BURE EMENT
COLO

ENVIRONMENTAL CONSTRAINT AND SETTLEMENT PREDICTABILITY, NORTHWESTERN COLORADO

•

Robert E. Hurlbett

CULTURAL RESOURCE SERIES

NO. 3

ARCHEOLOGICAL

ERRATUM

As the result of omissions in the text as submitted by the author, the "Environmental Item Cluster Profiles" (Figures 8-16) are incomplete as they appear in final published form. Each profile illustrates the relationships between one of the final 9 O Types (site-types) and the four environmental variables related to site location. For a more complete understanding of these relationships (as described in Chapter IV, pages 49-64), the reader is advised to consult the following completed profiles:

Figure 8

Environmental Item Cluster Profile

For O-TYPE 1

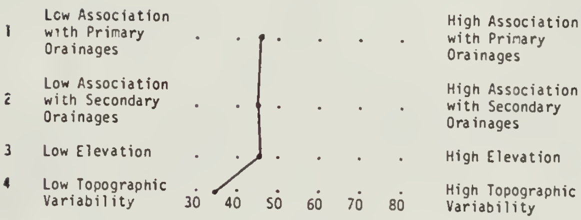


Figure 9

Environmental Item Cluster Profile

For O-TYPE 2

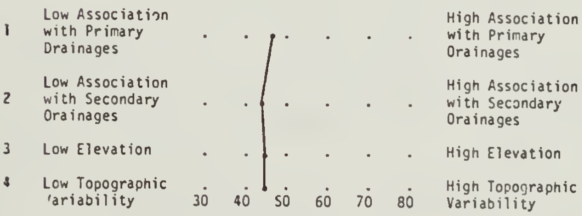


Figure 10

Environmental Item Cluster Profile

For O-TYPE 3

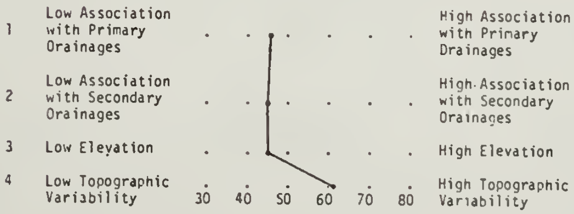


Figure 11

Environmental Item Cluster Profile

for O-TYPE 4

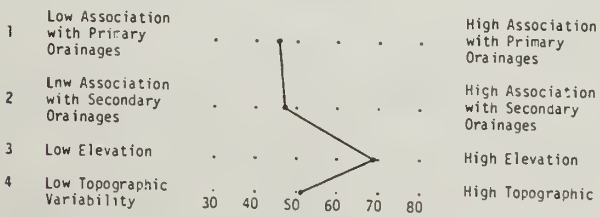


Figure 12

Environmental Item Cluster Profile
For O-TYPE 5

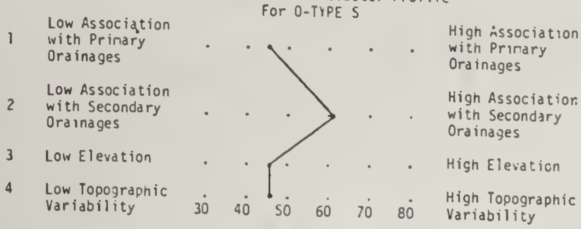


Figure 13

Environmental Item Cluster Profile
For O-TYPE 6

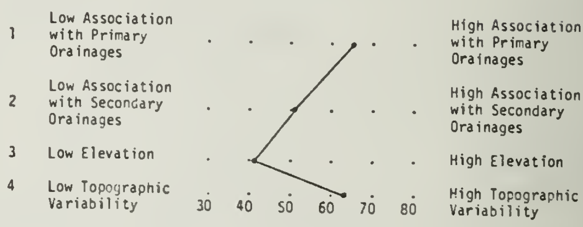


Figure 14

Environmental Item Cluster Profile
For O-TYPE 7

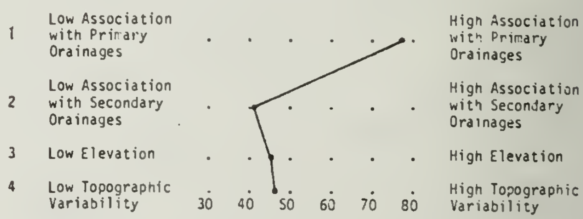


Figure 15

Environmental Item Cluster Profile
For O-TYPE 8

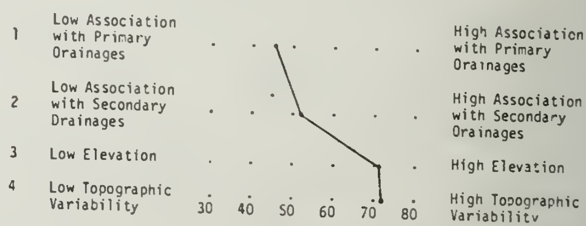
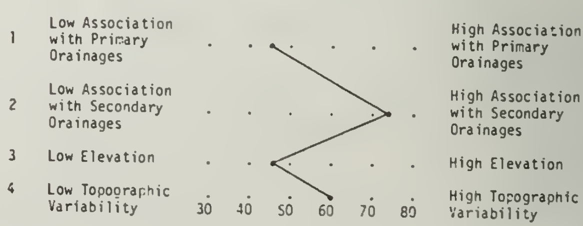


Figure 16

Environmental Item Cluster Profile
For O-TYPE 9



ENVIRONMENTAL CONSTRAINT AND SETTLEMENT PREDICTABILITY,

NORTHWESTERN COLORADO

by

Robert E. Hurlbett

COPIES OF THIS REPORT ARE AVAILABLE FROM:

BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
ROOM 700, COLORADO STATE BANK BUILDING
1600 BROADWAY
DENVER, COLORADO 80202

FOREWORD

Cultural resource management in the Bureau of Land Management is achieving a role of full scale implementation that necessitates innovative approaches to archaeological site inventory. The need to generate inventory on site locations, density, and relative significance for large land areas under study for Environmental Statement documents, planning areas, and other management considerations has increased my interest in sampling techniques.

The use of archaeological sampling applied to selected areas is expected to produce information that will assure application of sound management decisions for cultural as well as other resources within the purview of the Bureau of Land Management. Additionally, a broad identification of archaeological sites throughout the State of Colorado will occur.

The coal industry and BLM, working together, contributed to the generation of information used by Mr. Robert Hurlbett in this work; made in conjunction with coal studies in northwest Colorado.

As the importance of cultural resource management continues to emerge, a means of inventory, beyond the traditional methods, will become necessary to conduct archaeological surveys that will more rapidly produce physically obscure information. BLM will encourage research into these areas. Mr. Hurlbett's thesis in Settlement Predictability is an example of this involvement.

I am pleased to make this third publication in cultural resources available to the public and to the professional community.

DALE R. ANDRUS
State Director
Colorado
Bureau of Land Management

ABSTRACT

The Piceance Creek Basin is located in northwestern Colorado, midway between the Colorado and White Rivers and west of the Grand Hogback. During the summers of 1973 and 1974, selected areas of this region were intensively surveyed. On the basis of the data gathered, a predictive model is formulated. This model may be used to suggest areas of potential occupation in areas which are similar in environment, but untested archeologically.

The method selects discrete items of the modern environment that display statistical correlation with observed site distribution. These items are then grouped by cluster analysis to determine which environmental characteristics they are evaluating. A similar procedure classifies sites on the basis of patterned relationships with the characteristics. These patterns are then imposed on nearby areas yet to be investigated. If strong similarities are observed, occupation potential is assumed.

In the Piceance Creek Basin, the locations of 126 prehistoric and historic occupation sites were evaluated against 37 items of landform, drainage configuration, vegetation, and intersite distance. Fifteen of these items were found to be significant. They formed four clusters: primary and secondary drainage association, and elevation and topographic variability. Sites were grouped into nine types representing the observed statistical diversity between site distribution and present day environment. Fifteen sites were subsequently rejected as unique.

This methodology is unsuitable as an explanatory tool because paleoenvironmental and chronological data are absent. Its utility lies in the ability afforded the investigator to predict site locations within a region, after preliminary sampling has been completed. In this way, the economy of future investigations may be improved.

Robert E. Hurlbutt
Anthropology Department
Colorado State University
Fort Collins, Colorado 80523
Fall, 1976

ACKNOWLEDGMENTS

My appreciation is extended to: Dr. Calvin H. Jennings for his guidance, training and support during the development of the methodology, Dr. Douglas D. Sjogren for his invaluable statistical and programming assistance, Drs. Janet Jordan and John S. Krebs of my graduate committee, and to Dr. Elizabeth A. Morris for her interest, support and editorial assistance.

Valuable aid and encouragement was also provided by Bill Biggs, Marilee Montgomery, Paul and Diane Baxter, and my parents.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

STATEMENT OF OBJECTIVES

Since the 1950s, archeological studies have increasingly favored regional explanatory schemes over localized, hierarchical chronologies based on trait relationships. This trend has shifted emphasis from single site localities to non-randomly distributed site clusters. Often operating within an ecological framework, these studies have gathered data at a level where properly identified operational variables best characterize the broad range of prehistoric activities.

Northwestern Colorado's Piceance Creek Basin presented an opportunity to apply this regional perspective - within given limits of time, personnel, and money. The stated purposes of the original investigations were to identify the sites of former human activity, to assess their scientific and historical value, and to relate them to present-day activities. On the basis of the resultant information, a program of cultural resource management will be developed to prepare for the proposed exploitation of extensive deposits of oil shale. Corollary purposes included an inquiry into Ute Indian origins, an assessment of the extent of possible Paleoindian occupation, and a comparison of extinct patterns of socio-cultural interaction to those already intimated in surrounding areas of Colorado, Wyoming, and Utah.

This paper investigates variability in the distribution of occupation areas in the Piceance Creek Basin as an outgrowth of the initial objectives and field work. The method described herein recognizes that behavior is a patterned phenomenon, partially dependent upon the spatial distribution of resources (Huscher 1939; Judge 1973; Kroeber 1939). This distribution places undefined constraints on settlement, expressed, in part, by the observed non-random arrangement of site locations. It should be possible to theoretically identify specific resources operating within this system, by assessing the magnitude of the correlation between resource items and site locations, if the prehistoric resource compliment is known.

The circumstances of this analysis require resource distribution be expressed in the context of the current environment, because paleoenvironmental data are unavailable, although it may be assumed that certain modern phenomena such as aspect, slope, and drainage configuration have not appreciably altered. Prehistoric behavioral patterning, as reflected by modern conditions, does not imply causative relationships among observed phenomena. A present day configuration between site location and resource item may be observed, but correlation between this pattern and the prehistoric reality cannot be assumed.

With these limitations in mind, the objectives of this analysis are: 1) to identify environmental characteristics or variables composed of discrete environmental items displaying statistical correlation with site distribution; 2) to identify site types based upon patterned relationships to the variables; and 3) to predict site locations in unexamined areas of the survey region.

Shortcomings exist in the field procedures, with subsequent restrictions in the quantity and variety of data. Sources on the analysis of settlement were consulted but found to be inappropriate, because temporal relationships were undetermined and defined occupation sequences lacking. Therefore, it was necessary to hold cultural and temporal variability constant. Behavioral diversity through time is disregarded, and the final analysis identifies site locations by kind, but does not assess the reasons for occupancy.

The significance of the methodology lies in the ability of the investigator to predict site location in areas not already subjected to examination. Previously surveyed areas may also be reinvestigated for the presence of undiscovered sites. With the completion of the original field work and the identification of relationships between items of environment and site location, the economy of subsequent investigations within the region may be maximized. While the data are not amenable to cultural-historical reconstruction, they make predictive modeling possible without paleoenvironmental and chronological information.

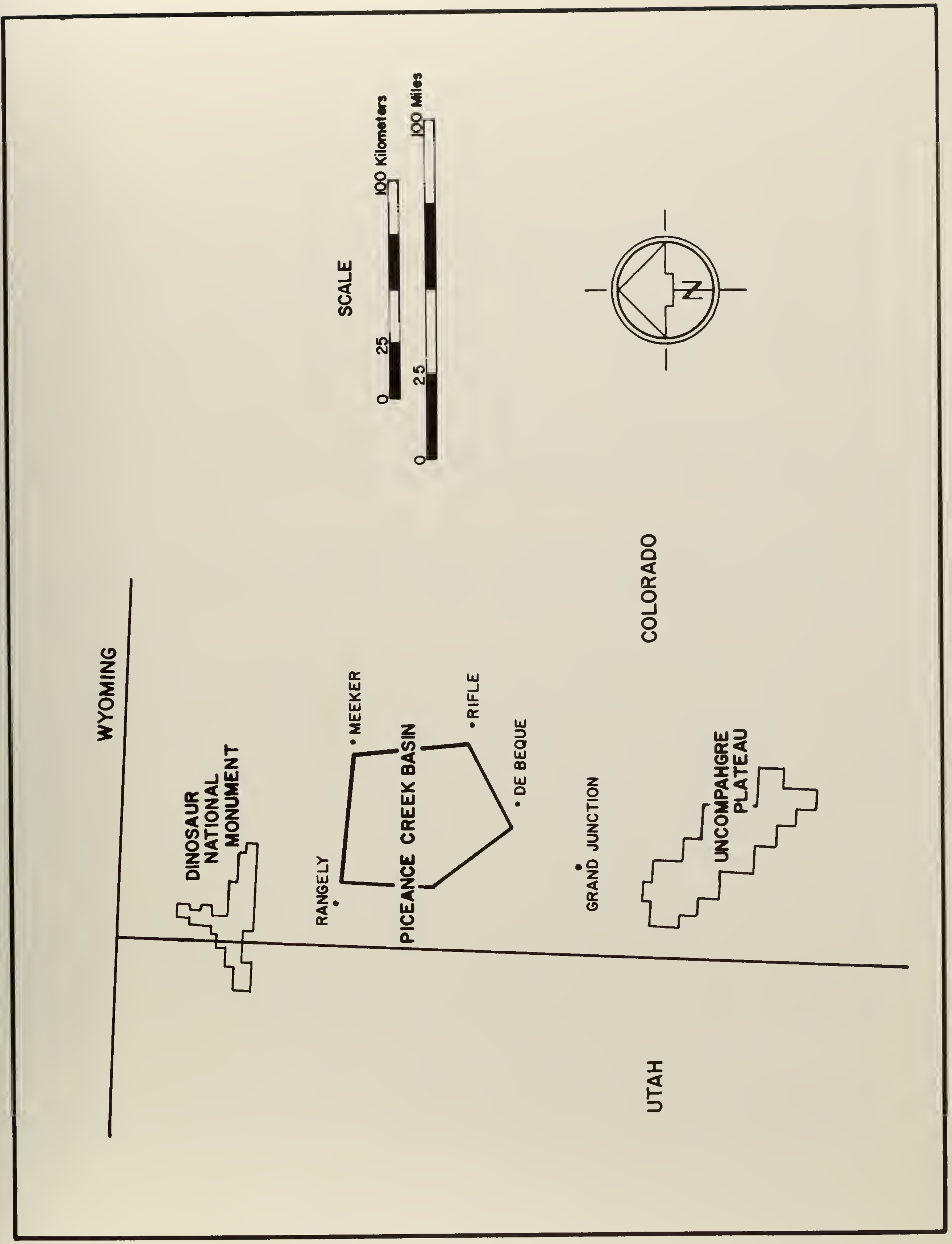


Figure 1. Location of Piceance Creek Basin and Related Areas of Western Colorado

CHAPTER II

DESCRIPTION OF THE SURVEY AREA

Physiography

The Piceance Creek structural basin (Figures 1 and 2) is an elongated, regional downwarp in northwestern Colorado between the Douglas Arch on the west and the Grand Hogback on the east. The periphery is bordered by the stream valley corridors of Government and Sheep Creeks on the east, the White River on the north, Douglas and East Douglas Creek on the west, and the Colorado River on the south. The corners of the circumscribed area are joined by the towns of Rifle, Meeker, Rangely, and DeBeque.

The region is drained from the south by the Colorado River and its tributaries, Parachute and Roan Creeks. Piceance Creek drains the central portion and Yellow Creek drains from the northwest; both are tributaries of the White River.

Cathedral Bluffs, the north-south backbone approximately 10 miles to the east, and roughly parallel to Douglas and East Douglas Creeks, is a major geographical feature separating distinct areas of prehistoric human occupation.

The greatly dissected Roan Plateau, which ranges from 4000 to 9000 feet, is the primary topographic feature. The uppermost member of the bedrock stratigraphy is composed of the youngest sediments of the Uinta Formation (Cashion and Donnell 1974: 68), formerly identified with the Evacuation Creek Member of the Green River Formation (Bradley 1931). These deposits are lacustrine sediments composed of buff to light brown sandstone, marlstone, siltstone, and shale (Bradley 1931: 1; Donnell 1961: 857-858; Cashion and Donnell 1974: G3), and overlie the harder impermeable marlstones and shales of the Parachute Creek Member (Landon 1973: II-1).

To prehistoric occupants of the area, the Uinta Formation was the most useful geographic element, because sandstone provided raw materials for tools (Jennings 1975a: 14). Sandstone milling implements recovered during the survey probably originated there. However, cryptocrystalline materials suitable for the manufacture of flaked tools are rare. While implements fashioned of oil shale are occasionally known from the Piceance Creek area, Jennings (1975a: 14) concludes that its use is infrequent.

The characteristic Uinta sandstones may have indirectly affected site distribution. They do not form large rock shelters or caves; other forms of natural shelter would have assumed greater importance (1975a: 15).

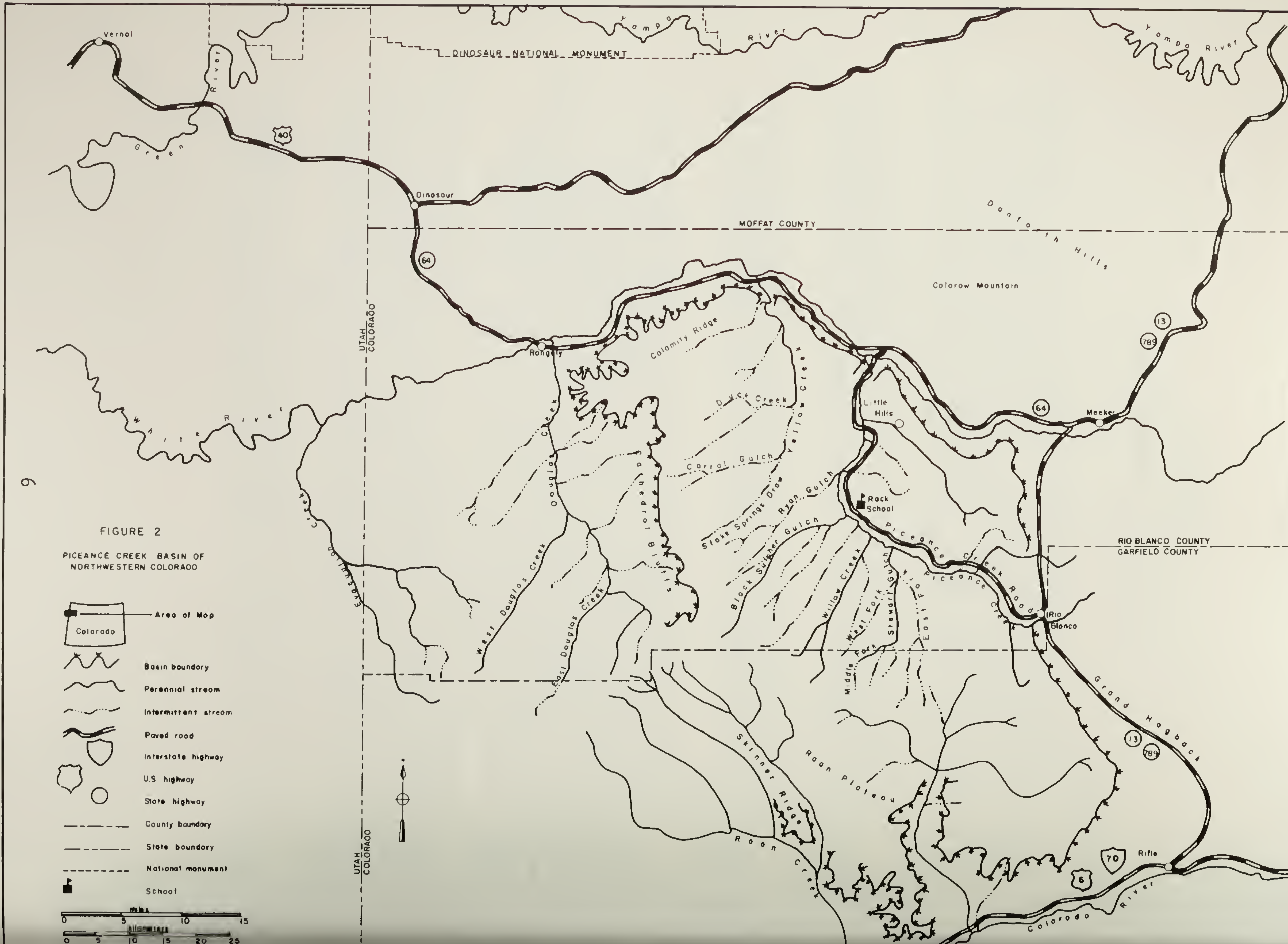


FIGURE 2

PICEANCE CREEK BASIN OF NORTHWESTERN COLORADO

Climate

Climatic records are scarce for the Piceance Creek Basin, and long-term records are nonexistent. Precipitation is influenced by terrain and elevation, and variations may be considerable even on an annual basis. As the result of elevation differences, lower interior regions are hot and dry, while higher rim areas tend to be cooler and more moist. This trend is further reenforced by evapotranspiration rates that are greatest at lower elevations and reduced at higher elevations (Ferchau 1973: VI-2).

The available precipitation data show a basin average of only two to five rain days per month, with an average annual precipitation of slightly more than 14 inches (Marlatt 1973: IV-3 - IV-6). The Cathedral Bluffs and the crest of the Roan Plateau average 26 inches annually, while lower areas average about ten inches. Rangely receives only slightly over one-half the precipitation received in Meeker, which lies approximately 60 miles to the east and 1100 feet higher. (Meiman 1973: V-2).

