R.
1976 Cultural Resource Inventory of the John Day River Canyon. Report on file, USDI Bureau of Land Management, Prineville District, Prineville, Oregon.

Ray, V.
1936 Native Villages and Groupings of the Columbia Basin. Pacific Northwest Quarterly 27:00-152.

Reid, K. C., J. Draper, and P. Wigand
1989 Prehistory and Paleoenvironments of the Silvies Plateau, Harney Basin, Southeastern Oregon. Center for Northwest Anthropology Project Report 8. Washington State University, Pullman, Washington.

Rice, D. G.
1972 The Windust Phase in the Lower Snake River Region Prehistory. Washington State University Laboratory of Anthropology Reports of Investigations 50. Pullman, Washington.

Roscoe, E.
1967 Ethnomalocology and Paleocology of the Round Butte Archaeological sites: Deschutes River Basin, Oregon. University of Oregon Museum of Natural History Bullitin 6. Eugene, Oregon.

Ross, C. S., and R. L. Smith
1958 Water and Other Volatiles in Volcanic Glasses. American Mineralogist 40:1071-1078.

Ross, R.
1963 Prehistory of the Round Butte Area, Jefferson County Oregon Unpublished Master's thesis, Department of Anthropology, University of Oregon, Eugene, Oregon.

Russell, I. C.
1905 Preliminary Report on the Geology and Water Resources of Central Oregon. US Geological Survey Bulletin 217.

Sampson, C. G.
1985 Nightfire Island: Later Holocene Lakemarsh Adaptation on the Western Edge of the Great Basin. University of Oregon Anthropological Papers 33. Eugene, Oregon.

Sappington, R. L.
1980 X-ray Flourescence Analysis of the Obsidian Artifacts From The Aurora Joint Venture Project, Southern Malheur County, Oregon. In A Survey For Cultural Resources For the Joint Venture Project, Southern Malheur County, Oregon, edited by Rick Minor. Oregon State Museum of Anthropology, Eugene, Oregon.

1982 X-ray Flourescence Analysis of a Sample of Obsidian Artifacts From the Gravelly Flat Site, Ochoco National Forest, Oregon. Letter report on file, Ochoco National Forest, Prineville, Oregon.

Sappington, R. L., and K. A. Toepel
1981 X-ray Flourescence Analysis of Obsidian Specimens From Central Oregon. In Survey and Testing of Cultural Resources Along Bonniville Power Administration's Buckley-Summer Lake Transmission Line Corridor, Central Oregon, edited by Kathryn Toepel and Stephen Dow Beckham. Eastern Washington Reports in Archaeology and History, pp. 100-105.

Schalk, R.
1987 Archaeology of the Morris Site (35GM91) on the John Day River, Gilliam County, Oregon. Prepared by the Universiyt of Washington, Office of Public Archaeology, for the U.S. Army Corps of Engineers, Portland District.

Scott, S.
1985 Sand Springs: A Lithic Workshop on the High Lava Plains of Central Oregon. Tebiwa 22:1-9.

1986a A Cultural Resource Survey of the Deschutes River, From Bend to the Deschutes/Jefferson County Line, Deschutes County, Oregon. Report on file, Deschutes County Community Development Department, Bend, Oregon.

1986b An Analysis of Archaeological Materials Recovered During Test Excavations of Six Prehistoric Sites on the Deschutes National Forest in Central Oregon. USDA Forest Service Cultural Resource Report 2. Report on file, USDA DEschutes National Forest, Bend, Oregon.

1986c A Preliminary Analysis of the Wind Creek Archaeological Site Assemblages. Manuscript on file Ochoco National Forest, Prineville, Oregon.

Sharrock, F.
1966 Prehistoric Occupation Patterns in Southwest Wyoming and Cultural Relations With the Great Basin. University of Utah Department of Anthropology Anthropological Papers No.77. Salt Lake City, Utah.