Winter snowfall statistics are quoted by Marlatt (1973: IV-5 - IV-7) for Meeker, near the basin's northwest corner, and Grand Junction, located south of the basin and twenty-five miles southwest of DeBeque. Meeker recorded 92 inches of annual snowfall during the period from 1951 to 1960. This contrasts sharply with the 23 inches recorded in Grand Junction during the same period. With an average ratio of one inch of water received from ten inches of snow, Grand Junction received approximately one-fourth of its annual precipitation in the form of snow, while in Meeker, approximately one-half of the annual precipitation was recorded in the form of snow. In lower elevations of the basin, snow may reach midwinter depths of two to three feet. Clear skies and high solar radiation prevent persistent snow depths at exposed locations below 7000 feet. Higher elevation snowpack may exceed an annual depth of six feet.

Climates characteristic of the survey area typically have wide-ranging diurnal and annual temperatures. At the Little Hills Fish and Game Station (Figure 2), located on the Dry Fork of Piceance Creek, three miles from its confluence with Piceance Creek, a maximum temperature of 98 degrees was recorded during the months of July and August for the period 1951 to 1960; (temperature statistics are from Marlatt 1973: IV-9 - IV-10; no minimum temperatures for Little Hills are available). In Meeker during the same period, maximum temperatures reached 100 degrees in June, and dropped to 33 degrees below zero in February. Maximum temperatures for Rangely were recorded in June at 104 degrees; the minimum temperature was 37 degrees below zero in January.

Valley frost is believed to exceed the intensity of mesa-top frost because of air stagnation (1973: IV-11). Average frost penetration is 24 inches; 50 inches is the recorded ten-year maximum. Frosts are common between mid-September and June 1. As a result, the average growing season below 5500 feet elevation is 100 to 130 days. The frost-free period is usually less than 30 to 45 days in areas above 8000 feet.

Air circulation data are scarce at the time of this writing, although several studies are in progress (1973: IV-11). At 8500 feet elevation, prevailing winds are from the southwest and west-southwest during much of the year. However, local wind circulation is strongly influenced by local topography. Basin drainage patterns predict vertical and up-valley daytime airflow, the result of solar heating. At night, as higher elevations cool, cold air fills the valleys and lower depressions and produces mountain or down-slope winds. Reinforced by mountain snow cover, this pattern may form an inversion layer in low-lying areas, that serves to retard the natural elimination of pollutants (1973: IV-22).

Paleoenvironmental Implications

In applying the preceding environmental conclusions to a study of prehistoric man, some questions arise about the credibility of abstracting the conditions of the past from present environments. It is uncertain whether the conditions presently observed in the Piceance Creek Basin were substantially the same for any but the most recent period of prehistoric occupation. There are, however, several complementary investigations suggesting Holocene environments have changed little since the Pleistocene (Baerreis and Bryson 1965; Beetle 1974; Bryson and Wendland 1967; Martin 1963; Schoenwetter 1970, 1974; Schoenwetter and Eddy 1964).

According to Bryson and Wendland (1967: 287), late glacial patterns of boreal forest changed abruptly to grassland over large areas of the northern Plains about 10,500 years ago. By 5500 B.C., Martin (1963: 61) suggests a shift in summer rain patterns throughout the southwest, that resulted in a moist altithermal (disputed by Antevs 1955; Benedict 1975). After 4000 B.C., this situation is thought to have returned to the warm, arid conditions of the early Holocene. About 500 B.C., summer precipitation patterns may have again been responsible for moisture increases in the Rocky Mountains (Bryson and Wendland 1967). These increases may have resulted from the shift of an upper-air anticyclonic eddy from the Great Basin to a position along the Rockies eastward into Ontario. Bryson and Wendland (1967: 292) conclude that Arizona may have been warmer during this time, and torrential rains likely drenched the southern Rocky Mountains.

About A.D. 850, stronger movements of moist air began to move into the Great Plains from the tropics. As a result, rains extended farther into the southwest; corn farming became possible on the Great Plains, and glaciers disappeared from the United States Rockies (1967: 292). This Neo-Atlantic period lasted until about A.D. 1200, when a diminution of summer precipitation may have ended corn agriculture by the people of the Upper Republican (Baerreis and Bryson 1965: 216).

A general, probably global, cooling trend began about A.D. 1550, and until A.D. 1850 colder, moister conditions characterized much of the mid-continent (1965: 292). Called the Neo-Boreal, this period produced increased summer precipitation in New Mexico, and glaciers formed in the Rocky Mountains (Benedict 1973: 593-594; 1975: 73).

Rising temperatures after the mid-19th century probably had an immediate impact on vegetation (Bryson and Wendland 1967: Fig. 20). Forest borders and forest composition may have altered slightly. Wood (1976: 206-207) concludes that during this period, forest-grassland ecotones were shifted, and climatic effects may have had impact on the principal plant communities.

However, it would seem that the overall impact of variation in Holocene climates has been small, when their effect on vegetation is assessed. According to Bryson and Wendland (1967: 279), during the past five millenia, climates have been sufficiently stable that variations are best described as ". . . perturbations from the present." These "perturbations" have likely resulted in impact to the boundaries of major biotic zones, to the ecotones, but not to ". . . the heart of the biotic region" (1967: 281).

Nevertheless, shifts among ecological relationships in the Piceance Creek Basin, while not extensive, may have been realized in a manner consistent with the climatic variation postulated for the area. Precipitation increases and accompanying temperature decreases would have affected water source locations, and favored upland woodland communities at the expense of sagebrush shrublands. Such a pattern would have had a notable effect on game movements. The hunting and gathering environment would have been favorably extended, but it is unlikely that it would have been appreciably altered.

Soils

Like many of the physiographic elements of the study area, little descriptive material is available on local soils. One series, Rencalson, has been described (Fox 1973) but boundary locations are unmapped. Other representative series include Dominguez, Troutville, Billings, Persayo, and Ravola (1973: III-6 - III-15). "Rock outcrop" soils are identified in areas where 90% or more of the exposed surface consists of bedrock. These areas are often unstable, and usually dominated by sandstone, shale, limestone or marlstone. Significant relief inhibits soil development (1973: III-17).

In many areas of the basin, the productiveness of naturally fertile soils is limited by low mean temperatures and insufficient moisture. Particularly in upland areas, cooler soils support a limited variety of range plants and shrubs. Only the alluvial soils of the Colorado and White Rivers and their main tributaries (including Piceance and Yellow Creeks) are warm enough to support alfalfa and related crops (1973: III-19).

Basin soils are characteristically calcareous or alkaline except those in conifer areas, which test positively for surface acidity. Textures are usually loamy, with permeability ranging from medium to high. Upland soils develop from shales, sandstones, or loess; lowland soils from alluvium (1973: III-19).

Characteristics of Soil Erosion

Processes associated with the characteristic aridity of basin environments have resulted in considerable erosion and accompanying sedimentation, that may or may not reflect prehistoric conditions. Available data suggest soil depletion continues, but provides an insufficient assessment of the rates of alteration under modern conditions compared with those of the past. Accelerated erosion is generally confined to steeper upland stream valleys and ridge systems, and largely attributable to overgrazing (Fox 1973: III-19). Elsewhere, erosion is concentrated along trails and roads, and along the banks of narrow drainages. More serious erosion is visible along Piceance and Yellow Creeks, and headcutting is common at the confluence of these streams and their tributaries (Meiman 1973: V-2).

Vegetation

In a study of the composition and distribution of natural vegetation in the Piceance Creek Basin, Ward, Slauson, and Dix (1974) identified 18 major plant communities. This is considered to be the most complete vegetation analysis available. Earlier sources were vegetation maps by Kuchler (1964), and Moriss and Dix (1971). Both illustrate the vegetation of this region by identifying only three types: pinyon-juniper, sagebrush, and oakbrush. A more recent paper by Ferchau (1973) is only a cursory examination of a few major communities, too general to be of great value.

Divisions among communities of the Ward, *et al* (1974) classification reflect variability in elevation and relevant species dominants. The 18 major communities are summarized below:

Bottomlands (areas of erosional deposition)

1) *Riparian woodland* communities are found along Roan and Parachute Creeks and their tributaries. Dominants are cottonwood, box elder, and chokecherry.

2) *Big sagebrush shrubland* is located in well-drained valley bottoms and alluvial fans, whose soils contain little or no salinity. The dominant, big sagebrush, often reaches heights of up to two meters, and extends its canopy over at least 75% of the area.

3) *Greasewood shrubland* (greasewood dominant) is restricted to valley bottoms with moderate to high salinity and alkalinity. The water table in these areas is at or near the surface for varying lengths of time. When surface soils are relatively low in alkalinity and salinity, rabbitbrush and sagebrush may appear as important components, but they tend to disappear when alkalinity and salinity increase.

Uplands (areas of erosional depletion)

4) Shad-scale shrubland (shad-scale dominant) is prevalent on dry, steep hillsides, particularly along the canyon walls of the basin's southern edge. Indian ricegrass is sometimes a co-dominant.

5) Hillside fringed sage and grassland is restricted to very steep hillsides with unstable, sandy soils. Fringe sage and Indian ricegrass dominate, and when accompanied by beardless wheatgrass and cheatgrass, a grassland appearance is evident. Normally, canopy is less than 20%.

Big sagebrush shrubland communities are generally characterized by a clear dominance of big sagebrush. They occupy a greater area than any other type, and are usually found in deeper soils than those in areas of pinyon-juniper woodland and mixed mountain shrubland.

6) Low elevation big sagebrush shrubland is found in elevations below 2000 meters (6500 feet), where the dominant rarely exceeds 0.5 meters in height. Soils in these areas are characteristically shallow, dry, and rarely alkaline, although they may sometimes be slightly saline. Shad-scale and spiny horsebrush are important species; winter fat is usually important in shale areas, and greasewood assumes importance in soils of significant salinity.

7) Mid elevation big sagebrush shrubland at elevations between 2000 and 2300 meters (6500 to 7500 feet), will attain heights up to 0.70 meters. Moderately deep soils usually contain greater amounts of water because of increased elevations. The shrub canopy is usually less conspicuous than in (6) or (8).

8) High elevation big sagebrush shrubland occurs above 2285 meters (7500 feet). The most mesic of the big sagebrush communities, this type may reach 1.00 meters in height. Important shrubs include bitterbrush, serviceberry, mountain mahogany, and snowberry. Soils usually exceed 0.5 meters in depth.

9) Big sagebrush shrublands of cliffs and rocky breaks predominates at intermediate elevations in deep soil which retains enough moisture to support a species composition similar to (8).

10) Mixed mountain shrubland is dominated by tall shrubs, particularly Gambel's oak and serviceberry, and is found in deep soils at elevations ranging from 2100 to 2400 meters (7000 to 8000 feet). These locations are usually protected areas, such as drainages and northerly exposures. While oak and serviceberry may occur together, an apparent moisture gradient restricts oak to wetter areas. Dominance may be assumed or shared by chokecherry, snowberry, big sagebrush, and mountain mahogany in (10), (11), or (12).

11) Oakbrush shrubland (Gambel's oak dominant) is found only in sheltered areas along upper Piceance, Roan, and Parachute Creeks. Canopy may exceed 80%.

12) Serviceberry shrubland is usually, but not always, dominated by serviceberry which is always present. This type is widespread, and often found on north-facing hillsides at mid and upper slope positions. Canopy may exceed 80%.

Pinyon-juniper woodland is dominated by pinyon pine and Utah juniper. Pure stands of one variety or the other are not uncommon, although mixed communities are the rule. While occupying the same elevation range with big sagebrush shrubland, pinyon-juniper woodland is found where soils are shallower. The two types overlap where soils are intermediate in depth.

13) Low elevation pinyon-juniper woodland is located below 2100 meters (7000 feet), where juniper is often the only tree species present because of dry and poorly developed soil, particularly on shales. On sandstone, juniper will dominate, but may be joined by pinyon. Big sagebrush is more prevalent on sandstone, where accompanying shrubs and herbaceous species compare to those characteristic of mid-elevation big sagebrush (7).

14) High elevation pinyon-juniper woodland, above 2100 meters (7000 feet), is dominated by pinyon pine. Soils tend to be well-developed. Shrubs include big sagebrush, rabbitbrush, and bitterbrush. Junegrass, beardless wheatgrass, needle-and-thread, and Indian ricegrass are the principal grasses.

15) Pinyon-juniper woodland on cliffs and rocky breaks form within all ranges of pinyon-juniper woodland. Juniper dominates in shale; pinyon dominates in sandstone. In either case, open woodlands are formed with poorly-developed shrubs and herbaceous cover.

16) High elevation grasslands form in shallow, rocky soils between elevations of 2330 and 2750 meters (8000 to 9000 feet). This type is common on the wind-swept ridges of the Cathedral Bluffs. Principal grass species are native bluegrasses, junegrass, and Idaho fescue. Stunted rabbitbrush and burrow weed are common shrubs.

17) Douglas Fir forests are found in drainage and north-facing slopes at 2400 to 2500 meters (7500 to 8000 feet) elevation. Douglas Fir is dominant, but may be accompanied by ponderosa pine. A well developed shrub layer includes serviceberry, chokecherry, snowberry, mountain mahogany, and rose. Forb and herbaceous species are poorly developed.

18) <u>Aspen forests</u> are found at elevations of 2400 to 2500 meters (7500 to 8000 feet), generally restricted to sheltered, north-facing slopes, where protection from solar radiation and wind is greater than in areas of Douglas fir. Forb, grass, and shrub understories are lush. Shrub species are dominated by common oak, big sagebrush, serviceberry, snowberry and juniper. Aspen forests are widespread, but individually restricted to small areas.

To summarize, higher elevations support widely-spaced communities of Douglas fir, spruce-fir, and aspen, interspersed with a mixed shrub community of Utah serviceberry, Gambel's oak, and snowberry. Big sagebrush and bitterbrush are often dominant in drier areas, and mountain mahogany is found in abundance on certain north-facing slopes. Inconsistencies in the distribution of tree stands are noted by Ferchau (1973: VI-1), but no reasons are suggested for the observed anomalies beyond the belief that fire and man may be primarily responsible. (Irregularities in the shrub and grass layers of pinyon-juniper woodlands are identified by Ward, et al. 1974: 42-43, and attributed to a decrease in fires, which has increased tree densities and leaf litter.)

In low elevation areas of significant aridity, shrub species occur with frequency. The pinyon-juniper woodland is particularly characteristic of these hotter, drier regions. Other lowland communities are usually variations of big sagebrush and mixed shrub groups. Greasewood, wild rye, Indian ricegrass, and species characteristic of high elevation grasslands (16), aspen forests (18), and mixed mountain shrublands (10) are generally found in regions where soil salinity, moisture content, wind volume, solar radiation, and other environmental factors in unique combinations, form different habitats.

Several of these factors operate in areas of varying slope. The insolation of slope vegetation is greatest on south-facing slopes and least on north-facing slopes. Evapotranspiration rates increase with an increase in insolation. Therefore, at any given altitude, south-facing slopes are driest, followed by west-facing, east-facing, and north-facing slopes in order of increasing moisture content (Ferchau 1973: VI-2).

Insolation is also a product of the degree of slope; the greater the slope, the less insolation and reradiation. The result is a decrease in temperature extremes. That is, in areas of greater topographic relief, the days are cooler and the nights warmer than in areas of more level terrain (1973: VI-2).

Wind direction also has an affect upon slope vegetation. Prevailing winds deposit drifted snow on east-facing slopes. Moisture is thereby increased in areas which already have a more favorable evapotranspiration rate than west-facing slopes (1973: VI-2).

Vegetation Resource Zones

Each of the 18 community types described here is characterized by a distinctive complex of plants. The accessibility of these resources for human utilization is enhanced by certain break points in topographic profiles that correspond to community borders (Ward, et al. 1974: 54). For example, on Piceance Creek, pinyon-juniper woodland borders hillside fringe sage grassland (5) at the brow, or break in slope between upland and hillside. At the slope break at the foot of the hillside, fringe sage (5) changes to bottomland big sagebrush (2).

Corresponding relationships between vegetation and topography exist in the Yellow Creek drainage, although specific community changes may vary. As topographic diversity increases, so does the frequency in the number of total plant communities likely to be found together (1974: 54). Conversely, in areas like the upper ends of many Piceance and Yellow Creek tributaries where topographic variation is minimized, fewer vegetation types are present.

It is a significant result of these resource characteristics that vegetation zones generally parallel drainage courses and each other, and are usually narrow in width. Access to a wide variety of plant types is available by perpendicular intersection of adjacent zones. By maintaining a parallel course between vegetation borders, as along a drainage bottom, a food-gatherer may remain within a single zone. Similar patterning has been identified in the Glenwood locality of the Missouri River by Anderson and Zimmerman (1976).

The implications of these observations have a direct bearing on the pattern of settlement in the Piceance Creek Basin. Because of the general south-to-north orientation of the interior drainages of Piceance and Yellow Creeks, lateral movement east and west affords generally unrestricted access to the full range of vegetation zones. On the other hand, north and south movement up and down stream courses serves to maintain contact with the same resource configurations. These patterns surely affected seasonal procurement activity reflected by settlement distribution.

Fauna

Baker and McKean (1971: 7-16) list 315 wildlife species in Wildlife Management Unit 22, which closely corresponds in area with the Piceance Creek Basin. Included are seven species of small and big game mammals, 37 species of small and upland game birds, and 24 species of raptors. Not included in the total are 23 mammal and two bird species more recently identified by Cringan (1973). Jennings (1975a: 23) has conjectured that 27 mammalian species presently occupying the area may have served the needs of prehistoric man.

Important mammal populations include a large mule deer herd, with an estimated winter range density of 52 animals per square mile in the Yellow Creek area (Baker and McKean 1971: 22). Only in certain areas of the basin are deer likely to be found in winter months; occupation is generally restricted to elevations between 6000 and 8100 feet (Baker 1970: 36-39). During the summer, deer range throughout the region, and densities vary sharply from territory to territory. Concentrations are usually greater at higher altitudes, where deer take advantage of better water and forage and avoid insects and high temperatures (Baker and McKean 1971: 19).

High elevation areas are also attractive to summering elk. Although the elk population is small and relatively stable, it varies in size from season to season as individuals migrate to and from adjoining areas (Baker and McKean 1971: 18; Cringan 1973: VII-11).

Approximately 150-200 wild horses occupy the northern portion of the Piceance Creek Basin, from Piceance Creek to the Cathedral Bluffs (Cringan 1973: VII-12). This area is almost exclusively the province of the Yellow Creek Drainage, the area of this analysis. During the field seasons of 1973 and 1974, wild horses were sighted with daily regularity. These animals are recent arrivals, but may have served as a resource to the most recent prehistoric occupants (Jennings 1975a: 23), and may have been introduced to the area by them.

A small herd of free-ranging bison were established by the Colorado Division of Game, Fish, and Parks in 1968 on upper Dry Fork Piceance Creek (Baker and McKean 1971: 17). They were removed in late 1973 or 1974 at the urging of local ranchers; it is unknown whether bison were ever indigenous to the area.

Other important wildlife species include black bear, rabbit (cottontail, jack, and snowshoe hare), beaver, varieties of waterfowl including several species of goose and duck, upland game bird species of grouse and pheasant, and raptors, including golden and bald eagles and varieties of owl (Cringan 1973; Baker and McKean 1971).

Prehistoric wildlife population figures cannot be estimated from present densities. It cannot be assumed that modern populations have been uniformly affected by range restrictions and human population pressures. However, present animal species imply the presence of past species in similar habitats. In the Piceance Creek Basin, they likely provided prehistoric man with a year-round food source. The distribution of these species would have placed certain constraints upon human activities, the nature of which should be reflected by the distribution of settlement.

Archaeology

No formal archaeological investigations are known to have occurred within the Piceance Creek Basin before the 1973 surveys leading to this analysis. Cultural resource management studies have produced reports by Buckles (1974), Jennings (1974, 1975a), and Olson, *et al*. (1975) since all are a consequence of recently accelerated interest in oil shale development.

Jennings (1975a) examined over 50 percent of the total area of 5094 acres in Oil Shale Tract C-b (Figure 4), located in the central portion of the basin, southeast of the Yellow Creek Drainage. He recorded three sites of prehistoric occupation designated 5RB136, 5RB146, and 5RB147 (see Figure 3). 5RB136 and 5RB146 are included among the sampled population of this analysis. His earlier study of the tract vicinity recorded two sites designated 5RB67 and 5RB69 (Jennings 1974). 5RB67 is from the historic period; 5RB69 is from the prehistoric period; both are included here. Several isolated artifacts were found scattered over the area.

During the field seasons of 1974 and 1975, Olson, et al (1975) conducted an extensive reconnaissance of Oil Shale Tract C-a (Figure 4), and nearby regions in the Yellow Creek Drainage, generally located in the areas adjacent to Stake Springs Draw, Box Elder and Corral Gulches, and Duck and Yellow Creeks. A site classification system was developed, based upon ceramics and specific tool types, and architectural features. Of the total 197 recorded locations of archaeological materials, 53 were considered to be primary and secondary site locations. The remaining 144 tertiary localities represent ". . . field locations of isolated artifacts or scatters of artifacts, too small to qualify as archaeological sites" (1975: 14).

A cluster analysis of certain undefined topographical features related to site location yielded four site clusters. These are located on upper Stake Springs Draw near the southeast corner of Tract C-a; at the confluence of Corral Gulch and Stake Springs Draw; along the southern periphery of Duck Creek east of the confluence of Big and Little Duck Creeks; and at the confluence of Duck and Yellow Creeks. These locations are upland areas adjacent to stream corridors, and according to Olson, et al. (1975: 18) probably represent seasonal occupation by Fremont and Ute culture groups.

A similar analysis of artifactual content produced inconclusive results, which Olson (personal communication 1976) attributes to the general distribution of artifact types over the site area. This distribution is thought to reflect a uniform pattern of resource distribution, dominated by the hunting of big game, but supplemented by the gathering of vegetable products.

Buckles (1974) investigated an area located immediately south of the Piceance Creek confluence with the White River, and another area approximately three miles further south situated along the western edge of Piceance Creek. Seven sites of prehistoric occupation were located in the first locality, and eight more in the second. Among recovered cultural materials is the basal portion of a projectile point described as probably characteristic of the Plainview type (1974: 29); this fragment displays evidence for basal and lateral edge grinding and basal thinning.

Jennings (1975a: 55-57) estimates that the materials from the areas of his investigations were first deposited by hunters and gatherers, followed by Euro-American pastoralists, who raised sheep and cattle. This period of occupation roughly extends throughout the past 7000 years.

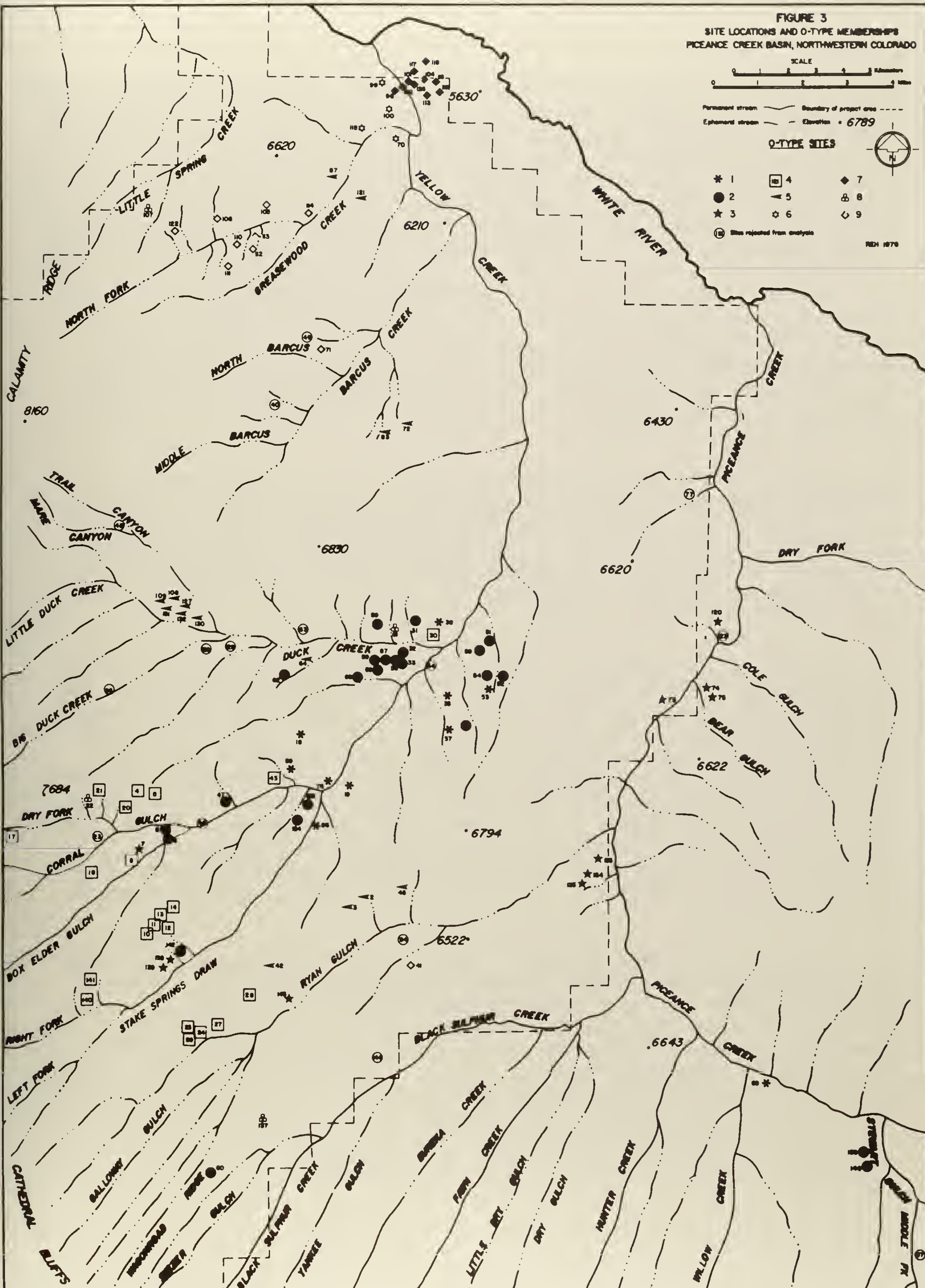


Figure 3. Site locations and O-type memberships, Piceance Creek Basin, Northwestern Colorado

Buckles (1974: 53) extends it further, by about 3000 years, probably based upon dates estimated for the possible Plainview projectile point (Wormington 1957). However, he concedes that the majority of the data suggests occupation during the past 1500 years. He tentatively classifies a small ceramic sample as Fremont Turner Gray: Emery (described by Wormington 1955), and Promontory (described by Steward 1937), a possible Fremont variant. Breternitz (1970) reports Fremont occupation in the Dinosaur National Monument area of northwestern Colorado at approximately A.D. 1000.

Buckles (1954: 51) proposes that resource distribution in the Piceance Creek-White River area is little changed from the past. On the basis of observed diversity in cultural materials, he concludes that greater permanence is represented by site locations along stream valley corridors than by those in the pinyon-juniper woodland. Very little evidence of occupation is noted in the ecological zone between the two areas (1974: 51).

Investigations in areas proximal to the Piceance Creek Basin included Wenger's (1956) examination of Douglas Creek, and its east and west forks (see Figure 2). The nature of the reported materials suggest occupation by the semi-sedentary Fremont. Similar manifestations have also been identified in the Dinosaur National Monument area of northwestern Colorado (see Figure 1), in reports by Breternitz (1970), Burgh and Scoggin (1948), Leach (1967), and Lister (1951).

A variety of archaeological manifestations are included within what is called the "Fremont culture." They occur throughout northern Utah and adjacent areas in Colorado and Nevada. Aikens (1966, 1967, 1970), Ambler (1969), Morss (1931), Steward (1937), Wedel (1967), and Wormington (1955) discuss the Fremont, its proposed antecedent and consequent cultural affinities. Such an analysis may prove of value in subsequent examination of areas within the Piceance Creek Basin, where sites may represent hunting and gathering elements of the Fremont settlement system. It has little bearing in the present analysis, because the only potential element of an otherwise extensive cultural assemblage presently encountered there is a limited and only tentatively identified ceramic sample; Fremont tenancy cannot be assumed.

Comparisons between materials from the area of this survey and those from the Umcompahgre Plateau, located approximately fifty miles further south (see Figure 1), are similarly inconclusive. Wormington and Lister (1956) first identified the "Uncompahgre Complex" in the latter area, after examining evidence of a hunting and gathering economy concentrated in four rock shelters in Mesa and Montrose counties. Later investigations of the type sites and related localities led Buckles (1971: iii) to conclude that this was a viable cultural element through a 10,000 year period representing " . . . one of the largest and most inclusive archaeological sequences established to date for Archaic Stage representations in the western United States."

The temporal diversification of this manifestation is evident in the general nature of the represented cultural materials. These include small to large, notched and unnotched projectile points, unshaped milling stones, and shallow, basin-shaped milling bases (Wormington and Lister 1956: 11-27). Such materials are present in the Piceance Creek Basin, but they are throughout substantial areas of the United States, where cultural manifestations have been identified during the Archaic Stage of prehistoric human development. Cultural concurrence between Piceance Creek and the Uncompahgre Plateau on the basis of the catholic nature of the respective artifact assemblages would be unfounded.

CHAPTER III

METHODS

Data Collection

Sampling

The following sampling procedure was employed by Calvin H. Jennings, Colorado State University; the author became associated with the project during the first field season of 1973.

The Piceance Creek Structural Basin encompasses approximately 1200 square miles or 768,000 acres. Logistical considerations prevented total coverage. The Yellow Creek drainage subbasin in the northwest corner of the structural basin was chosen for sampling because: 1) it offered accessibility to a permanent camp site of sufficient size to house field crews; 2) examination of available map coverage and preliminary field reconnaissance indicated that sites were likely to be present; 3) usable roads provided a transportation net, insuring accessibility to selected sample units.

When selectively sampling the 369 sections of approximately 236,170 acres in the Yellow Creek drainage, the following procedures were employed (Jennings, personal communication 1975b): 1) the dimensions of all sections were measured; those with a deviation of greater than plus or minus 5% from the standard one mile in any dimension were rejected; 2) from a random numbers table, 48 of the remaining sections were selected for investigation (Figure 4).

Three kinds of localities were examined in addition to random sample units: 1) intuitively selected areas of high occupational potential; 2) areas traversed by field personnel exploring on their own time; and 3) the C-a and C-b Oil Shale Lease Tracts (Figure 4) investigated in compliance with contract requirements. (Each tract is approximately 5100 acres in size; a single random sample unit was contained within the boundaries of Tract C-a.)

After all field work was completed, coverage had been extended to 17% (40,280 acres) of the total drainage, a figure that falls below the optimal sample size established by Mueller (1974: 60; for a challenge to Mueller's conclusions, see Plog 1975). It is slightly less than the hypothesized 20% sample selected by Binford (1964: 434) for regional survey.

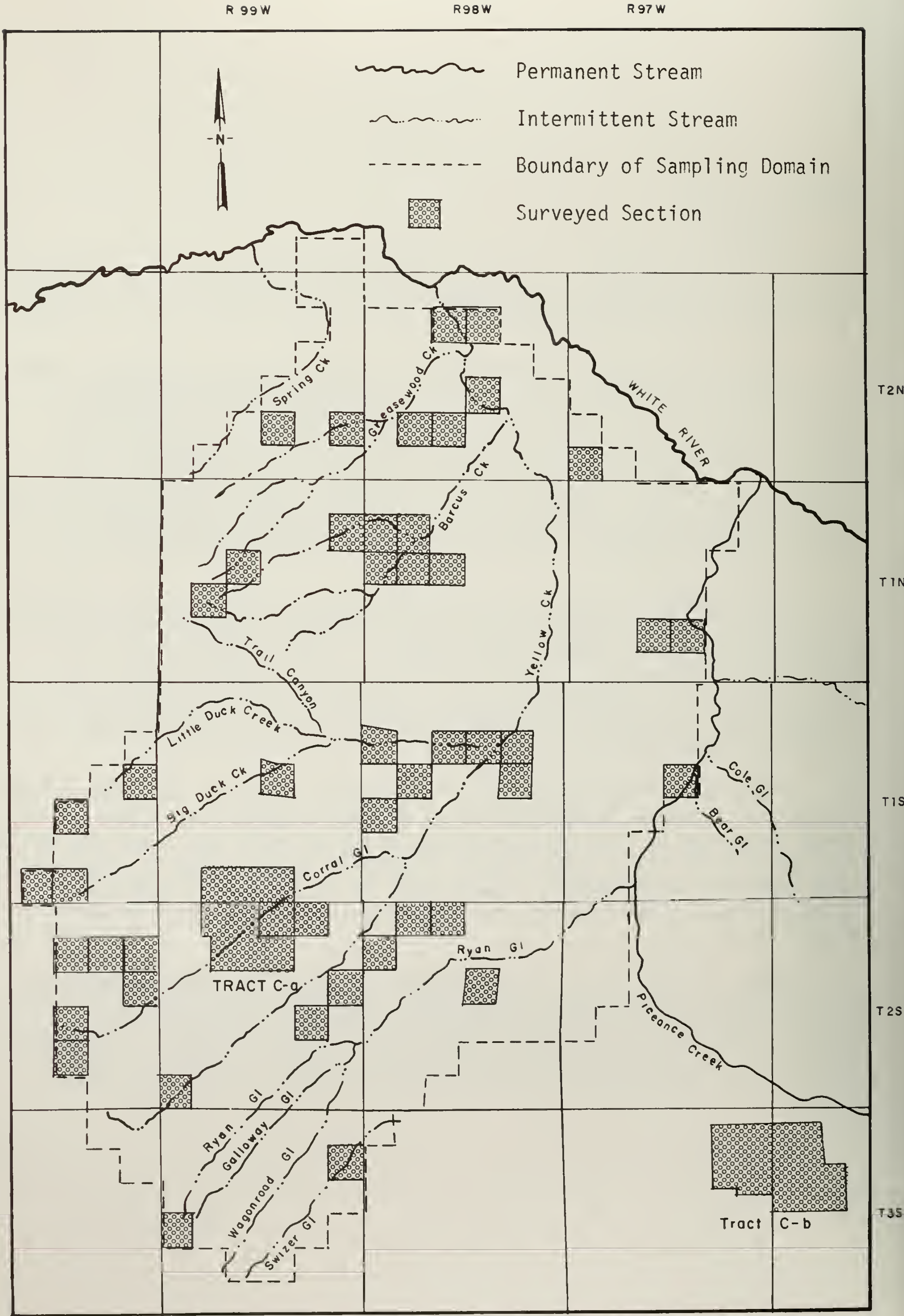


Figure 4. Project Area and Ramdom Sample Units

Field Methods

Field work was initiated during the summer of 1973, and completed during the season of 1974. Sixteen fieldworkers were used in the first season, 22 in the second, for a period of six weeks each season.

U.S. Geological Survey 7.5' quadrangle maps provided sufficient coverage of the survey area. Site locations were noted on field copies of these maps, and later transferred to laboratory copies stored in field laboratory facilities.

To make the survey as objective as possible, sections selected by the sampling procedure were systematically investigated in linear traverses by a field crew of four to seven persons. Each was separated by approximately 5 m intervals. Later, when patterns of site distribution became evident, areas of occupation potential were intuitively selected as time permitted. This practice violated sampling requirements, but increased ability to assess the extent of the region's cultural resources.

As the locus of cultural activity, a site was arbitrarily identified by the concentration of three or more examples of cultural debris. Environmental data relative to each site were recorded on Archeological Survey of Colorado inventory forms, and all cultural materials collected. No attempt was made to gain control over the intra-site location of artifacts and debitage concentrations. This may be detrimental to future research in the area, but was necessary for the time and financial resources available. Intra-site sampling techniques, such as those outlined by Binford (1964), were disregarded for the same reasons; no subsurface test excavations were employed.

5RB032 has been selected to illustrate the kinds of information recorded, and the subsequent steps taken for each site. Its progress from discovery to the final determination of its position in the taxonomy is outlined in the sections that follow.

5RB032: Field Methods

5RB032 is located near the confluence of Duck and Yellow Creeks (Figure 3). Vegetation species within the vicinity were identified in the juniper, big sagebrush, rabbitbrush, and various undefined species of native grasses. By Brunton compass, aspect was determined to be northeasterly. All other pertinent information was gathered during the laboratory phase of this project.

Laboratory Methods

Significant variables. Table 1 lists variable items investigated by this analysis. They are included within the four hypothesized categories of landform, vegetation, drainage configuration, and intersite distance. All values are recorded by presence/absence, or represent discrete or scaled measurements.

Table 1

Item Characteristics of Site Location and Measurement Procedures (Discrete, Scale, or Presence/Absence)

Item Number	Item
	Landform
1	Local Slope
	1) More than 75% of area gently sloping.
	2) 51-75% of area gently sloping.
	3) 25-50% of area gently sloping.
	4) Less than 25% of area gently sloping.
2	Site Slope
	1) 0-5%
	2) 6-10%
	3) 11-15%
	4) 16-20%
3	Local Relief
	1) 0-40 feet 7) 241-280 13) 481-520
	2) 41-80 8) 281-320 14) 521-560
	3) 81-120 9) 321-360 15) 561-600
	4) 121-160 10) 361-400 16) 601-640
	5) 161-200 11) 401-440 17) 641-680
	6) 201-240 12) 441-480
4	Profile Type
	1) More than 75% of gentle slope in lowland.
	2) 51-75% of gentle slope in lowland.
	3) 51-75% of gentle slope in upland.
	4) More than 75% of gentle slope in upland.
	Aspect (Presence/Absence)
5	North
6	South
7	East
8	West
9	Northwest
10	Northeast
11	Southwest
12	Southeast
13	Site Elevation
	Vegetation (Presence/Absence)
	Lowland

Table 1 (continued)

Item Number	Item
14	Big Sagebrush Shrubland
	Upland
15	Mid Elevation Big Sagebrush Shrubland
16	Low Elevation Pinyon-Juniper Woodland
17	High Elevation Pinyon-Juniper Woodland
	Drainage Configuration (Presence/Absence)
	Nearest Drainage
18	Rank 3, permanent
19	Rank 3, ephemeral
20	Rank 4, permanent
21	Rank 4, ephemeral
22	Rank 5, ephemeral
23	Rank 6, ephemeral
24	Distance to Nearest Drainage
25	Elevation Above Nearest Drainage
26	Distance to Nearest Permanent Water Source
	Drainage Rank and Type Within 3 km
27	Number of rank 2, permanent
28	Number of rank 3, permanent
29	Number of rank 3, ephemeral
30	Number of rank 4, permanent
31	Number of rank 4, ephemeral
32	Number of rank 5, permanent
33	Number of rank 5, ephemeral
34	Number of rank 6, ephemeral
35	Number of rank 7, ephemeral
	Intersite Distance
36	Number of Sites Within 1 km
37	Number of Sites Within 3 km

Explanation of Significant Variables

Variables of local slope, local relief, and profile type were first proposed by Hammond (1964a, 1964b), as part of a classificatory scheme for defining classes of landsurface forms in the continental United States. They were chosen for this analysis as an alternative to the more subjective terminology of mesa, ridgetop, plateau, etc.

Because of the discriminate nature of this study, local relief increments of 40 feet were used in place of Hammond's increments of 100 feet. (In this instance, standard units of measure were retained because they correspond to map contour intervals.) Gentle slope was arbitrarily established at less than 8%, in compliance with Hammond's convention that machine agriculture becomes difficult on steeper hillsides. This standard does not necessarily apply to prehistoric economies, but there is apparently no accepted standard among geographers (Krebs, personal communication 1975).

Local area contains all surface within a 1/2 km radius. By experimentation it was concluded that this arbitrary region best circumscribes the important topographical features of each relative landform, while excluding those features of adjacent areas.

Additional variables of site slope, aspect (exposure), and elevation were employed, because each is considered to be an important element in the site selection process. Five percent site increments were chosen as a test of Hammond's proposed gentle slope value of less than eight percent.

Limiting vegetation information to gross plant communities may lack statistical significance (as suggested by Plog and Hill (1971)), but more specific data on density, canopy, etc., are unavailable. Major species and elevation ranges for the four communities, from the Ward, et al. (1974) classification correlated with project sites, are listed in Table 2.

Table 2

Vegetation Communities and Important Species

Item Number	
	Lowland (area of erosional deposition)
14	Big Sagebrush Shrubland a. Dominant 1) big sagebrush b. Shrubs 1) rabbitbrush 2) shad-scale 3) fringe sage c. Understory 1) Indian ricegrass 2) species of wheat grass 3) greasewood
	Upland (area of erosional deposition)
15	Mid Elevation Big Sagebrush Shrubland - 2000 to 2300 m a. Dominant 1) big sagebrush b. Shrubs (less consipcuous than 14) 1) rabbitbrush 2) shad-scale 3) fringe sage 4) spiny horsebrush 5) winter fat 6) greasewood

Table 2 (continued)

Item Number	
	c. Understory 1) beardless wheat grass 2) junegrass 3) needle-and-thread 4) Indian ricegrass 5) western wheatgrass d. Forbes - principal varieties 1) Hood's phlox 2) beardtongue 3) Nuttall's golden weed
16	Low Elevation Pinyon-Juniper Woodland - Below 2100 m a. Dominant 1) Utah juniper 2) pinyon pine - may be present b. Shrubs - may or may not be present 1) shad-scale 2) spiny horsebrush 3) winter fat 4) greasewood 5) bitterbrush 6) serviceberry 7) mountain mahogany 8) snowberry 9) big sagebrush c. Understory - may be stunted and scattered 1) junegrass 2) beardless wheatgrass 3) needle-and-thread 4) squirreltail 5) Indian ricegrass 6) western wheatgrass
17	High Elevation Pinyon-Juniper Woodland - Above 2100 m a. Dominant 1) pinyon pine 2) Utah juniper (usually present) b. Shrub dominants 1) big sagebrush 2) rabbitbrush 3) bitterbrush 4) mountain mahogany 5) chokecherry 6) serviceberry

Table 2 (continued)

Item Number

c. Principal grasses
   1) junegrass
   2) beardless wheatgrass
   3) needle-and-thread
   4) Indian ricegrass
   5) western wheatgrass

Following the procedure suggested by Plog and Hill (1971: 17-18), drainage patterns are established by assigning the numerical value or rank of 1 to the stream into which all others flow. Streams entering number 1 are assigned the number 2, and so on. The Colorado and Rio Grande Rivers serve as a baseline, and are designated by a ranking of 0.

Drainages are further defined on the basis of flow regularity: permanent or ephemeral (seasonal). A third category, intermittent, is suggested (1971: 18), but insufficient data prevent its use. Variables of distance to, and elevation above, nearest drainage are included, to test for the possible weighting of one over the other. A 3 km drainage/site distance was arbitrarily selected. Areas within this range are considered to be within regular walking distance. Ease of accessibility decreases sharply beyond the 3 km range, because of the general topographical variation characteristic of the region.

Distances between sites are measured on the basis of observed variability in site clustering between 1 km and 3 km distances. Because temporal data are lacking, it cannot be determined whether site aggregates reflect long-term efforts to gather resource concentrations, or represent social clustering.

5RB032: Laboratory Methods

Landform. The local area of 5RB032 was measured from the Wolf Ridge 7.5' quadrangle map, with the aid of an acetate template on which a 1 km diameter circle was drawn (1:24000 scale). Perpendicular lines divided the circumscribed area into 4 quandrants. By centering the site in the template, the local area was outlined.

Local slope was measured by the Breed (1957) slope formula in combination with the local area template. Fifty to seventy-five percent of the local area was found to be gently sloping.

A site slope of 0-5% was determined by measuring a straight line distance between two adjacent map contours in the site area and inserting the measured distance into the formula.

Profile type 3 (50-75% of gentle slope in upland) was estimated relative to the local area of the site, by inspection of the landform characteristics outlined on the map by the local area template.

The site elevation of 1929 m was also determined on the basis of map coverage.

Vegetation. Gross floral identification made during field inspection of 5RB032 was correlated with the Ward, et al. (1974) taxonomy. This site was found to associate with the lowland community of big sagebrush shrubland, and the upland community of low elevation pinyon-juniper woodland. Both communiites are present within the local area of the site.