Shipman, P., G. Foster, and M. Schoeninger
1984 Burnt Bones and Teeth: and Experimental Study of Color, Morphology, Crystal Structure and Shrinkage. Journal of Archaeological Science 11(4):307-327.

Skinner, C.
1983 Obsidian Studies in Oregon: An Introduction to Obsidian and an Investigation of Selected Methods of Obsidian Characterization Utilizing Obsidian Collected at Prehistoric Quarry Sites in Oregon. Master's thesis in Interdiscplinary Studies, University of Oregon, Eugene, Oregon.

1993 Comparison of the Chemical Composition of the Obsidian from the Wind Creek Sites, Beaverdam Creek Site, and a Sample of Projectile Points from Central Oregon. Letter report submitted to, and in the possession of the author.

Steumke, S.
1989 The Archaeology of Peninsula I Site, 35JE-53, A Central Oregon Rock Shelter. Master's paper, Department of Anthropology, University of Oregon, Eugene, Oregon.

Steward, J. H.
1938 Basin -Plateau Aboriginal Sociopolitical Groups. Bureau of American Ethnology Bulletin 120.

Stewart, O.
1939 The Northern Paiute Bands. University of California Anthropological Records, (2) 3,

1941 Culture Element Distributions: XIV Northern Paiute. University of California Anthropological Records, 4:361-447.

Thomas, D. H.
1973 An Emperical Test for Steward's model of Great Basin Settlement Paterns. American Antiquity (38):155-176.

1981 How to Classify Projectile Points from the Monitor Valley Nevada. Journal of California and Great Basin Anthropology, 3 (1):7-43.

1983 The Archaeology of Monitor Valley. Vol. 59 (1), Anthropological Papers of the Americam Museum of Natural History, New York.

Toepel, K. A.
1985 The Flanagon Site: 6000 Years of Occupation in The Upper Willammette Valley, Oregon. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene, Oregon.

Toepel, K. A., W. Willingham, and R. Minor
1980 Cultural Resource Overview of BLM Lands in North-Central Oregon: Archaeology, Ethnography, History. University of Oregon Anthropological Papers 17, Eugene, Oregon.

USDA
1984 Programmatic Memorandum of Agreement for the Treatment of Lithic Scatters. Pacific Northwest Region, Portland, Oregon.

Van Winkle, W.
1914 The Quality of Surface Water In Oregon. U.S. Geological Survey Water Paper 363.

Weeden, N.
1975 A Survival Handbook to Sierra Flora. Interface California Corporation.

Weide, M. L.
1968 Cultural Ecology of Lakeside Adaptations In the Western Great Basin. Phd. dissertation, Department of Anthropology, University of California, Los Angeles.

Wigand, P. E.
1987 Diamond Pond, Harney County, Oregon: Vegetation History and Water Tables in the Eastern Oregon Desert. Great Basin Naturalist 47:427-458.

Wilde, J. D.
1985 Prehistoric Settlements in the Northern Great Basin: Excavations and Collections Analysis in the Steens Mountain Area, Southeastern Oregon. Unpublished Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugenc, Oregon.

Willig, J. A.
1988 Paleo-Archaic Adaptations and Lakeside Settlement Patterns in the Northern Alkali Basin, Oregon. In Early Human Occupations in Far Western North America: the Clovis Archaic Interface, edited by Judith A. Willig, C. Melvin Aikens, and John L. Fagan. Nevada State Museum Anthropological Papers 21:417-482. Carson City, Nevada.

Wissler, C.
1922 The American Indian: An Introduction to the Anthropology of the New World. 2nd ed. Oxford University Press.

Yellen, J. E.
1977 Archaeological Approaches to the Present. Academic Press.

Zilverberg, G. M.
1983 Building Subsistence Models in the Blue Mountain Region of Northeastern Oregon. In Contributions to the Archaeology of Oregon: 1981-1982. Association of Oregon Archaeologists Occasional Papers No. 2, pp 123-136.