Drainage Configuration. The drainage nearest to 5RB032 (Duck Creek) was determined to be a rank 4, ephemeral stream. Measurements on the basis of map coverage were made for distance to nearest drainage (175 m), elevation above nearest drainage (26 m), and distance to permanent water source (900 m).

The type and rank of all drainages within 3 km of 5RB032 was determined by overlaying the site with a 3 km template (1:24000 scale). Each included drainage was counted, typed, and ranked. Recorded were drainages of rank 3, permanent (1), rank 4, ephemeral (6), rank 5, ephemeral (8), and rank 6, ephemeral (3).

Intersite Distance. The number of sites included within the limits of the 1 km and 3 km templates relative to 5RB032 were recorded as 6 and 14, respectively.

Analysis

Chi-Square

Chi-square analysis determines the degree to which each selected item is randomly distributed in a given population. The reliability of each item as a testing instrument is determined by the extent to which its distribution is found to be non-random, based upon a level of significance equal to, or less than 5% (Huntsberger 1967: 235). Only items characterized by the required level of significance are further investigated by cluster analysis.

Cluster Analysis

The procedures of cluster analysis described here are based on Tryon and Bailey's BCTRY system (1970), a collection of programs that offer the analyst alternative approaches to a particular problem. The discussion that follows is intended as an introduction for those not already familar with cluster and factor analytical procedures; except where noted, it is adapted from the general, nonmathematical description of Oetting, Cole and

Miller (1974: 1-40). Minor modifications have been made for this analysis, primarily when choosing rational and empirical criteria for selecting variables, variable definers, and site types.

Cluster analysis objectively groups together things--objects, persons, or entities--based upon similarities and differences (Tryon and Bailey 1970: 1) in their descriptive characteristics. The fundamental procedure is to gather together the selected items for study into groups or clusters. Variables or types may result from the grouping of items, in which case the procedure is called V-analysis, or from the grouping of objects, called O-analysis (1970: 2). Both procedures were applied in this study.

The process began with measuring the relationships between each site, and the items selected from the natural environment. After the chi square test determined that each of the chosen items was non-randomly associated with site location, the items were grouped into variables (V-analysis). In this way, it was determined which items were evaluating which characteristics of site location. Then sites were grouped together into types (O-analysis), based upon the similarity of their relationship to the variables.

Clustering items into variables serves to reduce the number of items necessary to consider during analysis. A few variable scores account for most of the differences among the item values, and a number of item responses is reduced to a workable quantity. As an analytical unit, each item cluster should measure an important characteristic of site location.

The clustering process also reveals information about what is actually being measured by the analysis. Items that were constructed to measure a particular characteristic may prove to be independent of each other, or may relate to another characteristic altogether. It may be revealed that an expected characteristic does not exist, or that items to measure it were improperly chosen. It may also become evident that a characteristic exists that was not previously considered, or that two planned characteristics really measure the same thing, and can be represented by a single, underlying variable.

Further insight into the nature of the measurement process is gained from the clustering procedure, when empirically derived clusters are compared with those originally developed on a theoretical basis. Items are originally grouped by their appearance--that is, those items that appear to measure the same thing are placed within an intuitively established category. Although the final variables are often comprised of items predicted by a priori definition, that is not always the case.

Once variables have been formed and their nature understood, they are used to group sites together into types. The members of each type display a similar pattern of characteristics with each of the variables. The nature of these patterned characteristics is determined on the basis of item cluster scores. Sites with similar scores are grouped together. Each group should be as unique as possible; its members should be as alike as possible; and the final set of groups should contain as many as possible of the total site population.

Methods in Cluster Analysis

Step I: Selecting the data. Cluster analysis may be applied to a remarkable range of data. As in the case of this investigation, they may include items of scale, items of discrete measurement, or dummy variables coded by presence or absence. They must be numerical measures so correlation may be calculated between them. A series of scores is required, representing the characteristics of what is being sampled, and the subjects, whether sites, people, or neighborhoods, must be represented by the same set of scores.

The process begins by developing a hypothetical model suggesting the characteristics to be measured. A set of items is selected to measure these characteristics. Each characteristic must be represented by several items, because in the clustering of variables, if only one item measures an independent characteristic, it will be unrelated to the others and dropped from analysis. If a characteristic is assessed by items radically different from the majority, the outcome of clustering might reflect only that fact, rather than imply any statistical relationship between items and characteristic.

The development of a predictive model and the subsequent selection of an item pool is important, because unless the item pool actually measures the characteristics of the sampled population, no meaningful results are possible from cluster analysis.

Sampling. Sampling considerations as they apply to cluster analysis depend upon several factors related to the process of finding types (O-types). This process, to be described in more detail later, begins by representing each object as a point in a multi-dimensional score space. The coordinates of this point are determined by the pattern of correlations each object exhibits with each variable. The initial group of O-types, of which there may be many, is selected by arbitrarily sectioning the score space (Tryon and Bailey 1970: 153). In general, the number of sectors is determined by the number of broad categories (i.e., high, middle, and low) chosen to represent the breadth of correlation between each variable and each object, and by the number of variables to be used in the analysis. The number of sectors "S" is equal to

$$S = C^k$$

when there are "K" dimensions and "C" categories of each dimension (1970: 154).

In order that O-types be practically significant for purposes of classification, it is necessary to include as many objects as possible within each sector during the process of O-typing; the greater the number of sectors, the greater should be the number of objects. This optimal number is open to interpretation, but depends a great deal upon the kinds of data under investigation. Oetting, et al. (1974: 8) suggest that in developing future analyses, an investigator sample 35 subjects for each O-type ultimately identified by cluster analysis. Such a sample, classified into six types, would require a subject population of 210 individuals. Tryon and Bailey (1970: 147-150), for a hypothetical typology based upon six types, select a sample of only 100 individuals organized on the basis of six variables.

Of importance in deciding upon the necessary size of a population sample is the homogeneity likely to exist among individuals comprising each O-type, the number of O-types finally selected, and the number of individuals in each (Sjogren, personal communication 1976). For investigators concerned by a reduced number of objects, the BCTRY system provides alternative methods of analysis (Tryon and Bailey 1970: 30).

Step II. Variable cluster analysis. Although cluster analysis may proceed by several different methods, the underlying principal is the same. Each cluster is selected so that its characteristic items are collinear or "tight" as possible, as nearly independent as possible, and account for as much general variability as possible (1970: 5). Not only must these items correlate highly with each other, they must also display the same general pattern of correlation with all other items.

The "index of proportionality" is a direct indication of the similarity in these patterns of correlation. It measures the similarity of two items in the way they relate to, or sample the domains from which all the items are drawn (Tryon and Bailey 1970: 21). It ranges from -1.00, indicating a perfect but negative similarity, to zero, or no similarity, to +1.00, showing a perfect, positive similarity; that is, the items have identical correlation with all other items. From this index of proportionality, a correlation matrix is constructed that identifies the degree of similarity between every item under investigation. It would be possible, though time-consuming, to visually select similar items likely to represent the same characteristic by comparing proportionality indexes. Items identifying the same characteristic or variable would display a mutually high proportionality index (as near ± 1.00 as possible), and a similar pattern of values with all other items. The magnitude of the task increases markedly as the number of items increases; a computer completes the process in seconds.

Once the first group of items has been selected, the magnitude of its correlation with every item in the matrix is removed. This leaves a new correlation matrix, devoid of all influences from the first cluster. Therefore, the second cluster must measure some other characteristic. This process continues until the remaining items are characterized by proportionality indexes considered too small to accurately identify another characteristic.

Step III: Selecting the variables. Once clusters have been identified empirically, it is up to the discretion of the analyst to alter or eliminate them, based upon his interpretation of their structure. Each cluster must be examined to ensure that it adds materially to the classification of sites into types. Characteristics may be identified from the item responses that are considered unimportant to classification. Others may be so closely dependent upon each other that their collective value is questioned; in which case, one may be eliminated, or two or more combined.

The final decision in selecting relevant variables is based, in part, upon certain statistical aids made available by the BCTRY system. One of the most useful is a graphical representation which plots each item on the surface of a sphere. Each cluster is identified by a dimension that is characterized by a certain amount of independence from all other dimensions, depending upon the purity of the sampling instrument. Each dimension appears as a black line on the graph (Figures 5, 6, and 7); its location is only theoretical. The real items composing the represented clusters may be related in varying degree to each other, and the distance between them is directly related to their similarity, considering all three dimensions at once. The closer together the items of a dimension lie to each other, the more similar they are. The more distant the clusters are from each other, the more independent they are, and the closer they will lie to the appropriate apex of the triangle formed by the three dimensions.

The actual position of each item on the graph is determined by its augmented, i.e., normalized, factor coefficient. Its communality, a measure of the variance among individual items (Tryon and Bailey 1970: 4), is the sum of its relationships to all the dimensions existing in the data. The degree of relationship between any item and a given dimension is determined by the square of its factor coefficient. Dividing this value by the total community gives the augmented factor coefficient. A measure of the proportion of that item's total contribution of any single item can usually be accounted for by one, two, or three dimensions, so each can usually be displayed accurately on the surface of the spherical graph.

Another statistical tool for estimating the practical validity of cluster content is the average correlation value computed for cluster definers (key items selected as most characteristic of the dimension), and other highly correlated items listed for each dimension. A given definer, rather than adding to the collinearity and therefore the reliability of a dimension, may detract from it, so a decision may be made to drop it.

Reliability may also be increased by adding items to a characteristic. The cluster analysis program lists correlations of nondefiners with a dimension, and the change in reliability if a nondefiner is added. If the content of the nondefiner closely matches or contributes to the cluster dimension, and if cluster reliability is enhanced, the decision to add it as a definer may be justified.

It is possible that two dimensions may be so closely correlated or dependent on one another that their validity as separate dimensions may be questioned. The spherical graph provides information about cluster dependence based upon the location of clustered items in relationship to the three points marking the ends of the dimensions. Another method is to compare the estimated correlations between cluster domains illustrated in Table 9. (Tryon and Bailey 1970: 92-94). These values help define the relationship between variables, if it was possible to thoroughly measure the variation each variable represents. Theoretically, this could be done by adding a great many tests to each variable cluster, tests that are collinear with the observed test items. The higher the correlation value between any two dimensions, the less independent is each in measuring a characteristic. It is likely that by eliminating one, or combining both, a greater degree of clarity may be achieved in the final variable set.

One of the most important considerations in selecting valid characteristics is to limit them to as few as possible. Prediction of site location based upon a large number of variables becomes increasingly more difficult and time-consuming. Also, a classification system based on too many variables is almost certain to create a confusing number of patterns that may be difficult to interpret. With many variables and only a limited number of sites, each site will likely differ independently on at least one variable, and no classification system is possible. A rule of thumb limits variables to those that are of distinct value in classifying sites and predicting their location; the total should rarely exceed six.

Step IV: Clustering of sites (O-analysis). When the final number of variables has been selected, the BCTRY program determines a score on each variable for every site in the population. To ensure that each variable has equal weight in establishing the typology, each variable score is converted to standard score form, with a mean of 50 and standard deviations of 10 (Tryon and Bailey 1970: 140). The score set or profile for each site is then compared with the score set for every other site, and those with similar profiles are grouped together into O-types.

Site types can be formed similarly to forming variables, but a large number of sites will cause the necessary calculations to be excessively time-consuming, even by computer. Another method is used, yielding essentially the same results, that develops a typology by "iterative condensation of centroids" (1970: 147). This procedure (1970: 147-150) begins by representing the total site population as "a swarm of points in a hyperspace of scores..." (1970: 137). Each point represents an individual site profile or pattern of scores on a given set of variables (1970: 136).

The first iteration selects an arbitrary set of trial O-types from the swarm of points by arbitrarily sectioning the score space (1970: 153). The coordinates of the centroid or center of each O-type are computed as the average of the coordinates of all its constituent points (1970: 151). Each site is then assigned to the closest centroid--the one to which it has the smallest Euclidean distance. After all sites have been assigned, the coordinates of all centroids are recomputed, because their positions have changed with the addition of real sites to the arbitrary O-types. This process continues until all the sites remain unreassigned, and the positions of each O-type centroid remain unchanged.

As the iteration process proceeds, the trial O-types wander within the score space, until they approach centers of site density. Two O-types may form a single O-type, if they move together closely enough. If an individual site lies too far from any centroid, it will be cast aside. It may later be included within a cluster, if during iteration it falls within the arbitrarily established criterion of fit.

Step V: Selecting and interpreting O-types. Each type, once established, must be interpreted on the basis of its prominent characteristics and its relationships to all the other types undergoing analysis. Mean score differences are the most obvious. Types may also be compared by the manner in which member sites vary in their association with each variable. One type may be significantly more homogeneous on a particular variable than another. It may even be determined that differences between two or more types are insignificant on a theoretical basis, and they may be combined.

The manner in which a type is interpreted will determine whether its content should be altered to strengthen internal homogeneity. For instance, if the important characteristic of a type is taken to be a high score on any particular variable, a minimum score for that variable may be arbitrarily set. Because of the way in which sites are assigned to types, there may be sites with low mean scores on any given variable, although overall average scores are high.

5RB032: O-Type Analysis

The sites of this analysis were subjected to seven iterations, before the final types were firmly established. 5RB032 was initially assigned to O-type 2, and remained there throughout the process. Scores on each of the four variables identified by V-analysis from the data of this survey are consistent with the O-type mean values, and indicate that this site is compatible with the type. A more detailed analysis of the character of 5RB032, and other members of O-type 2, is available in the discussion of results in Chapter IV.

CHAPTER IV

RESULTS

Chi-Square

Chi-square values were useful in helping to determine the credibility of variable items, based upon assessed nonrandomness. These values and related information are available in Appendix A. Because expected variable items were not always represented by observed data, empty cells sometimes occurred (see cases 3, 8-11, and 14). In these instances, chi-square values are suspect. However, a visual examination of observed cell frequencies reveals significant nonrandom distribution in every case. Only variable items actually represented by the data (as indicated by positive observed frequencies) were further analyzed by the BCTRY system of cluster analysis.

Sum/Mean/Sigma Item Values

The BCTRY system routinely computes sum, mean, and sigma values for each variable item. These values are listed in Appendix B and discussed below.

Significant Characteristics of Landform

Note the mean value for: local slope (46.5% of local area gently sloping); site slope (7.1%); local relief (306.8 ft.); and profile type (78.5% of gentle slope in upland areas). These items describe the mean values of significant modern landform characteristics, related to site location in the Piceance Creek Basin. Also not that aspect frequencies are highest for southerly (31.0) and southeasterly (25.0) exposures, but also significant for easterly (15.0) and northeasterly (19.0) exposures.

Environmental conditions are expected to be most favorable for human occupation on south to east-facing upland slopes, where exposure to sunlight is greater, and evapotranspiration and moisture conditions support greater vegetation growth and soil development. High local relief is greater in upland areas and serves to reduce the temperature extremes. The observed site slope mean of 7.1% may be unrealistically extreme, a possible cartographic error; however, it suggests that Hammond's (1964a, 1964b) slope convention of 8% may be justified, as a standard for the determination of gentle slope.

Significant Characteristics of Vegetation

The greatest numerical association between site location and plant communities is noted for big sagebrush shrubland (72.0), and low elevation pinyon-juniper woodland (89.0). These communities are often found in association with each other, and are the dominant communities within the study area. This apparent correlation may more directly result from less apparent relationships between game movement patterns, or landform and climatic characteristics attractive to both plant species and local human occupants. However, gathering activities were likely concentrated in pinyon forests during times of high seed yield; apparent relationships between these areas and site locations may accurately reflect the prehistoric situation.

Significant Characteristics of Drainage Configuration

Semipermanent drainages of ranks 4 and 5 are most often those nearest to site locations, where the distance to the nearest permanent water source averages almost 2400 meters. Sites are located within relatively short horizontal and vertical distances from nearest drainage bottoms (343 and 52 meters, respectively).

Significant Characteristics of Intersite Distance

From these statistical results, it may be concluded that sites exhibit a tendency to cluster in certain areas. The averages listed in Appendix B indicate that slightly more than three sites are generally found within a 1 km diameter area (item 36), and more than nine sites may be found in areas of 3 km diameter (item 37).

V-Analysis

Artifact Content

An effort was made to identify discrete artifact assemblages by V-analysis: fourteen artifact categories were selected to represent the cultural materials observed in the sampled site population (see Table 3).

V-analysis identified two characteristics based upon artifact content (see Table 4); each reflects either aboriginal or non-aboriginal occupation during the post-contact period. The number of sites likely to show positive correlation with either of these clusters is small (three aboriginal; twelve non-aboriginal). Furthermore, environmental variability is expected to be significant among post-contact sites. Post-contact artifactual variables use is limited, particularly when their relationships to site location cannot be compared to similar relationships of the prehistoric period; therefore, the decision was made to eliminate both artifact clusters and all artifact items from further analysis. This resulted in the subsequent development of O-types based on patterned relationships with environmentally oriented variable clusters. The final hypothesized characteristics and item content appear in Table 5.

The fact that prehistoric assemblages were not represented among statistically identified variables suggests those chosen for analysis are generally distributed throughout all locations of prehistoric occupation. This lack of common variance would fail to produce significant category groups and may reflect sampling error, possibly from amateur collecting.

Table 3

Artifact Categories Investigated by V-analysis

Item #	Item
38	Debitage
39	Unifacially flaked tools
40	Bifacially flaked tools
41	Groundstone tools
42	Trade items
43	Metal artifacts - non-aboriginal
44	Ceramics - aboriginal
45	Ceramics - non-aboriginal
46	Hearths - aboriginal
47	Hearths - non-aboriginal
48	Corrals/enclosures - aboriginal
49	Corrals/enclosures - non-aboriginal
50	Architecture - aboriginal
51	Architecture - non-aboriginal

Table 4

Items in the Clusters Related to Post Contact Occupation

"Aboriginal Post Contact" Cluster

Original Definers	Item #	Item
D	48	Corrals/enclosures - aboriginal
D	44	Ceramics - aboriginal
D	50	Architecture - aboriginal
D	42	Trade items

"Non-Aboriginal Post Contact" Cluster

Original Definers	Item #	Item
D	51	Architecture - non-aboriginal
D	45	Ceramics - non-aboriginal
-D	-38	Debitage
D	43	Trade items - non-aboriginal

Table 5

Hypothesized Environmental Characteristics of Site Location

Item #	
	Landform
1	Local Slope
2	Site Slope
3	Local Relief
4	Profile Type
	Aspect
5	North
6	South
7	East
8	West
9	Northwest
10	Northeast
11	Southwest
12	Southeast
13	Site Elevation
	Vegetation
14	Big Sagebrush Shrubland
15	Mid Elevation Big Sagebrush Shrubland
16	Low Elevation Pinyon-Juniper Woodland
17	High Elevation Pinyon-Juniper Woodland
	Drainage Configuration
	Nearest Drainage
18	Rank 3, permanent
19	Rank 3, ephemeral
20	Rank 4, permanent
21	Rank 4, ephemeral
22	Rank 5, ephemeral
23	Rank 6, ephemeral
24	Distance to Nearest Drainage
25	Elevation Above Nearest Drainage
26	Distance to Nearest Permanent Water Source
	Drainage Rank and Type Within 3 km
27	Number of rank 2, permanent
28	Number of rank 3, permanent
29	Number of rank 3, ephemeral
30	Number of rank 4, permanent
31	Number of rank 4, ephemeral
32	Number of rank 5, permanent
33	Number of rank 5, ephemeral
34	Number of rank 6, ephemeral
35	Number of rank 7, ephemeral
	Social Distance
36	Number of Sites Within 1 km
37	Number of Sites Within 3 km

Landform

The items designed to measure landform are listed in Table 5. The six major categories are: local slope, site slope, local relief, profile type, aspect, and site elevation, each of which might group items under separate clusters. For example: local slope, site slope, and local relief might be included under the heading "topographic variability"; profile type and site elevation both reflect elements of "elevation variability"; and aspect is a singular measurement of "exposure." Because of the nature of the interdependence of many of the variable items in all categories of the measuring instrument, items from other hypothesized characteristics might group under common headings; the analysis generally shows this pattern. The clusters reflecting landform variability appear in Table 6. Items preceded by a "D" are the definers of each cluster. They are most commonly related to each other in terms of the pattern of their relationships with all the other elements of landform. The other items are nondefiners; they are also correlated with the definers, and are similar in their pattern of relationships.

Table 6

Items in the Initial Three Clusters Related to Landform

Original Definers	Item #	Item
"Elevation Variability" Cluster		
D	17	High elevation pinyon-juniper woodland
-D	-16	Low elevation pinyon-juniper woodland
D	13	Site elevation
D	30	Number of R 4, permanent within 3 km
Unnamed Cluster		
D	4	Profile type
-D	-14	Big sagebrush shrubland
D	24	Distance to nearest drainage
	22	Nearest drainage: R 5, ephemeral
	20	Nearest drainage: R 4, permanent
"Topographic Variability" Cluster		
D	3	Local relief
D	1	Local slope
D	25	Elevation above nearest drainage

In cluster analysis, items group together based on the pattern of coorelations each shows with the other. They must also show similar patterns of correlation with other items under investigation. These two criteria lead to the selection of a group of items that are probably measuring the same characteristic. Three such item groups or clusters were identified by V-analysis to measure characteristics of landform. The first was labeled "elevation variability." It is composed of two items of vegetation that not only reflect community composition, but also indicate the elevation range in which related species are likely to be found. A positive correlation with high elevation pinyon-juniper woodland, in this case, also refers to areas of maximum elevation. This assumption is given further support by a positive correlation with site elevation, and a negative correlation with low elevation pinyon-juniper shrubland.

However, the relationship between the cluster and item number 30 is less clear. As a definer, this item may indicate that rank 4, permanent drainages are most often located within 3 km of the sites that correlate highly with the cluster, but it does little to add meaning to the overall interpretation of the other definers as a variable. Furthermore, with a communality equal to 0.5867, it is the only definer with such a value below 0.8. This item was eliminated as a definer to strengthen the interpretation given the cluster, and to add to the cluster reliability coefficient of 0.9216 (an indication of the degree of internal consistency among definers). This value increased to 0.9395.

The landform cluster labeled "topographic variability" is composed of three definers that reflect significant vertical relief. Sites highly correlated with this variable are likely to be located in areas easily identified from others, in the basin where topographic variation is less extreme. This cluster is less internally consistent than the others, as indicated by a reliability coefficient that falls below 0.8. On the basis of the estimated correlations between factor domains, it shows some dependence (0.3696) upon the "secondary drainage association" cluster. However, in view of the interpretive advantages in retaining it as a variable, these other considerations are within acceptable limits for O-typing.

A third cluster based upon landform characteristics is less easily understood; it seems to refer to upland areas significantly removed from nearby drainages. The two nondefiners do little to enhance this interpretation, and some conflict is noted between it and the meaning ascribed to the "elevation variability" cluster. Furthermore, the estimated correlation between this cluster and the "primary drainage association" cluster is -0.4593; this high negative correlation implies a strong interrelationship. The purpose of V-analysis is to develop a few variables as independent of each other as possible, in an effort to improve the significance of each O-type; therefore, the unnamed landform cluster was eliminated from further consideration, and the number of landform variables established at two.

Drainage Configuation

The two clusters developed on the basis of drainage relationships appear in Table 7; both are represented by cluster reliability coefficients greater than 0.87. The first reflects association between site location and major drainages as they exist in the study area. Sites correlating with this variable would be expected along the periphery of Piceance and Yellow Creeks, and their primary tributaries. Those correlating with the second drainage cluster should lie in the vicinity of drainages ranked 5, 6, and 7. Item 28, although not selected as a definer of the "secondary drainage association" cluster, has a B-reliability coefficient of 0.8854. This value indicates that if the item were added to the cluster as a definer, the overall cluster reliability coefficient of 0.8701 would be increased. The nature of item 28 suggests that its addition to the cluster definers would enhance the interpretive strength of the variable; therefore, the number of definers was increased from 4 to 5, and the cluster reliability coefficient subsequently increased to 0.8793.

Table 7

Items in the Initial Two Clusters Related to Drainage Configuration

"Primary Drainage Association" Cluster

Original Definers	Item #	Item
D	29	Number of R 3, ephemeral within 3 km
D	27	Number of R 2, permanent within 3 km
D	31	Number of R 4, ephemeral within 3 km
	50	Number of sites within 1 km
D	19	Nearest drainage: R 3, ephemeral

"Secondary Drainage Association" Cluster

Original Definers	Item #	Item
D	34	Number of R 6, ephemeral within 3 km
D	26	Distance to nearest permanent water source
	-28	Number of R 3, permanent within 3 km
D	33	Number of R 5, ephemeral within 3 km
D	35	Number of R 7, ephemeral within 3 km
	23	Nearest drainage: R 6, ephemeral
	-18	Nearest drainage: R 3, permanent
	-37	Number of sites within 3 km
	-20	Nearest drainage: R 4, permanent

Relationships Among Final Variables Used to Assess Site Location

Each cluster was examined logically and statistically to determine: (1) which items provided the most valid and reliable score for each item cluster, and (2) which item clusters best measured significant characteristics of site location, and should be used in the further grouping of sites into O-types. Once item clusters have been redefined by the addition or deletion of items, and by the elimination and combining of some clusters, the relationships among them will change. Table 8 illustrates the final variables and their item content, and the spherical graphs that follow (Figures 5, 6, and 7) show the relationships between them.

Table 8

Items in the Final Four Clusters Related to Site Location

1. "Primary Drainage Association" Cluster

Definers	Item #	Item
D	29	Number of R 3, ephemeral within 3 km
D	27	Number of R 2, permanent within 3 km
D	31	Number of R 4, ephemeral within 3 km
	36	Number of sites within 1 km
D	19	Nearest drainage: R 3, ephemeral
	- 4	Profile type
	14	Big sagebrush shrubland
	-22	Nearest drainage: R 5, ephemeral

2. "Secondary Drainage Association" Cluster

Definers	Item #	Item
D	34	Number of R 6, ephemeral within 3 km
D	26	Distance to nearest permanent water source
D	33	Number of R 5, ephemeral within 3 km
-D	-28	Number of R 3, permanent within 3 km
D	35	Number of R 7, semipermanent within 3 km
	23	Nearest drainage: R 6, ephemeral
	-18	Nearest drainage: R 3, permanent
	-37	Number of sites within 3 km

3. "Elevation Variability" Cluster

Definers	Item #	Item
D	17	High elevation pinyon-juniper woodland
-D	-16	Low elevation pinyon-juniper woodland
D	13	Site elevation
	30	Number of R 4, permanent within 3 km

4. "Topographic Variability" Cluster

Definers	Item #	Item
D	3	Local relief
D	1	Local slope
D	25	Elevation above nearest drainage

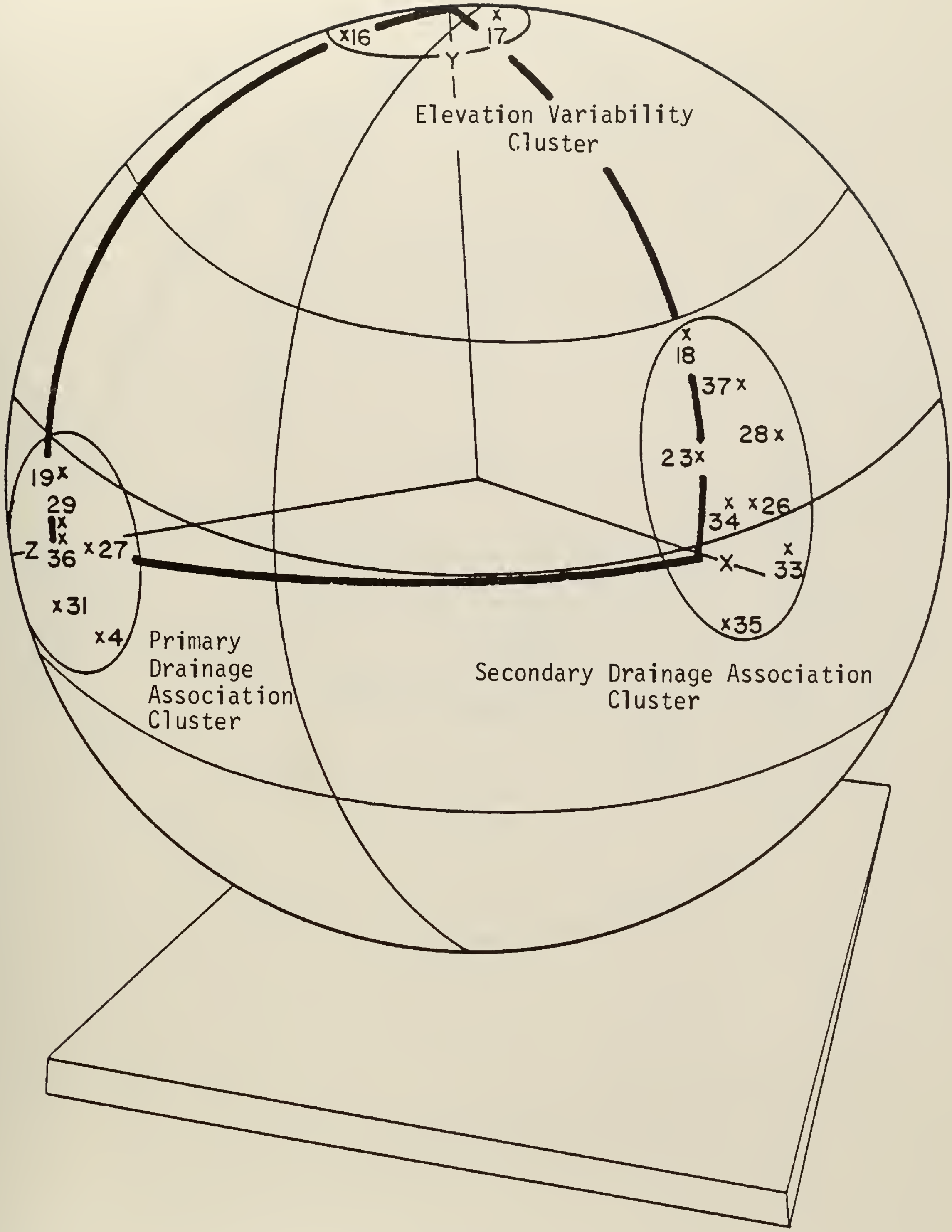


Figure 5

Spherical Graph of the Relationships Among
Final Item Clusters of Site Location

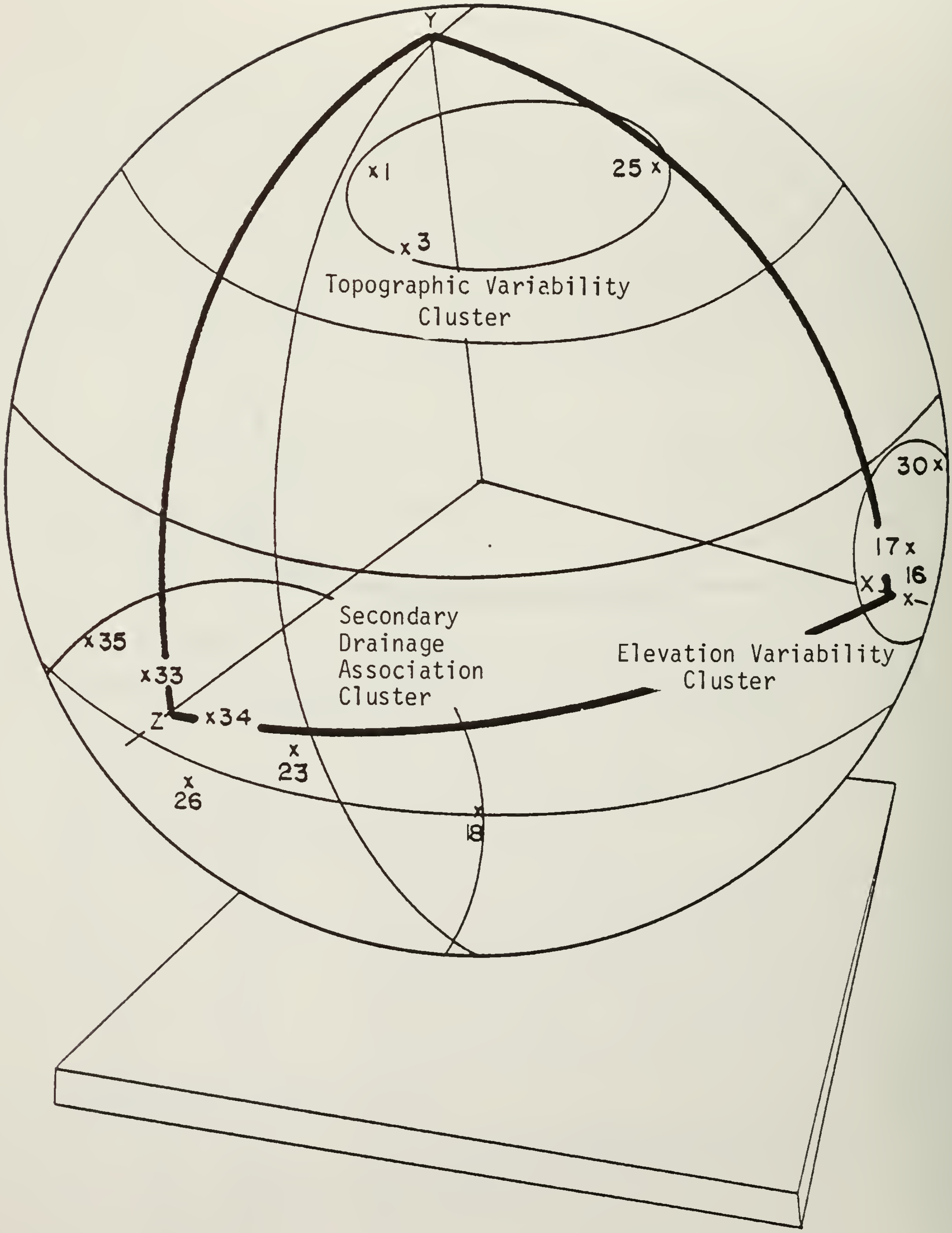


Figure 6

Spherical Graph of the Relationships Among Final Item Clusters of Site Location

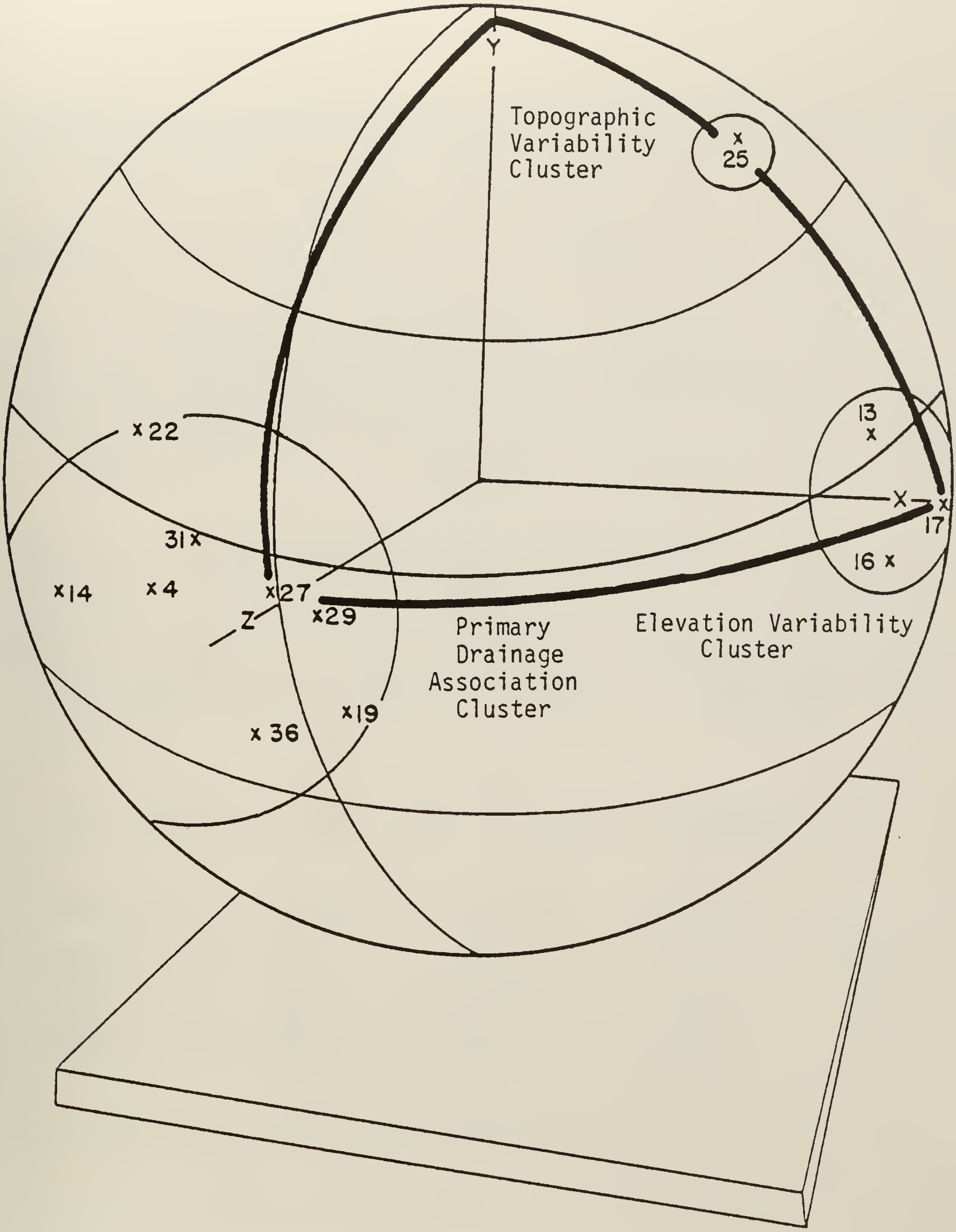


Figure 7

Spherical Graph of the Relationships Among Final Item Clusters of Site Location

The two drainage clusters contain items of measurement, particularly among definers, that are directly related to the expected relationships between site location and drainage. Sites highly correlated with the primary drainage cluster should be located nearest to major stream courses of rank 2, 3, or 4 (the largest stream in the Yellow Creek area is the White River, of rank 2 designation). Sites correlated with the secondary drainage cluster should be found in areas distant from Yellow Creek and its major tributaries.

The nondefiners of each cluster suggest other environmental elements characteristic of each area. For instance, sites highly correlated with the first group should frequently occur in lowland areas in association with big sagebrush shrubland. By implication, sites highly correlated with the second variable are likely to be found in upland areas, where greater diversity may exist among plant communities.

The spherical graph in Figure 5 illustrates the relative independence between the two drainage variables; the estimated correlation between them is -0.3699 (Table 9). The negative value of this correlation score reflects the fact that sites in lowland areas near permanent drainages cannot also be positively correlated with upland areas distant from permanent drainages. Therefore, sites positively correlated with either of these variables will display a low positive or a negative correlation with the other.

Table 9

Estimated Correlations Between Final Variables

	Variable 1	Variable 2	Variable 3	Variable 4
Variable 1	1.0000	-0.3699	-0.2064	-0.0281
Variable 2	-0.3699	1.000	-0.0407	0.3787
Variable 3	-0.2064	-0.0407	1.0000	0.2699
Variable 4	-0.0281	0.3787	0.2699	1.0000

Less independence exists between the secondary drainage cluster and the topographic cluster; the latter lacks absolute independence (see spherical graphs, Figures 6 and 7). Its dependence upon the former is seen in the estimated cluster domain value of 0.3787 (Table 9). This information suggests that areas of significant topographical variation within the Yellow Creek drainage will sometimes, but not always, occur in the uplands. Therefore, sites positively correlated with the secondary drainage cluster may also correlate positively with the topographic cluster.

The spherical graphs illustrated in Figures 5, 6, and 7 represent each dimension in the analysis, and indicate that each cluster is now tight and well-separated from the other clusters. There are inter-domain correlations between clusters still present, because none fall absolutely on the points of the dimensions. Significant independence between any two clusters may be assumed when they do not appear on the same graph. The structure of the clusters indicates that it is now reasonable to proceed to the next step of the analysis.

O-Typing

Sites are classified into types, based upon their scores, with each of the item clusters identified by V-analysis. Each member of a type has a pattern of scores that is similar to every other member. In other areas, other patterns might emerge; if other analytical items were used, sites would be classified differently. Nine types emerged from analysis; each is profiled and described in the following pages.

O-TYPE 1

Figure 8

Environmental Item Cluster Profile

For O-TYPE 1

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites:			
	5RB018	5RB053	5RB096
	019	063	128
	035	069	129
	037	076	
	038	095	

The distinguishing element between O-types 1, 2, and 3 is the manner in which they vary in vertical relief. Sites belonging to O-type 1 display the greatest vertical stability, slightly greater than a full standard deviation below the mean (Figure 8). From Figure 3 it can be seen that these locations may occur in lowland areas, but are also found in broad upland plains, where erosional activity has been minimized. Principal site locations occur at the confluence of Yellow and Duck Creeks, and at the confluence of Stake Springs Draw and Corral Gulch.

5RB076 and 5RB096 are non-aboriginal sites of the historic period, and 5RB129 is an aboriginal site occupied during the post-contact period. The remaining ten sites were occupied prehistorically.

Table 10 lists the standard scores on each variable for each member site in O-type 1. These values approximate the O-type mean, and reflect the internal homogeneity of the group. Appendix C lists the raw scores for each site on the variable definers. By comparing the standard score values from Table 10 with the raw score values from Appendix C, it is possible to determine which item characteristics are contributing to any observed variation in standard scores. Any lack of internal consistency among O-type members is a result of the way in which they are selected by the iteration procedure of the BCTRY system. This selection process is a "best-fit" procedure, and Euclidean distances among the members of any given O-type may vary. It may become necessary to eliminate deviant members to increase internal homogeneity.

Table 10

O-TYPE Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
018	46.5347	41.6592	45.0924	38.1872
019	46.5347	42.4843	43.9927	36.4804
035	47.1470	42.2672	41.2602	38.4460
037	47.1470	43.3001	43.9927	30.6263
038	47.6437	48.0798	43.9261	32.0766
053	47.1470	43.4971	44.2926	33.8894
063	44.6979	54.7893	44.9924	37.3732
069	45.9224	40.2866	51.3183	35.6874
076	47.1470	41.7523	51.7515	30.7472
095	47.1470	40.8729	44.3926	35.8231
096	47.1470	42.2796	43.4929	39.1711
128	44.6979	56.5000	44.9924	33.5268
129	44.6979	55.7943	45.0924	36.3595
Mean	46.4316	45.6587	45.2761	35.2611

In O-type 1, variation in standard score values (Table 10) is apparent on variable 2 for sites 5RB063, 5RB128, and 5RB129. Appendix C reveals that this variation primarily results from divergence in the raw score values for item 26, the distance to the nearest permanent water source. Because of the inconsistency among these values, a decision was made to eliminate the three deviant sites from O-type 1; as a result, the mean score on item 26 of the remaining O-type members was reduced from 1775 m to 728 m. Other changes in mean score values on variable 2 may be noted in Table 19.

Site 5RB069 on the Piceance Creek flood plain near the confluence of Willow Creek (Figure 3) appears to be a deviant from other members of this O-type. However, the unique nature of its position has resulted in part from the fact that few site locations were located along the Piceance Creek periphery. Areas east of the drainage were not investigated.

<u>O-TYPE 2</u>

Figure 9

Environmental Item Cluster Profile

For O-TYPE 2

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	. 30	. 40	. 50	. 60	. 70	. 80	High Topographic Variability

Member Sites	5RB006	5RB036	5RB051	5RB058	5RB124
	009	039	052	059	125
	031	040	054	060	136
	032	044	055	062	142
	033	047	056	066	146
.	034	048	057	123	

As a group, the sites in this O-type are aligned slightly below the median values of each variable as illustrated by Figure 9. In terms of vertical relief, they are located midway between O-types 1 and 3. Site locations occur in upland areas of moderate elevation, often along the crests of broad ridges. Principal localities occur near the confluence of Duck and Yellow Creeks, with smaller site clusters located at the confluences of Corral Gulch and Stake Springs Draw, Corral and Box Elder Gulches, and Stewart Gulch and Piceance Creek (see Figure 3).

5RB031, 5RB044, and 5RB045 are non-aboriginal (historic) sites, and 5RB118 shows evidence of both aboriginal and non-aboriginal occupation. The remaining sites represent aboriginal occupation during the prehistoric period.

Internal homogeneity as illustrated in Table 11 is fairly consistent. All standard scores fall within one standard deviation of the O-type mean scores for each variable. However, from Appendix C it is apparent that a broad range of values exist for item 26 (distance to nearest permanent water source). These values extend from a minimum of 10 m (5RB034) to a maximum of 11600 m (5RB048). For sites 5RB034, 5RB040, 5RB048, 5RB066 and 5RB123, excessive variation on item 26 is compromised by variation on one or more of the other definers of variable 2. As a result, the standard variable score for each site falls within acceptable limits of the mean. Each of these sites was eliminated from the O-type as a deviant, from this observed internal inconsistency on the variable.

Table 11

O-TYPE 2 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
006	48.3715	40.8760	47.0252	44.9043
009	48.3715	40.8062	46.3254	42.2455
031	48.9838	43.2459	42.9597	53.2753
032	48.3715	44.9815	43.1930	49.5288
033	47.1470	45.1799	42.7598	43.2124
034	47.7592	42.6736	43.5928	41.2467
036	47.7592	42.1509	42.9597	41.2935
039	48.3715	43.9516	42.9597	46.7172
040	47.7592	40.2866	44.0927	47.8197
044	47.1470	40.8729	44.3926	42.0187
047	47.7592	40.2075	44.9924	42.0568
048	48.3715	39.7872	45.2257	46.2189
051	47.7592	42.7526	43.6928	43.1064
052	47.7592	42.6596	43.6928	43.1064
054	47.1470	43.0675	44.5926	51.4625
055	47.7592	43.2412	43.9927	48.3413
056	47.7592	44.8201	43.7928	43.6958
057	47.7592	43.5654	43.8928	41.6093
058	47.7592	43.7515	43.7928	40.8842
059	47.7592	44.4603	43.8928	47.0797
060	47.1470	46.2067	44.1593	43.7637
062	47.7592	44.8124	43.7928	44.9043
066	46.5347	44.6836	44.0927	45.6295
123	53.0730	40.7628	39.4274	44.0435
124	46.5347	42.7635	45.2257	46.7172
125	46.5347	42.6704	44.2926	44.5418
136	47.7592	41.2420	46.9252	51.5895
142	44.6979	48.6847	47.8583	46.5285
146	47.7592	41.3444	47.3584	49.2403
Mean	47.7736	42.9832	44.3087	45.4063

O-TYPE 3

As suggested by Figure 10, the members of this group are characterized by a greater degree of vertical relief than those of the preceding types. Sites in O-type 3 most often occur in upland areas of moderate elevation, often along ridgecrests. This pattern is similar to that shown by the site locations of O-type 2, except that vertical relief is more radical, and ridges tend to be narrower with sharply descending sides. Primary locations include the periphery of Piceance Creek near the confluences of Bear and Ryan Gulches, and along Stake Springs Draw downstream from the confluence of Right and Left Forks (see Figure 3).

Figure 10

Environmental Item Cluster Profile

For O-TYPE 3

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites:			
	5RB007	5RB133	5RB143
	073	134	144
	074	135	
	075	138	
	120	139	

All of the member sites of O-type 3 evidence prehistoric aboriginal occupation; 5RB120 was also inhabited during the historic period by non-aboriginals.

Internal homogeneity (Table 12) is acceptable, with the exception of 5RB144. This site deviates on variable 4 by a factor greater than one standard deviation from the mean. Because of the extreme nature of this variance, 5RB144 was eliminated from the O-type.

Table 12

O-TYPE 3 Member Standard Scores on Each of the Final Variables

Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
007	48.3715	40.9784	49.4911	66.1093
073	48.3715	41.2514	43.6928	66.2450
074	48.9838	41.5414	42.6798	58.4104
075	48.9838	41.7740	43.0930	64.6790
120	53.0730	41.0652	41.2602	57.2338
133	47.7592	43.2459	43.8928	64.4322
134	47.1470	44.2106	43.9927	58.2366
135	47.1470	44.9302	44.4926	56.8012
138	44.6979	48.4986	48.3248	54.0386
139	44.6979	48.0969	48.5581	55.4359
143	44.0856	52.8459	47.5584	59.7718
144	43.4734	49.3904	48.3581	71.8425
Mean	47.0376	45.0197	45.5000	60.5436

O-TYPE 4

Figure 11

Environmental Item Cluster Profile

for O-TYPE 4

		30	40	50	60	70	80	
1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic

Member Sites:

5RB 4	5RB 12	5RB 20	5RB 27	5RB141
5	13	21	28	
8	14	24	30	
10	16	25	43	
11	17	26	140	

The sites of O-type 4 are similar in their environmental relationships to those of O-type 2, with the exception that they are located at greater elevations (an average of 147 m). As a result, the associated plant community is high, rather than low, elevation pinyon-juniper woodland. This difference in nomenclature is based upon an elevation break arbitrarily established at 2100 m. Figure 3 illustrates that significant variability is present between each group. The sites of O-type 4 tend to locate further from the primary confluences of Yellow and Piceance Creeks, and site locations are characterized by greater vertical relief (by less than a standard full deviation).

From surface evidence, 5RB004 was primarily occupied during the historic period by non-aboriginals, although some evidence for prehistoric occupation within the site area was also evident. 5RB028 and 5RB141 were occupied prehistorically by aboriginal inhabitants, and again during the historic period by non-aboriginals. The remaining sites of this O-type represent prehistoric occupation by the indigenous aboriginal population.

Internal homogeneity (Table 13) is moderately consistent, with the exception of the standard score on variable 1 for 5RB016. At first glance, this variation of less than one standard deviation appears to be extreme. However, it is based upon the presence of a single, ephemeral drainage of rank 3 within 3 km; slightly more than twice the average of rank 4, ephemeral drainages within 3 km (but only one more than 5RB008, also a member of O-type 4); and a nearest drainage of rank 3, ephemeral. In regard to the latter, the drainage nearest to 5RB016 (Corral Gulch) becomes permanent approximately one mile downstream at its confluence with Dry Fork (Figure 3). In this instance, the difficulties inherent in determining drainage flow during the prehistoric period effectively negate the impact of item 19 (nearest drainage: R 3, ephemeral); therefore, a decision was made to retain 5RB016 as a member of O-type 4.

Member sites of O-type 5 compare in their environmental relationships to those in O-type 2, except that they are more highly associated with secondary drainages (Figure 12), and are generally located further from Yellow and Piceance Creeks (Figure 3). These sites occur in upland areas of moderate elevation, often along the crests of narrow ridges. They are significantly distant from permanent water, and spatially are located midway between sites of O-types 2 and 4. Primary locations occur near the confluence of Trail Canyon and Little Duck Creek, below the confluence of Greasewood Creek and North Fork, midway between Barcus and Yellow Creeks, and along the northern perimeter of Ryan Gulch below its confluence with Wagonroad Gulch.

5RB049, 5RB064, and 5RB093 are historic wild horse traps, and 5RB067 is a non-aboriginal occupation site of the historic period. The remaining sites of this group represent occupation during the prehistoric period.

Table 13

O-TYPE 4 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
004	47.1470	47.6800	68.9209	44.1792
005	47.1470	47.5311	68.5210	45.4938
008	48.3715	40.9830	68.2211	51.4305
010	44.6979	43.4103	69.9206	52.3295
011	44.6979	43.4568	69.6207	48.8926
012	44.6979	43.8399	68.9209	52.9128
013	44.6979	44.0260	69.4874	48.4092
014	44.6979	43.9795	69.4207	46.5433
016	62.2122	44.5347	68.7209	54.8378
017	47.0314	46.0717	70.7537	53.6760
020	45.3102	46.1725	69.0209	49.4671
021	48.8682	45.1023	70.7537	48.3413
024	44.6979	51.3957	69.0209	55.2152
025	44.6979	51.6005	69.2208	54.3162
026	44.6979	51.4981	69.0209	55.2152
027	44.6979	50.3333	68.9209	56.3029
028	44.0856	51.2764	69.0209	52.6391
030	44.6979	49.4540	64.3556	48.6150
043	44.0856	51.4625	68.9209	52.2765
140	44.6979	55.0265	70.2538	55.3890
141	44.6979	53.2786	71.1536	41.9570
Mean	46.2206	47.7197	69.1510	50.8781

O-TYPE 5

Figure 12

Environmental Item Cluster Profile For O-TYPE 5

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites:

5RB002	5RB049	5RB093	5RB121
003	064	094	127
042	065	097	130
045	067	108	131
046	072	109	132

It is evident from Table 14 that internal homogeneity lacks uniformity on variables 2 and 4. 5RB065 is almost a full standard deviation from the mean on variable 2. Its raw scores on all variable definers, as illustrated in Appendix C, compare more favorabley with the mean raw scores for O-type 2. Furthermore, it is located in the vicinity of a cluster of O-type 2 member sites (Figure 3). In an effort to improve the internal consistency of both groups, 5RB065 was removed from O-type 5, and added to O-type 2.

Table 14

O-TYPE 5 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
002	45.3102	57.8492	46.7253	37.4323
003	45.3102	57.7329	46.9252	38.0366
042	44.0856	53.7470	45.9255	45.3199
045	45.3102	59.1195	46.0255	41.3465
046	45.3102	59.2591	45.6256	41.7091
049	44.6979	65.9545	49.4911	35.4987
064	44.6979	55.4407	44.5592	52.1198
065	44.6979	51.9495	44.8925	49.9803
067	44.0856	57.9190	47.5584	48.4622
072	47.7592	67.1536	46.4254	44.9573
093	47.7592	67.1520	46.4254	53.1396
094	44.0856	58.1269	45.3257	56.7504
097	48.3715	62.2450	38.8279	44.0435
108	44.0856	62.3889	46.9252	43.5811
109	44.0856	61.2846	47.3584	49.4290
121	49.5960	63.7339	41.3602	42.7819
127	44.0856	62.4463	46.9252	48.3413
130	44.0856	62.2136	47.4584	50.8793
131	44.0856	62.2602	46.4254	47.9787
132	44.0856	62.0741	46.1254	47.9787
Mean	45.2796	60.5025	45.8655	45.9883

5RB049 and 5RB094 both exceed the mean on variable 4 by a factor greater than one standard deviation (Table 14). Each is characterized by extreme local relief and local slope (Appendix C); both were eliminated from membership in O-type 5.

Although 5RB046 and 5RB067 conform well to the standard score means on each variable, both deviate from the raw score means on the first three definers of variable 2, as illustrated in Appendix C. This deviation is most apparent on item 26, distance to nearest permanent water source. The O-type mean value for item 26 is 4406 m. The raw scores on this item for 5RB046 and 5RB067 are 40 m and 75 m, respectively; both were eliminated from O-type membership.

O-TYPE 6

Figure 13

Environmental Item Cluster Profile
For O-TYPE 6

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites: 5RB070
077
099
100
115

The sites of this group are similar to those of O-type 7. However, they are more closely associated with secondary drainage, (Figure 13) and are slightly higher in elevation (Appendix C). They score lower on the elevation variable (variable 3), because of their relationships to local vegetation. The member sites of this O-type are associated with low elevation pinyon-juniper woodland, an upland community, and a negative variable definer. By contrast, although a mean difference of only 68 m in elevation separates them, member sites of O-type 7 are associated with the lowland plant community, big sagebrush shrubland.

Sites in O-type 6 are primarily located near the confluence of Yellow and Greasewood Creeks (see Figure 3). These areas are found along the margin, between bordering ridge systems and the flood plains of major drainage courses. They are within easy access to permanent water.

Internal consistency is good, with the possible exceptions of the variable 2 standard score for 5RB077, and the variable 4 standard score for 5RB115 (see Table 15). Inspection of the raw score values in Appendix C reveals the reasons for these deviations. 5RB077 scores nearly one standard deviation below the group mean on primary drainage association, because of its distance from the White River, a rank 2 drainage. It is more strongly associated with rank 5, ephemeral drainages, and is located at a greater vertical distance from the nearest drainage than other members of its type. On the basis of these relationships, 5RB077 is a site unique to the general population, and was eliminated from O-type membership.

On the other hand, although 5RB115 exceeds the mean standard score on variable 4 by more than a full standard deviation, it was retained. The raw score values in Appendix C indicate that the major portion of the standard score variance is caused by greater than average local relief. This value has resulted from the fact that the ridge system nearest 5RB115 ascends to a greater elevation than those proximal to other sites of O-type 6, with the exception of 5RB100 which lies along the northwest side. Although 5RB115 is an extreme example of the O-type, its location exposes it to the same micro-environmental elements as other type sites, and it was retained.

Table 15

O-TYPE 6 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
070	68.2419	49.6373	37.3947	56.8713
077	55.7187	56.2461	42.2599	69.1455
099	67.2019	47.6970	45.7256	54.1275
100	65.9429	48.4989	38.3944	55.6010
115	65.4117	52.4864	40.6270	75.4914
Mean	64.5034	50.9131	40.8803	62.2474

O-TYPE 7

Figure 14

Environmental Item Cluster Profile For O-TYPE 7

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites:

5RB 23	5RB103	5RB118
98	104	119
101	116	126
102	117	

With the exception of 5RB023, the sites composing O-type 7 are located along both sides of a narrow northwest-trending ridge, that borders Yellow Creek on the east and extends to the Yellow Creek confluence with the White River. These sites are slightly higher in elevation than those in O-type 6, and are associated with the lowland plant community, big sagebrush shrubland.

5RB126 is an historic occupation camp site, and 5RB103 and 5RB118 are prehistoric sites that were later occupied during the historic period by non-aboriginals. The remaining membership of this O-type represent prehistoric occupation by aboriginal populations.

5RB023 displays the greatest inconsistency in its relationships to the defining variables, particularly on variable 1 (see Table 16). The standard score is between one and two standard deviations below the mean. The raw score values in Appendix C disclose that this site deviates on three of the four defining items of variable 1, on three of the five defining items of variable 2, and two of the three defining items of variable 3. Figure 3 shows its position near the confluence of Corral and Box Elder Gulches; this site is obviously unique to the type; it was eliminated from membership.

Table 16

O-TYPE 7 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
023	63.4367	42.7589	49.1579	49.2403
093	73.4746	40.3099	45.2201	47.4804
101	72.9779	40.2634	45.0201	47.1179
102	73.4746	40.1796	44.0204	45.3051
103	86.4374	40.7845	47.2528	55.0498
104	86.4374	40.8217	46.9529	40.2588
116	86.4374	41.0078	46.8529	40.6214
117	74.2024	40.6263	46.9529	56.7333
118	86.4374	40.4945	46.4531	45.3199
119	85.9407	41.5662	46.4531	37.5470
126	73.7057	40.6356	47.0529	55.1622
Mean	78.4511	40.8589	46.4899	47.2578

O-TYPE 8

O-type 8 has the smallest membership of all the groups originally selected by O-analysis. Its sites are scattered widely throughout the study area. Generally, they are found at higher elevations, in areas of extreme vertical relief, often at the terminus of narrow ridges overlooking prominent drainage courses (see Figure 3). All represent aboriginal occupation during the prehistoric period.

Figure 15

Environmental Item Cluster Profile
For O-TYPE 8

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites: 5RB 22
61
107
137

Table 17 illustrates that internal consistency is solid on variables 1 and 3, but less profound on variables 2 and 4. 5RB107 displays the greatest variability, with a standard score on variable 2 that is slightly greater than one standard deviation above the mean. This value is the result of the location of 5RB107 along Little Spring Creek, not far from the Little Spring Creek confluence with the White River. As a result, it is considerably farther from a permanent water source, and more closely aligned with ephemeral drainages of rank 6. This site is a marginal member of O-type 8, but its physical locale in many respects approximates that of the other member sites, and its scores are consistent on the definers of variables 1, 3, and 4. Therefore, the decision was made to retain it in the type membership.

Table 17

O-TYPE 8 Member Standard Scores on Each of the Final Variables
Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
022	48.8682	45.3815	71.8534	65.8356
061	44.0856	49.3004	72.4865	66.4189
107	48.8682	62.8091	70.2538	76.3991
137	43.4734	50.4977	70.4538	78.8372
Mean	46.3239	51.9972	71.2619	71.8727

O-TYPE 9

In the manner of O-type 8, the sites of O-type 9 are the most unique of those in the sample population. As shown in Figure 16, they are highly associated with secondary drainages, are of moderate elevation, but lie in areas of significant vertical relief. These sites occupy small, horizontal localities in areas of extreme topographic diversification. They occur individually, often at the terminus of a narrow ridge overlooking a prominent drainage course. In this respect, they resemble sites of O-type 8, with the exceptions that they occur at slightly lower elevations, and are substantially more distant from sources of permanent water. Eight of the eleven sites of O-type 9 lie within a four square mile area in the vicinity of the North Fork confluence with Greasewood Creek (Figure 3).

Figure 16

Environmental Item Cluster Profile
For O-TYPE 9

1	Low Association with Primary Drainages	.	.	.	.	.	.	High Association with Primary Drainages
2	Low Association with Secondary Drainages	.	.	.	.	.	.	High Association with Secondary Drainages
3	Low Elevation	.	.	.	.	.	.	High Elevation
4	Low Topographic Variability	.	.	.	.	.	.	High Topographic Variability
		30	40	50	60	70	80	

Member Sites:

5RB 41	5RB110	5RB122
50	111	
71	112	
105	113	
106	114	

All members of this group were occupied prehistorically; 5RB114 also shows evidence of limited occupation by post-contact non-aboriginals.

Internal homogeneity of O-type 9 falls within acceptable limits for this analysis, with the possible exception of the standard score of 5RB122 on variable 3 (Table 18). This statistical variance has resulted from the fact that the site area is slightly higher in elevation than the type average (Appendix C), and is associated with mid-elevation big sagebrush shrubland, rather than the type community which is low-elevation pinyon-juniper woodland. However, low and high elevation pinyon-juniper woodland communities are located nearby, and because of consistent scores on the definers of the other variables, this site was retained as a member of the O-type.

Table 18

O-TYPE 9 Member Standard Scores on Each of the Final Variables Related to Site Location

Site	Variable 1	Variable 2	Variable 3	Variable 4
041	44.0856	73.3913	45.7256	52.3147
050	45.3102	69.5342	45.7256	59.2205
071	44.6979	71.6822	45.5256	64.9686
105	45.3102	74.5761	45.5256	61.9081
106	47.6437	71.0555	47.4584	59.6361
110	47.1470	79.6121	45.6256	63.6983
111	44.6979	73.5122	47.5584	61.9472
112	44.6979	75.1733	46.3254	56.0253
113	44.6979	75.0430	44.9924	60.4821
114	45.3102	73.0269	40.4271	54.9376
122	48.8682	63.8947	59.7492	67.7334
Mean	45.6788	72.7729	46.7853	60.2611

Table 19

A. Raw Score Mean Values for Final O-types on Definers in the Four Variables Related to Site Location

	Variable 1.				Variable 2					Variable 3			Variable 4		
O-TYPE	29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
1	0.1	0.0	5.4	0.0	2.0	0728	3.5	0.9	0.0	0.0	0.8	1959	4.7	1.5	034
2	0.0	0.0	6.0	0.0	2.3	1232	5.1	0.8	0.0	0.0	1.0	2001	6.0	1.9	044
3	0.6	0.0	6.2	0.0	1.1	0759	6.0	0.7	0.0	0.0	1.0	2002	9.4	2.7	081
4	0.1	0.0	4.0	0.0	3.3	1451	6.8	0.7	0.0	0.9	0.1	2149	7.4	2.1	063
5	0.0	0.0	3.3	0.0	8.8	4998	12.8	0.1	0.6	0.0	1.0	2024	6.9	1.9	044
6	11.8	1.0	13.3	0.0	6.5	0715	7.5	1.0	1.0	0.0	1.0	1862	12.5	2.5	055
7	20.5	1.0	17.4	0.5	0.0	0592	2.9	1.0	0.0	0.0	0.0	1773	7.9	2.0	032
8	0.5	0.0	5.8	0.0	7.3	3731	4.8	0.5	0.0	0.8	0.3	2150	11.0	2.8	111
9	0.2	0.0	3.8	0.0	13.8	6265	12.0	0.1	2.0	0.0	1.0	2021	10.4	2.8	050

B. Definer Definitions

Item #	Item	Item #	Item
29	Number of R 3, ephemeral within 3 km	35	Number of R 7, ephemeral within 3 km
27	Number of R 2, permanent within 3 km	17	High elevation pinyon-juniper woodland
31	Number of R 4, ephemeral within 3 km	-16	Low elevation pinyon-juniper woodland
19	Nearest drainage: R 3, ephemeral	13	Site elevation
34	Number of R 6, ephemeral within 3 km	3	Local relief
26	Distance to nearest permanent water source	1	Local slope
33	Number of R 5, ephemeral within 3 km	25	Elevation above nearest drainage
-28	Number of R 3, permanent within 3 km		

CHAPTER V

SUMMARY AND CONCLUSIONS

A total of fifteen sites was eliminated from this analysis, because each displayed significant raw or standard score deviation on a given definer, and/or a given variable. These rejected sites represent 12% of the total population. This figure is considered extreme, probably resulting from the inconsistent application of recording procedures by field personnel, or inaccuracies inherent in the map coverage. It does not negate the value of the methodology; it is based on the general nature of the results.

V-Analysis

Table 19 lists the mean values of the raw score totals for each of the nine types on all variable definers. As items of the extant environment, the definers evaluate the characteristics of drainage, elevation, and topographic variability. These are represented by the four variables identified by the BCTRY system; these represent the elements of modern environment statistically most significant for revealing or predicting site location in the Piceance Creek Basin. The raw score values illustrate the environmental diversity present there.

O-Analysis

Nine taxonomic divisions were developed to represent the site types under investigation; these are based on the selected site sample, and statistically correlated environmental relationships. Descriptions of each follow:

O-type 1

The ten sites of O-type 1 score between one and two standard deviations below the mean, on the variable for topographic variability, but only slightly below the mean on the other three variables. These relationships are reflected in locations of less local relief and slope than all other groups, and a small average distance above nearest drainages (57 m, 62% of area gently sloping, and 32 m respectively). Concomitant with significant vertical stability is the relative proximity to permanent water (728 m), and an average elevation (1959 m), that is exceeded by all groups, with the exception of O-types 6 and 7 (1862 m and 1773 m, respectively). O-type 1 localities occur near the confluence of yellow and Duck Creeks, and Stake Springs Draw and Corral Gulch (Figure 3).

O-type 2

The twenty-four sites of O-type 2 comprise the largest membership of the types identified by this analysis. They are similar to O-type 1 in the pattern of their relationships to the four variables, with the exception that the value for topographic variability is more nearly aligned with the mean. Furthermore, the average distance to permanent water of 1232 m for this group, exceeds the value for O-type 1 by 504 m. Site locations occur not only in the vicinity of O-type 1 sites, but are also found in areas further from the basin interior, near the confluence of Corral and Box Elder Gulches with Stake Springs Draw (Figure 3).

O-type 3

Eleven sites comprise the membership of O-type 3. They differ from O-types 1 and 2 in their relationships to the variable for topographic variability. O-type 3 sites occur in areas where distance above nearest drainages average 81 m, and where vertical relief may exceed 65 m. These localities lie at moderate elevations averaging 2002 m, often along the crests of the narrow ridges bordering Piceance Creek and Stake Springs Draw (Figure 3).

O-type 4

Twenty-one sites are grouped under O-type 4. Environmental relationships are moderate on all but the variable for elevation. The O-type 4 standard score on this variable is nearly two standard deviations above the mean (site elevations average 2001 m). Only the sites of O-type 8 are found to occur at these elevations. O-type 4 site localities lie in upland areas bordering the basin's interior regions between Ryan and Corral Gulches (Figure 3).

O-type 5

The fifteen sites of this group deviate from mean relationships to the environmental variables only in their association to secondary drainages. This value is in excess of one standard deviation above the mean value of 50. Consequently, sites occur in areas where ephemeral drainages of ranks 5 and 6 are most common, and permanent drainages are significantly distant (4998 m, average). These locations are most common along Ryan Gulch below the confluence of Wagon Road Gulch, and near the confluence of Trail Canyon and Little Duck Creek (Figure 3).

O-type 6

Only four sites are contained within O-type 6. They are highly associated with primary drainages and display significant vertical relief. O-type 6 localities occur at lowland elevations which average 1862 m. They are found along the margins of ridge systems bordering the flood plain near the confluence of Yellow Creek and the White River (Figure 3).

O-type 7

O-type 7 sites, ten in number, are highly correlated with primary drainages (almost three standard deviations above the mean), and comprise the only group not directly associated with vegetation communities dominated by pinyon and juniper. They lie among species of the big sagebrush shrubland, at elevations averaging only 1773 m. These areas display moderate vertical relief, and occur along the east and west perimeters of a ridge which borders the east side of Yellow Creek and extends to the White River flood plain (Figure 3).

O-type 8

The four sites comprising O-type 8 are widely scattered throughout the upland perimeter of the basin interior (Figure 3). They are found in areas of extreme elevation (2150 m. average), and vertical relief (averages distance above nearest drainages is 111 m; average local relief may exceed 125 m). Permanent water sources are located at an average distance of 3731 m. This value is only exceeded by O-types 5 and 9. Site localities occur near the termination of narrow ridges, often overlooking prominent drainages.

O-type 9

The eleven sites of O-type 9 correlate highly with the variables for secondary drainage association and topographic variability. They are found to locate further from permanent water sources (6265 m, average) than the sites of all other types. In the manner of the localities of O-type 5, they are found in areas dominated by ephemeral drainages of ranks 5 and 6. Primary locations occur near the North Fork confluence with Greasewood Creek (Figure 3).

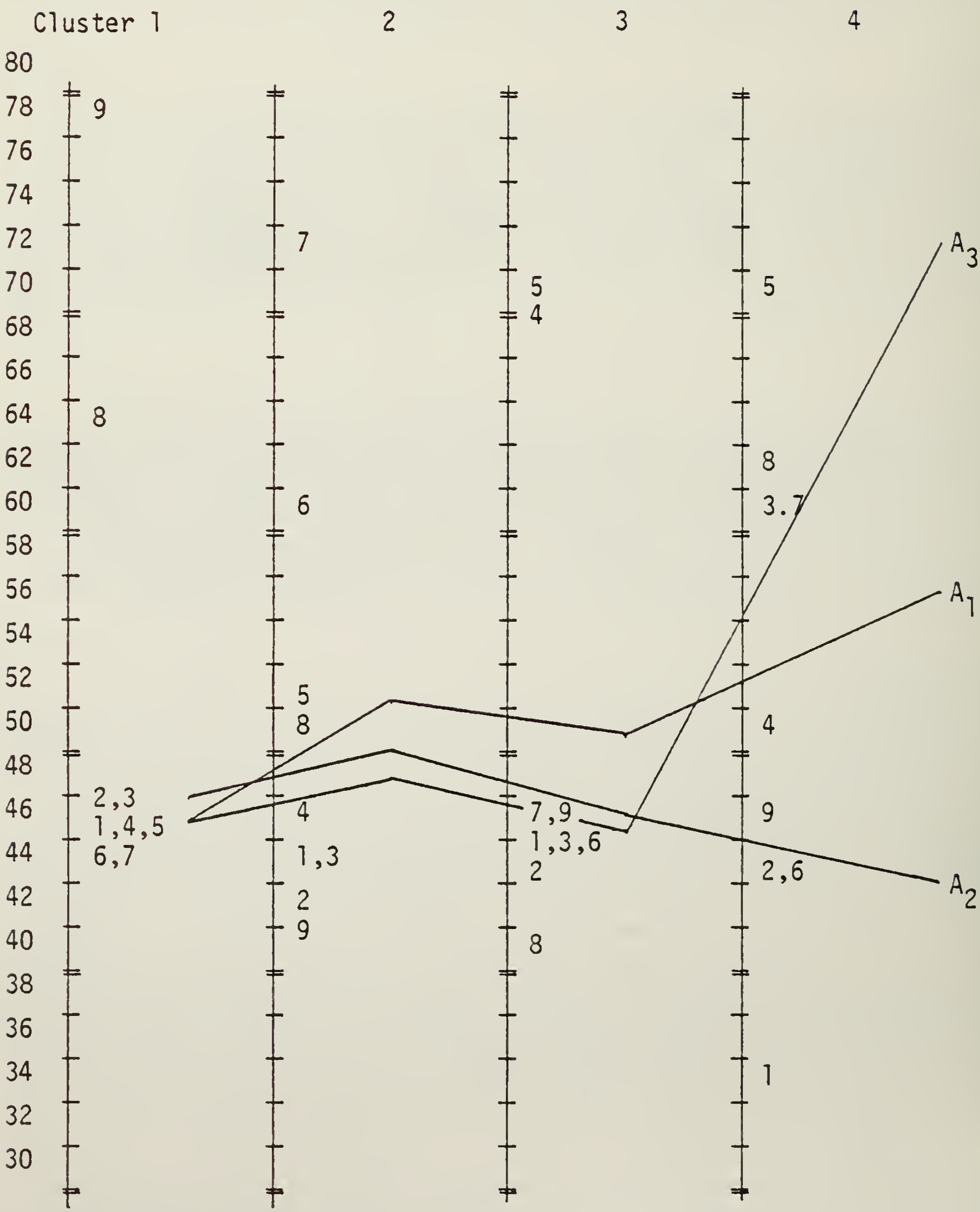
Predictability

The accuracy of the statistical procedures utilized by this analysis may be determined, in part, by a test of predictability - that is, can they be used to predict site location in areas of the region not yet investigated. Tryon and Bailey (1970: 171-173) propose a screening procedure for determining whether a new subject fits into a typology developed by the BCTRY system of cluster analysis; such a method may also be applied to current reconnaissance activities in the basin. The method begins by subdividing each new area of investigation into smaller areas, measuring 1 km along each dimension; each approximates in size the local area utilized by this analysis. These test areas are treated as individual sites; raw definer scores are summed on each of the four variables, and converted to standard scores, with a mean of 50 and standard deviations of 10. If an area is successfully typed by the screening procedure, it may be inferred that sites of that type are likely to occur there.

Individuals are typed by a method that determines with which of the nine O-types it has its lowest Euclidean distance D. This is achieved without the aid of a computer, by using the screening chart in Figure 17. Each variable is represented by a vertical scale of standard scores; the score values of each O-type are represented by a type-number on the scale.

Figure 17

Dimension Scales Illustrating the 9 Types and 3 Test Profiles



Standard scores are plotted for each test individual between the scales, as represented by the three sample subjects in the Figure. To be identified with any given type, an area's standard scores must lie within 1 standard deviation of the average from those of the type. The first step is to determine the scale on which there are the fewest number of types lying within 10 score units (one standard deviation) from the area's scores. When these types are located, the actual amounts of the deviations are summed, and the mean computed. If this mean deviation exceeds 10, the area is unique, and sites are not expected to lie within its boundaries. If there is more than one type that yields a mean of less than 10, the area is assigned to the type with the lowest mean value. Since the Euclidean distance D of an area is the square root of the sum of the squares of the deviation (Tryon and Bailey 1970: 173), the type with which the test area has the smallest mean deviation will also be the type with which it has its smallest Euclidean distance. The calculations necessary for determining a test area's best fit to a type are illustrated below:

1. From the test area profile in Figure 17, select the variable scale on which is located the fewest number of O-types within 10 score units of the test area's standard score on that scale. Count the number of scales on which each of these O-types is located within 10 score units of the test area's standard scores.

2. Select only those O-types that lie within 10 score units of the test area's standard scores on all four scales; read from the scales the value of each deviation, and compute the mean. Thus:

	Area 1	Area 2		Area 3
	O-type 3	O-type 1	O-type 2	Unique
Cluster 1	1	1	0	
2	7	5	8	
3	5	2	3	
4	3	9	1	
Sum	16	17	12	
Mean	4	4.25	3	

On the basis of these hypothetical results, area 1 would be expected to contain sites of O-type 3; area 2 would be expected to contain sites of O-type 2; and area 3 is unique, because none of the established types lay within 10 score units of each of its plotted standard scores.

New sites may be typed by the same procedures.

The conversion of raw scores to standard scores requires the total mean and sigma values for each variable on all definers for the 126 sites investigated by this analysis. Standard scores are determined as follows:

	Total Mean	Total Sigma
Cluster 1	8.4173	11.1364
2	2397.7638	2698.7106
3	2010.5197	119.8356
4	61.8504	39.1848

To illustrate, the standard score Z of area 1 with a raw score total on cluster 1 of 5.5 is

$$Z = 10 \frac{5.5 - 8.4173}{11.1364} + 50 = 47.3804$$

This procedure has not been applied to the Piceance Creek Basin, because of insufficient opportunity for reconnaissance beyond that already completed for this analysis. Its reliability depends on the application of the BCTRY system to an adequate sample of the sites located within a study region. Its utility lies in maximizing an investigator's efforts by statistically identifying areas of high-site potential within a larger zone of investigation, and concentrating his reconnaissance efforts within these selected areas.

REFERENCES

Aikens, C. Melvin

1966 Fremont-Promontory-Plains Relationships. University of Utah Anthropological Papers, No. 82.

1967 Plains Relationships of the Fremont Culture: A Hypothesis. American Antiquity 32: 198-208.

1970 Hogup Cave. University of Utah Anthropological Papers, No. 93.

Ambler, Richard J.

1969 The Temporal Span of the Fremont. Southwestern Lore 34: 107-117.

Anderson, Adrian D. and Larry J. Zimmerman

1976 Settlement--Subsistence Variability in the Glenwood Locality, Southwestern Iowa. Plains Anthropologist 21: 141-154.

Antevs, E.

1955 Geologic-Climatic Dating in the West. American Antiquity 20: 317-355.

Baerreis, D. A. and R. A. Bryson

1965 Climatic Episodes and the Dating of the Mississipean Cultures. Wisconsin Archaeologists 46: 203-220.

Baker, B. D.

1970 Big Game Winter Range Analysis, Game Unit 22--Piceance. In Game Reserve Report, July--Part 1. Colorado Game, Fish and Parks, pp. 15-58.

Baker, B. D. and W. T. McKean

1971 Wildlife Management Unit 22 (Piceance). Colorado Game, Fish and Parks, Research Center and Northeast Regional Office, Fort Collins. Xeroxed.

Beetle, Alan A.

1974 Holocene Changes in Wyoming Vegetation. In Applied Geology and Archaeology: The Holocene History of Wyoming, edited by Michael Wilson. The Geological Survey of Wyoming, Report of Investigations, No. 10: 71-73.

Benedict, James B.

1973 Chronology of Cirque Glaciation, Colorado Front Range. Journal of Quaternary Research 3: 584-599.

1975 Prehistoric Man and Climate: The View From Timberline. In Quaternary Studies, edited by R. P. Suggate and N. M. Cresswell, pp. 67-74. The Royal Society of New Zealand, Wellington.

Binford, Lewis R.
1964 A Consideration of Archaeological Research Design. American Antiquity 29: 425-441.

Bradley, W. H.
1931 Origin and Microfossils of the Oil Shale of the Green River Formation of Colorado and Utah. U.S. Geological Survey Professional Paper 168.

Breed, Charles B.
1957 Surveying. John Wiley and Sons, Inc., New York.

Breternitz, David A., assembler
1970 Archaeological Excavations in Dinosaur National Monument, Colorado-Utah, 1964-65. University of Colorado Studies, Series in Anthropology, No. 17.

Bryson, R. A. and W. M. Wendland
1967 Tentative Climatic Patterns for Some Late Glacial and Post-Glacial Episodes in Central North America. In Life, Land, and Water, edited by W. J. Mayer-Oakes, pp. 271-298. University of Manitoba Press, Winnipeg.

Buckles, William G.
1971 The Uncompahgre Complex: Historic Ute Archaeology and Prehistoric Archaeology on the Uncompahgre Plateau in West Central Colorado. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado.

1974 An Archaeological Survey in the Vicinity of White River City, Rio Blanco County, Colorado. A report for Superior Oil Company, Houston, Texas. Department of Anthropology, Southern Colorado State College. Mimeographed.

Burgh, Robert F. and Charles R. Scoggin
1948 The Archaeology of Castle Park, Dinosaur National Monument. University of Colorado Studies, Series in Anthropology, No. 2.

Cashion, W. E. and John R. Donnell
1974 Revision of Nomenclature of the Upper Part of the Green River Formation, Piceance Creek Basin, Colorado and Eastern Basin, Utah. U.S. Geological Survey Bulletin 1394G.

Ferchau, Hugo
1973 Vegetation of the Piceance Creek Basin. In An Environmental Reconnaissance of the Piceance Creek Basin, Part 1, Phase 1, pp. VI-1 - VI-3. Thorne Ecological Institute, Boulder.

Fox, Charles J.
1973 Soils of the Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. In _An Environmental Reconnaissance of the Piceance Creek Basin, Part 1, Phase 1_, pp. III-1 - III-26. Thorne Ecological Institute, Boulder.

Gunnerson, James H.
1956 Plains-Promontory Relationships. _American Antiquity_ 22: 69-72.

1960 The Fremont Culture: Internal Dimensions and External Relationships. _American Antiquity_ 25: 272-280.

1962 Plateau Shoshonean Prehistory: A Suggested Reconstruction. _American Antiquity_ 28: 41-45.

1969 The Fremont Culture: A Study of Culture Dynamics on the Northern Anasazi Frontier. _Papers of the Peabody Museum of Archaeology and Ethnology_, No. 59.

Hammond, Edwin H.
1964a Analysis of Properties of Land Form Geography: An Application to Broad-Scale Land Form Mapping. _Annals of the Association of American Geographers_ 54: 11-19.

1964b Classes of Land-Surface Forms in the United States. _Annals of the Association of American Geographers_ 54. Map supplement 4. 1:5,000,000.

Huntsberger, David V.
1967 _Elements of Statistical Inference_. Allyn and Bason, Inc., Boston.

Huscher, Harold A.
1939 Influence of the Drainage Pattern of the Uncompahgre Plateau on the Movements of Primitive Peoples. _Southwestern Lore_ 5: 22-41.

Husted, Wilfred M. and Oscar L. Mallory
1967 The Fremont Culture: Its Derivation and Ultimate Fate. _Plains Anthropologist_ 12: 222-232.

Jennings, Calvin H.
1974 Impacts of the Oil Shale Industry on Archaeology and History, Piceance Creek Basin. In _Regional Oil Shale Study: Environmental Inventory, Analysis, and Impact Study, Piceance Creek Basin_. Thorne Ecological Institute, Boulder.

1975a Cultural and Paleontological Resources. Federal Oil Shale Lease Tract C-b. A report for Woodward-Clyde Consultants, Western Region. Department of Anthropology, Colorado State University. Mimeographed.

1975b Personal communication on procedures and methodology applied in sampling Piceance Creek Basin survey region.

Judge, James W.
1973 Paleoindian Occupation of the Central Rio Grand Valley in New Mexico. University of New Mexico Press, Albuquerque.

Krebs, J. Stuart
1975 Personal communication on geographic terminology related to characteristics of slope.

Kroeber, A. L.
1939 Culture and Natural Areas of North America. University of California Press, Los Angeles.

Kuchler, A. W.
1964 Potential natural vegetation of the conterminous United States. American Geographical Society, Special Publication No. 36.

Landon, Robert E.
1973 Surface Geology and Geomorphology of the Piceance Creek Basin. In An Environmental Reconnaissance of the Piceance Creek Basin, Part 1, Phase 1, pp. II-1 - II-33. Thorne Ecological Institute, Boulder.

Leach, Larry L.
1967 Archaeological Investigations of Deluge Shelter, Dinosaur National Monument. Clearinghouse for Federal Scientific and Technical Information, Publication PB 176 960. Department of Commerce, Springfield.

Lister, Robert H.
1951 Excavations at Hell's Midden, Dinosaur National Monument. University of Colorado Studies, Series in Anthropology, No. 3.

Marlatt, William E.
1973 Climate of the Piceance Creek Basin. In An Environmental Reconnaissance of the Piceance Creek Basin, Part 1, Phase 1, pp. IV-1 - IV-63. Thorne Ecological Institute, Boulder.

Martin, Paul S.
1963 The Last 10,000 Years: A Fossil Record of the American Southwest. University of Arizona Press, Tucson.

Meiman, James R.
1973 Surface Runoff and Snow Cover in the Piceance Creek Basin. In An Environmental Reconnaissance of the Piceance Creek Basin, Part 1, Phase 1, pp. V-1 - V-64. Thorne Ecological Institute, Boulder.

Moriss, M. S. and R. L. Dix
1971 Natural vegetation of Colorado map (1:500,000) with 10 mapping units. Department of Botany and Plant Pathology, Colorado State University.

Morss, Noel
1931 The Ancient Culture of the Fremont River in Utah. Papers of the Peabody Museum of Archaeology and Ethnology. No. 12.

Mueller, James W.
1974 The Use of Sampling in Archaeological Survey. American Antiquity 39: 1-91.

Oetting, E. R., C. W. Cole and C. D. Miller
1974 Social Systems Intervention Improving Work Adjustment of the Disadvantaged, Vol. 5. Experimental Manpower Laboratory, Colorado State University. Mimeographed.

Olson, Alan P., Thomas G. Bridge, Christopher Craig, Betty LeFree and Sue Strenrod
1975 An Archaeological Survey Assessment for Rio Blanco Oil Shale Project. A report for Gulf Oil Corporation and Standard Oil Company (Indiana). Department of Anthropology, University of Denver. Mimeographed.

Plog, Stephen
1975 Sampling in Archaeological Surveys: A Critique of Mueller. Department of Anthropology, Colorado State University. Xeroxed.

Plog, Fred and James N. Hill
1971 Explaining Variability in the Distribution of Sites. In The Distribution of Prehistoric Population Aggregates, edited by George J. Gumerman. Prescott College Press, Prescott.

Schoenwetter, James
1970 Archaeological Pollen Studies of the Colorado Plateau. American Antiquity 35: 35-48.

1974 Pollen Records of Guila Naquitz Cave. American Antiquity 39: 292-303.

Sjogren, Douglas D.
1976 Personal communication on the BCTRY system of cluster and factor analysis.

Steward, Julian H.
1937 Ancient Caves of the Great Salt Lake Region. Bureau of American Ethnology Bulletin, No. 16.

Tryon, Robert C. and Daniel E. Bailey
1970 Cluster Analysis. McGraw-Hill Book Company, San Francisco.

Ward, Richard T., William Slauson and Ralph L. Dix
1974 The Natural Vegetation in the Landscape of the Colorado Oil Shale Region. In Surface Rehabilitation of Land Disturbances Resulting from Oil Shale Development, edited by C. Wayne Cook. Technical Report Series, No. 1. Environmental Resources Center. Colorado State University: 30-66.

Wedel, Waldo R.
1967 Review of "Fremont-Promontory-Plains Relationships in Northern Utah." American Journal of Archaeology 71: 426-427.

Wenger, Gilbert
1956 An Archaeological Survey of Southern Blue Mountain and Douglas Creek in Northwestern Colorado. Unpublished M.A. thesis. Department of Anthropology, University of Denver.

Wood, W. Raymond
1976 Vegetational Reconstruction and Climatic Episodes. American Antiquity 41: 206-207.

Wormington, H. M.
1955 A Reappraisal of the Fremont Culture with a Summary of the Archaeology of the Northern Periphery. Denver Museum of Natural History. Proceedings, No. 1.

1957 Ancient Man in North America. Denver Museum of Natural History. Popular Series, No. 4.

Wormington, H. M. and Robert H. Lister
1956 Archaeological Investigations on the Uncompahgre Plateau in Western Colorado. Denver Museum of Natural History. Proceedings, No. 2.

APPENDIX A

Chi-square Values; Degrees of Freedom; Cell Values; and Contingency Tables (Observed versus Expected Frequencies).

Case 1: Local Slope — Chi-Square Value: 47.55

Cell Values: — Degrees of Freedom: 3

1. More than 75% of area gently sloping.
2. 51-75% of area gently sloping.
3. 25-50% of area gently sloping.
4. Less than 25% of area gently sloping.

Contingency Table:

18.0	75.0	32.0	2.0
31.8	31.8	31.8	31.8

Case 2: Site Slope — Chi-Square Value: 64.20

Cell Values: — Degrees of Freedom: 3

1. 0-5%
2. 6-10%
3. 11-15%
4. 16-20%

Contingency Table:

89.0	26.0	9.0	3.0
31.8	31.8	31.8	31.8

Case 3: Local Relief — Chi-Square Value: 65.02

Cell Values: — Degrees of Freedom: 16

1. 0-40 feet
2. 41-80
3. 81-120
4. 121-160
5. 161-200
6. 201-240
7. 241-280
8. 281-320
9. 321-360
10. 361-400
11. 401-440
12. 441-480
13. 481-520
14. 521-560
15. 561-600
16. 601-640
17. 641-680

Contingency Table:

0.0	0.0	2.0	12.0	10.0	25.0	21.0	12.0	16.0
7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5

13.0	5.0	4.0	2.0	3.0	1.0	0.0	1.0
7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5

Case 4: Profile Type   Chi-Square Value: 15.71

Cell Values: Degrees of Freedom: 3

1. More than 75% of gentle slope in lowland.
2. 51-75% of gentle slope in lowland.
3. 51-75% of gentle slope in upland.
4. More than 75% of gentle slope in upland.

Contingency Table:

13.0	24.0	34.0	56.0
31.8	31.8	31.8	31.8

Case 5: Aspect   Chi-Square Value: 17.16

Cell Values: Degrees of Freedom: 7

1. North   3. East   5. Northwest   7. Southwest
2. South   4. West   6. Northeast   8. Southeast

Contingency Table:

7.0	31.0	15.0	5.0	13.0	19.0	12.0	25.0
15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

Case 6: Site Elevation   Chi-Square Value: 28.98

Cell Values: Degrees of Freedom:

1. 1700-1800M   3. 1901-2000   5. 2101-2200
2. 1801-1900   4. 2001-2100   6. 2201-2300

Contingency Table:

11.0	8.0	43.0	36.0	23.0	6.0
21.2	21.2	21.2	21.2	21.2	21.2

Case 7: Plant Communities   Chi-Square Value: 21.63

Cell Values: Degrees of Freedom: 2

1. Lowland Communities
2. Upland Communities
3. Lowland and Upland Communities

Contingency Table:

12.0	55.0	60.0
42.3	42.3	42.3

Case 8: Lowland Plant Communities Chi-Square Value: 51.68

Cell Values: Degrees of Freedom: 2

1. None
2. Big Sagebrush Shrubland
3. Greasewood Shrubland

Contingency Table:

55.0	72.0	0.0
42.3	42.3	42.3

Case 9: Upland Plant Communities Chi-Square Value: 130.17

Cell Values: Degrees of Freedom: 7

1. None
2. Low Elevation Big Sagebrush Shrubland
3. Mid Elevation Big Sagebrush Shrubland
4. High Elevation Big Sagebrush Shrubland
5. Oakbrush Shrubland
6. Serviceberry Shrubland
7. Low Elevation Pinyon-Juniper Woodland
8. High Elevation Pinyon-Juniper Woodland

Contingency Table:

12.0	0.0	1.0	0.0	0.0	0.0	89.0	25.0
15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

Case 10: Drainage Configuration Chi-Square Value: 99.63

Cell Values: Degrees of Freedom: 11

1. Rank 1, permanent
2. Rank 1, ephemeral
3. Rank 2, permanent
4. Rank 4, ephemeral
5. Rank 3, permanent
6. Rank 3, ephemeral
7. Rank 4, permanent
8. Rank 4, ephemeral
9. Rank 5, permanent
10. Rank 5, ephemeral
11. Rank 6, permanent
12. Rank 6, ephemeral

Contingency Table:

0.0	0.0	0.0	0.0	25.0	7.0	12.0	38.0
10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6

0.0	36.0	0.0	9.0
10.6	10.6	10.6	10.6

Case 11: Drainage Configuration   Chi-Square Value: 64.98

Cell Values: Degrees of Freedom: 5

1. Rank 1, permanent and ephemeral
2. Rank 2, permanent and ephemeral
3. Rank 3, permanent and ephemeral
4. Rank 4, permanent and ephemeral
5. Rank 5, permanent and ephemeral
6. Rank 6, permanent and ephemeral

Contingency Table:

0.0	0.0	32.0	50.0	36.0	9.0
21.2	21.2	21.2	21.2	21.2	21.2

Case 12: Distance to Nearest Drainage   Chi-Square Value: 48.43

Cell Values: Degrees of Freedom: 7

1.	0-150 M	4.	451-600	7.	901-1050
2.	151-300	5.	601-750	8.	1051-1200
3.	301-450	6.	751-900		

Contingency Table:

32.0	38.0	24.0	17.0	9.0	2.0	3.0	2.0
15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

Case 13: Elevation Above Nearest Drainage   Chi-Square Value: 31.32

Cell Values: Degrees of Freedom: 7

1.	0-20M	4.	61-80	7.	121-140
2.	21-40	5.	81-100	8.	141-160
3.	41-60	6.	101-120		

Contingency Table:

25.0	34.0	25.0	13.0	17.0	6.0	4.0	3.0
15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

Case 14: <u>Distance to Nearest Permanent Water Source</u> Chi-Square Value: 87.27

Cell Values: Degrees of Freedom: 23

1. 0-500M	7. 3001-3500	13. 6001-6500	19. 9001-9500
2. 501-1000	8. 3501-4000	14. 6501-7000	20. 9501-10000
3. 1001-1500	9. 4001-4500	15. 7001-7500	21. 10001-10500
4. 1501-2000	10. 4501-5000	16. 7501-8000	22. 10501-11000
5. 2001-2500	11. 5001-5500	17. 8001-8500	23. 11001-11500
6. 2501-3000	12. 5501-6000	18. 8501-9000	24. 11501-12000

Contingency Table:

35.0	18.0	16.0	17.0	4.0	4.0	5.0	3.0
5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
2.0	0.0	2.0	2.0	3.0	0.0	2.0	6.0
5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
4.0	1.0	2.0	0.0	0.0	0.0	0.0	1.0
5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3

Case 15: <u>Intersite Relationships Within 1 km</u> Chi-Square Value: 47.11

Cell Values: Degrees of Freedom: 4

1. 0-1	4. 6-7
2. 2-3	5. 8-9
3. 4-5	

Contingency Table:

70.0	23.0	23.0	7.0	4.0
25.4	25.4	25.4	25.4	25.4

Case 16: <u>Intersite Relationships Within 3 km</u> Chi-Square Value: 31.78

Cell Values: Degrees of Freedom: 7

1. 0-2	4. 9-11	7. 18-20
2. 3-5	5. 12-14	8. 21-23
3. 608	6. 15-17	

Contingency Table:

21.0	18.0	29.0	23.0	24.0	8.0	2.0	2.0
15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

APPENDIX B

Sum, Mean, and Sigma Values for 37 Item Variables Investigated by Cluster Analysis (N=127)

Item #	Sum		Mean		Sigma
1	272.0	2.1417	(46.5% of area gently sloping)	0.6608	(16.5%)
2	180.0	1.4173	(7.1% slope)	0.7257	(3.6%)
3	974.0	7.6693	(306.8 ft.)	2.6681	(106.7 ft.)
4	387.0	3.0472	(78.5% of gentle slope in upland)	1.0184	(25.5%)
5	7.0	0.0551		0.2282	
6	31.0	0.2441		0.4295	
7	15.0	0.1181		0.3227	
8	5.0	0.0394		0.1945	
9	13.0	0.1024		0.3031	
10	19.0	0.1496		0.3567	
11	12.0	0.0945		0.2925	
12	25.0	0.1969		0.3976	
13	255222.0	2009.6220M		118.9801M	
14	72.0	0.5669		0.4955	
15	1.0	0.0079		0.0884	
16	89.0	0.7008		0.4579	
17	25.0	0.1969		0.3976	
18	25.0	0.1969		0.3976	
19	7.0	0.0551		0.2282	
20	12.0	0.0945		0.2925	
21	38.0	0.2992		0.4579	
22	36.0	0.2835		0.4507	
23	9.0	0.0709		0.2566	
24	43601.0	343.3150M		244.4530M	
25	6609.0	52.0394M		35.8559M	
26	302895.0	2385.0000M		2687.7914M	
27	14.0	0.1102		0.3132	
28	76.0	0.5984		0.4902	
29	275.0	2.1654		5.8495	
30	59.0	0.4646		0.6616	
31	773.0	6.0866		4.7455	
32	2.0	0.0157		0.1245	
33	926.0	7.2913		4.7853	
34	579.0	4.5591		4.8141	
35	40.0	0.3150		0.8296	
36	286.0	2.2520		2.2058	
37	1045.0	8.2283		4.8654	

APPENDIX C

Raw Site Scores (Grouped by Original O-Types) on Each of the Definers in the Final Four Variables Related to Site Location

		VARIABLE 1				VARIABLE 2					VARIABLE 3			VARIABLE 4		
	Site	29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
O-TYPE 1	018	00	00	05	00	00	1600	03	01	00	00	01	1999	03	01	079
	019	00	00	05	00	03	0250	04	01	00	00	01	1966	05	01	038
	035	00	00	00	00	02	0450	04	01	00	00	01	1935	04	02	037
	037	01	00	06	00	02	1900	03	00	00	00	01	1964	04	01	015
	038	00	00	08	00	02	0700	07	01	00	00	01	1935	06	02	055
	053	00	00	06	00	03	2000	02	01	00	00	01	2000	06	03	040
	063	00	00	02	00	04	4200	11	00	00	00	01	1983	07	03	032
	069	00	00	04	00	00	0125	03	01	00	00	00	1926	06	01	018
	076	00	00	06	00	03	0025	03	01	00	00	00	1939	04	01	004
	095	00	00	06	00	02	0200	02	01	00	00	01	1978	04	01	046
	096	00	00	06	00	03	0030	04	01	00	00	01	1951	05	02	006
	128	00	00	02	00	04	5900	10	00	00	00	01	1996	04	01	027
	129	00	00	02	00	03	5700	10	00	00	00	01	1999	05	01	037
	Mean	0.1	0.0	4.5	0.0	2.4	1775	5.1	0.7	0.0	0.0	0.9	1967	4.8	1.5	033
O-TYPE 2	006	00	00	08	00	01	0200	03	01	00	00	01	2057	06	02	040
	009	00	00	08	00	01	0125	03	01	00	00	01	2036	06	02	018
	031	00	00	08	00	02	1250	08	01	00	00	01	1942	06	03	024
	032	00	01	06	00	03	0900	08	01	00	00	01	1929	06	02	026
	033	00	00	07	00	02	0450	05	01	00	00	01	1954	06	01	064
	034	00	00	06	00	01	0010	06	01	00	00	01	1884	05	02	000
	036	00	00	06	00	03	2250	02	01	00	00	01	1966	04	01	003
	039	00	00	07	00	01	0690	01	01	00	00	01	1969	04	02	091
	040	00	00	01	00	16	8625	14	00	02	00	01	2018	09	02	061
	044	00	00	03	00	07	3800	10	00	01	00	01	2027	05	02	024
	047	00	00	08	00	00	0150	02	01	00	00	01	2003	08	02	024
	048	00	00	02	00	14	11600	08	00	00	00	01	2131	07	01	003
	051	00	00	07	00	03	1000	03	01	00	00	01	1957	04	02	052

	Site	VARIABLE 1				VARIABLE 2					VARIABLE 3			VARIABLE 4		
		29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
O-TYPE 2 (continued)	052	00	00	06	00	03	1900	03	01	00	00	01	1975	04	01	030
	054	00	00	07	00	03	1625	03	01	00	00	01	1966	07	02	055
	055	00	00	07	00	03	1075	07	01	00	00	01	1960	06	02	030
	056	00	00	07	00	03	0850	05	01	00	00	01	1963	06	01	067
	057	00	00	07	00	03	1050	05	01	00	00	01	1960	06	01	061
	058	00	00	07	00	03	1250	06	01	00	00	01	1963	06	02	058
	059	00	00	06	00	02	2000	09	01	00	00	01	1971	05	02	044
	060	00	00	01	00	02	2650	04	00	00	01	00	2262	10	03	110
	062	00	00	02	00	04	3500	11	00	00	00	01	1996	03	02	018
	066	00	00	01	00	08	8000	05	00	00	00	01	2073	07	02	056
	123	07	00	10	00	00	0075	04	01	00	00	01	1829	08	02	006
	124	00	00	05	00	03	0550	04	01	00	00	01	2003	06	02	055
	125	00	00	05	00	03	0450	04	01	00	00	01	1975	06	02	037
	136	00	00	07	00	00	0590	04	01	00	00	01	2054	09	02	055
	142	00	00	02	00	01	0300	08	00	00	00	01	2082	07	02	040
	146	00	00	07	00	00	0700	04	01	00	00	01	2067	08	02	049
	Mean	0.2	0.0	5.7	0;0	3.3	1987	5.5	0.8	0.1	0.0	1.0	1999	6.2	1.9	041
O-TYPE 3	007	00	00	08	00	01	0310	03	01	00	00	01	2131	11	03	094
	073	00	00	08	00	00	0600	04	01	00	00	01	1957	09	03	122
	074	00	00	09	00	00	0350	05	01	00	00	01	1926	10	02	098
	075	00	00	09	00	00	0600	05	01	00	00	01	1939	11	03	082
	120	07	00	10	00	00	0400	04	01	00	00	01	1884	10	03	034
	133	00	00	07	00	01	0500	07	01	00	00	01	1963	09	03	107
	134	00	00	06	00	01	0975	08	01	00	00	01	1966	09	02	110
	135	00	00	06	00	02	1190	08	01	00	00	01	1981	07	02	125
	138	00	00	02	00	01	0100	08	00	00	00	01	2096	09	03	021
	139	00	00	02	00	01	0230	07	00	00	00	01	2103	08	03	046
	143	00	00	01	00	05	3100	07	00	00	00	01	2073	10	03	055
	144	00	00	00	00	02	0500	08	00	00	00	01	2097	12	03	128
	Mean	0.6	0.0	5.7	0.0	1.2	0738	6.2	0.7	0.0	0.0	1.0	2010	9.6	2.8	085

		VARIABLE 1				VARIABLE 2					VARIABLE 3			VARIABLE 4		
	Site	29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
O-TYPE 4	004	00	00	06	00	06	1350	09	01	00	01	00	2155	06	02	034
	005	00	00	06	00	06	1190	09	01	00	01	00	2134	08	02	018
	008	00	00	08	00	01	0315	03	01	00	01	00	2134	06	02	094
	010	00	00	02	00	01	1800	05	01	00	01	00	2185	07	02	088
	011	00	00	02	00	01	1850	05	01	00	01	00	2176	06	02	073
	012	00	00	02	00	01	1700	06	01	00	01	00	2155	06	03	052
	013	00	00	02	00	01	1900	06	01	00	01	00	2172	06	02	069
	014	00	00	02	00	01	1850	06	01	00	01	00	2170	05	02	067
	016	01	00	09	01	02	2450	05	01	00	01	00	2149	11	02	055
	017	01	00	05	00	04	1300	08	01	00	01	00	2210	09	03	018
	020	00	00	03	00	05	0850	08	01	00	01	00	2158	10	02	024
	021	01	00	08	00	06	1950	03	01	00	01	00	2210	07	02	055
	024	00	00	02	00	05	0980	08	00	00	01	00	2158	09	02	085
	025	00	00	02	00	05	1200	08	00	00	01	00	2164	08	02	091
	026	00	00	02	00	05	1090	08	00	00	01	00	2158	09	02	085
	027	00	00	02	00	05	0400	07	00	00	01	00	2155	09	02	094
	028	00	00	01	00	01	1400	11	00	00	01	00	2158	06	02	104
	030	00	00	09	00	01	0500	07	01	00	00	01	1935	06	03	055
	043	00	00	06	00	02	0200	02	01	00	00	01	1978	04	02	043
	140	00	00	02	00	06	3200	10	00	00	01	00	2195	10	02	073
	141	00	00	02	00	04	3000	09	00	00	01	00	2222	08	01	043
	Mean	0.1	0.0	4.0	0.0	3.3	1451	6.8	0.7	0.0	0.9	0.1	2149	7.4	2.1	063
O-TYPE 5	002	00	00	03	00	08	3000	08	00	01	00	01	2048	07	01	019
	003	00	00	03	00	08	2875	08	00	01	00	01	2054	07	01	024
	042	00	00	01	00	01	1600	11	00	00	01	00	2155	06	02	101
	045	00	00	03	00	07	3950	10	00	01	00	01	2015	05	02	027
	046	00	00	07	00	00	0040	03	01	00	00	01	1996	07	02	003
	049	00	00	03	00	10	7700	20	00	01	00	01	2018	11	03	037
	064	00	00	02	00	02	3250	08	00	00	00	01	1993	06	02	082
	065	00	00	05	00	03	1490	06	01	00	00	01	1969	06	02	046
	067	00	00	02	00	02	0075	05	00	00	00	01	2030	10	03	006

		VARIABLE 1				VARIABLE 2					VARIABLE 3			VARIABLE 4		
	Site	29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
O-TYPE 5 (continued)	072	00	00	07	00	10	4450	27	00	00	00	01	2039	07	02	027
	093	00	00	07	00	10	5010	26	00	00	00	01	2039	08	03	027
	094	00	00	01	00	05	3850	10	00	01	00	01	2006	10	03	030
	097	00	00	08	00	10	2240	14	01	03	00	01	1811	08	02	006
	108	00	00	01	00	11	8320	10	00	00	00	01	2054	09	01	043
	109	00	00	01	00	09	8250	10	00	00	00	01	2067	07	02	064
	121	00	00	10	00	12	1600	16	01	03	00	01	1887	07	02	009
	127	00	00	01	00	11	7820	11	00	00	00	01	2054	07	02	055
	130	00	00	01	00	11	7570	11	00	00	00	01	2070	07	02	076
	131	00	00	01	00	11	7620	11	00	00	00	01	2039	07	02	052
	132	00	00	01	00	11	7420	11	00	00	00	01	2030	07	02	052
	Mean	0.0	0.0	3.4	0.0	7.6	4406	11.8	0.2	0.6	0.0	1.0	2019	7.4	2.0	039
O-TYPE 6	070	09	01	18	00	05	0210	10	01	01	00	01	1768	10	03	031
	077	00	00	20	00	07	1010	25	01	00	00	01	1914	09	03	146
	099	18	01	09	00	06	0375	05	01	01	00	01	2018	09	02	076
	100	13	01	11	00	06	0675	06	01	01	00	01	1798	14	02	021
	115	07	01	15	00	09	1600	09	01	01	00	01	1865	17	03	091
	Mean	9.4	0.8	14.6	0.0	6.6	0774	11.0	1.0	0.8	0.0	1.0	1873	11.8	2.6	073
O-TYPE 7	023	01	00	11	01	01	1100	05	01	00	00	01	2121	08	02	049
	098	22	01	16	00	00	0150	03	01	00	00	00	1743	09	02	021
	101	21	01	16	00	00	0100	03	01	00	00	00	1737	09	02	018
	102	22	01	16	00	00	0010	03	01	00	00	00	1707	09	02	003
	103	20	01	18	01	00	0660	03	01	00	00	00	1804	15	02	003
	104	20	01	18	01	00	0700	03	01	00	00	00	1795	05	02	015
	116	20	01	18	01	00	0900	03	01	00	00	00	1792	05	02	018
	117	21	01	18	00	00	0490	03	01	00	00	00	1795	08	02	111
	118	20	01	18	01	00	0910	02	01	00	00	00	1780	07	02	030
	119	19	01	18	01	00	1500	03	01	00	00	00	1780	04	02	006
	126	20	01	18	00	00	0500	03	01	00	00	00	1798	08	02	098
	Mean	18.7	0.9	16.8	0.5	0.1	0638	3.1	1.0	0.0	0.0	0.1	1805	7.9	2.0	034

		VARIABLE 1				VARIABLE 2					VARIABLE 3			VARIABLE 4		
	Site	29	27	31	19	34	26	33	-28	35	17	-16	13	3	1	25
O-TYPE 8	022	01	00	08	00	06	2250	03	01	00	01	00	2243	11	02	146
	061	00	00	07	00	02	1625	07	01	00	00	01	1960	06	02	040
	107	01	00	08	00	16	9350	04	00	00	01	00	2195	13	04	098
	137	00	00	00	00	05	1700	05	00	00	01	00	2201	14	03	159
	Mean	0.5	0.0	5.8	0.0	7.3	3731	4.8	0.5	0.0	0.8	0.3	2150	11.0	2.8	111
O-TYPE 9	041	00	00	01	00	03	3500	10	00	00	00	01	2024	07	02	030
	050	00	00	07	00	03	1100	03	01	00	00	01	1957	04	02	052
	071	00	00	02	00	16	7220	19	00	01	00	01	2012	10	03	098
	105	00	00	03	00	15	5100	12	00	04	00	01	2012	13	04	018
	106	01	00	06	00	16	7800	11	00	02	00	01	2070	12	03	027
	110	00	00	06	00	18	8275	13	00	04	00	01	2015	14	02	088
	111	00	00	02	00	18	8200	13	00	02	00	01	2073	10	03	073
	112	00	00	02	00	17	6180	15	00	03	00	01	2036	10	03	024
	113	00	00	02	00	17	6040	15	00	03	00	01	1996	12	03	034
	114	00	00	03	00	11	6100	17	00	03	00	01	1859	10	03	015
	122	01	00	08	00	18	9400	04	00	00	00	00	2179	12	03	094
	Mean	0.2	0.0	3.8	0.0	13.8	6265	12.0	0.1	2.0	0.0	1.0	2021	10.4	2.8	050

. Government Printing Office: 1977-779-784/223 Region 8

s Card

onstraint and settlement
Northwestern Colorado.

r	Division	Date Ret'd
ublic Lib	TLC	1/18-90

DSC 1279-3a (Feb. 1977)

STATE OF COLORADO